

EXHIBIT 1

A1-A13

Exhibit A1

Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262 to TGN Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGN Sync Proposal 2005"), Alone or in Combination With PHY Updates to TGN Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005) ("2005 TGN Sync PHY Updates"), TGN Sync Complete Proposal, Document No. IEEE 802.11-04/888r9 (March 4, 2005) ("2005 TGN Sync Proposal Presentation"), and/or TGN Sync Proposal, Document No. IEEE 802.11-04/888r0 (August 13, 2004) ("TGN Sync 2004") (collectively, "TGN Sync Proposal")

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by the TGN Sync Proposal¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of the TGN Sync Proposal standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of the TGN Sync Proposal in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ TGN Sync Proposal 2005 published and made publicly available at least as early as May 18, 2005.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 8,675,754 to Yonge, III et al. (“Yonge”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosures in the TGn Sync Proposal
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent that the preamble is limiting, TGn Sync Proposal 2005 disclosed a wireless OFDM transceiver. See, e.g.:

Claim Elements	Disclosures in the TGn Sync Proposal
	“Our proposal support full backwards compatibility with existing 802.11a/b/g standards. Our preamble design support PHY layer interoperability with the OFDM preamble from 802.11a/g, while providing a robust mechanism for synchronization of the high throughput data.” [TGn Sync Proposal 2005 at 17]

Table 18: Summary of OFDM parameters

11.1.1.2.1 Direct Map MIMO Overview

Direct map MIMO is the simplest antenna mapping transformation. The Q-matrix is simply the identity mapping, i.e. each spatial stream maps to one antenna. Hence, there is a one-to-one correspondence between spatial streams and transmit antennas. Figure 22 illustrates the simplified datapath for direct map MIMO.

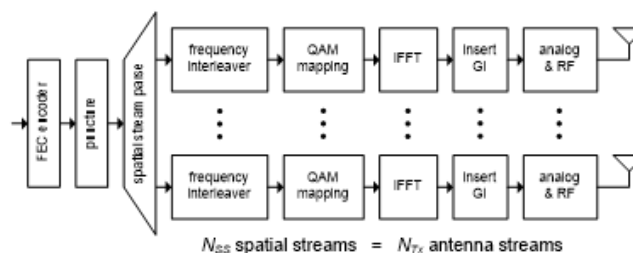


Figure 22: Direct Map MIMO.

11.1.1.2.2 Spatial Spreading

Direct map MIMO only utilizes as many antennas as there are spatial streams; that is $N_{SS} = N_{Tx}$. Spatial spreading is one way to map spatial streams when the number of spatial streams is less than the number of transmitting antennas; that is $N_{SS} \leq N_{Tx}$.

The basic spatial spreading function is achieved using the first N_{SS} columns of a fixed $N_{Tx} \times N_{Tx}$ unitary matrix $\mathbf{W}$. The same matrix $\mathbf{W}$ is used for all subcarriers. Typically one uses the Walsh matrix for $N_{Tx} = 2$ and 4, or the Fourier matrix for $N_{Tx} = 3$. A problem with this basic spatial spreading function is that it can result in undesired beamforming effects. To mitigate this effect, time-domain cyclic delays are applied to OFDM symbols prior to GI insertion. The first antenna is not delayed. Linearly increasing cyclic delays are then applied to the remaining antennas. In addition to mitigating undesired beamforming, the cyclic delays can also yield some performance improvement via transmit diversity. Thus, the method is referred to as Cyclic Delay Diversity (CDD). Since the unitary spatial spreading matrix is typically the Walsh matrix, this method is often called “Walsh+CDD.”

Claim Elements	Disclosures in the TGn Sync Proposal
	[TGn Sync Proposal 2005 at 72] 11.2.1.3 Legacy Protection All MIMO transmissions are protected against legacy OFDM devices at the physical <u>layer, and</u> protected against legacy CCK/DSSS devices at the MAC layer. The legacy short training field, the legacy long training field and the legacy signal field are transmitted such that a legacy OFDM receiver (802.11g or 802.11a) <u>is able to</u> “understand” these fields. In the basic MIMO mode, the transmitter selects the Modulation Coding Scheme either based on conventional rate selection heuristics or via implicit or explicit feedback. Thus, the RATE and LENGTH fields in the legacy signal field can be “spoofed” to allow the legacy OFDM receivers to correctly set their NAV. [TGn Sync Proposal 2005 at 87]

Claim Elements	Disclosures in the TGn Sync Proposal																																							
	11 MIMO-OFDM HT PHY specification 11.1 Overview 11.1.1 Introduction (Informative) The PHY layer introduces several techniques for increasing the rate and reliability of the wireless link, as shown in Table 17: <table><tr><th>Feature</th><th>Mandatory</th><th>Optional</th></tr><tr><td>Number of Spatial Streams</td><td>1 and 2</td><td>3 and 4</td></tr><tr><td>Number of Transmit Antennas</td><td>2</td><td>Greater than 2</td></tr><tr><td>Channelization bandwidth</td><td>20MHz</td><td>40MHz</td></tr><tr><td>Number of Occupied Subcarriers</td><td>56 in 20MHz</td><td>114 in 40MHz</td></tr><tr><td>Number of Data Subcarriers</td><td>52</td><td>108</td></tr><tr><td>Number of Pilot Subcarriers</td><td>4</td><td>6</td></tr><tr><td>Modulation Order</td><td>BPSK, QPSK, 16-QAM, 64-QAM</td><td>256-QAM</td></tr><tr><td>Code Rate</td><td>1/2, 2/3, 3/4, 5/6</td><td></td></tr><tr><td>Guard Interval</td><td>800ns</td><td>400ns</td></tr><tr><td>Convolutional Coding</td><td>R=1/2, K=7, (g₁=133₈, g₂=171₈)</td><td></td></tr><tr><td>LDPC</td><td></td><td>TX and RX Optional</td></tr><tr><td>TX Beamforming</td><td></td><td>TX and RX Optional</td></tr></table> Table 17: PHY Feature Set	Feature	Mandatory	Optional	Number of Spatial Streams	1 and 2	3 and 4	Number of Transmit Antennas	2	Greater than 2	Channelization bandwidth	20MHz	40MHz	Number of Occupied Subcarriers	56 in 20MHz	114 in 40MHz	Number of Data Subcarriers	52	108	Number of Pilot Subcarriers	4	6	Modulation Order	BPSK, QPSK, 16-QAM, 64-QAM	256-QAM	Code Rate	1/2, 2/3, 3/4, 5/6		Guard Interval	800ns	400ns	Convolutional Coding	R=1/2, K=7, (g ₁ =133 ₈ , g ₂ =171 ₈)		LDPC		TX and RX Optional	TX Beamforming		TX and RX Optional
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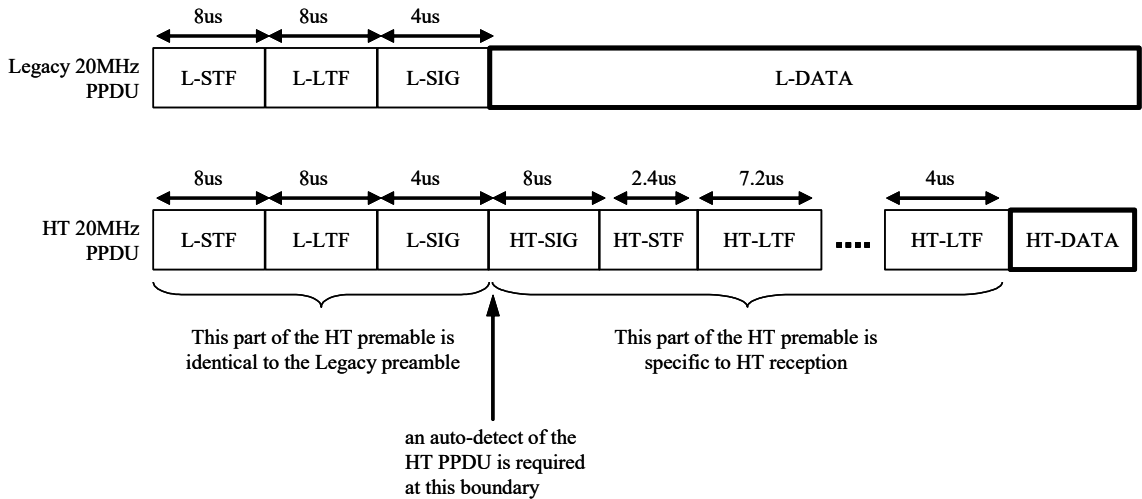
Claim Elements	Disclosures in the TGn Sync Proposal
	[TGn Sync Proposal at 70] August 2004 doc.: IEEE 802.11-04/888r0 PHY Summary of TGn Sync Proposal • Basic configuration delivers 243 Mbps using only two antennas – Follows historical trend of 5x for 802.11 (.11 → .11b → .11a/g) • Higher optional PHY data rate rates (>600 Mbps) for future generation devices • MIMO evolution of 802.11 OFDM PHY with spatial division multiplexing of spatial streams • Multiple antennas (2 mandatory, greater than 2 optional) • Preamble designed for seamless interoperability with legacy 802.11a/g • Wider bandwidth options with fully interoperable 20 MHz and 40 MHz* channel capability • Support for licensed 10 MHz modes • Optional enhancements – Advanced <u>FEC</u> coding techniques (RS, <u>LDPC</u>) – Transmit beamforming with negligible additional cost in receiving client device – 1/2 guard interval – Rate 7/8 coding *Not required in regulatory domains where prohibited. Submission Slide 5 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 5]

Claim Elements	Disclosures in the TGn Sync Proposal
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	TGn Sync Proposal 2005 disclosed receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits. See, e.g.: PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:  Figure 1: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.

Claim Elements	Disclosures in the TGN Sync Proposal
	Figure 2: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3. Figure 3 illustrates the PPDU format for two transmit antennas (ANT_1 and ANT_2), each operating at 40MHz. The format is divided into two sub-channels: Lower Sub-channel and Upper Sub-channel. The fields and their durations are as follows: Lower Sub-channel: L-STF (8us), L-LTF (8us), L-SIG (4us), HT-SIG (8us), HT-STF (2.4us), HT-LTF (7.2us), HT-LTF (4us), HT-DATA. Upper Sub-channel: L-STF (90° rotated), L-LTF (90° rotated), L-SIG (90° rotated), HT-SIG (90° rotated), HT-STF, HT-LTF, HT-LTF, HT-DATA.

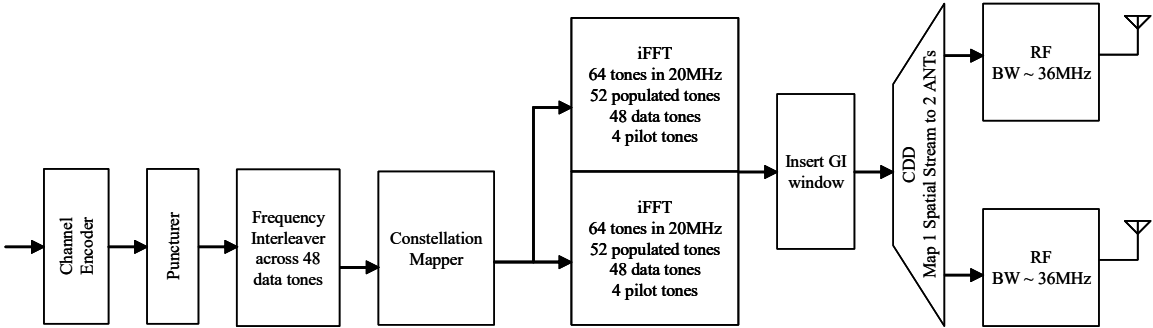
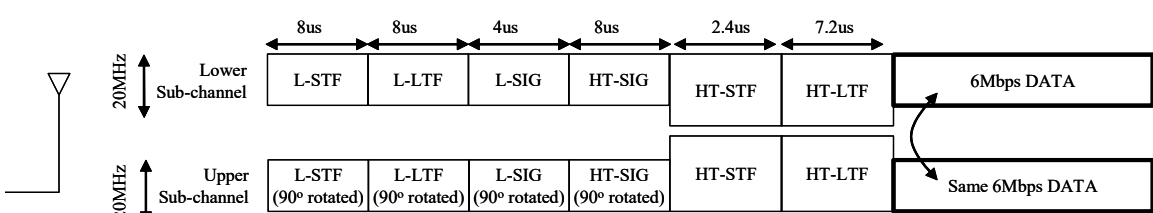
Claim Elements	Disclosures in the TGn Sync Proposal
	Figure 3: PPDU Format for 2x40 Basic MIMO Transmission³ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 0. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PCLP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation 4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:

³ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosures in the TGn Sync Proposal
	 The diagram illustrates the HT Preamble format by comparing a Legacy 20MHz PPDU with an HT 20MHz PPDU. The Legacy PPDU consists of L-STF (8us), L-LTF (8us), L-SIG (4us), and L-DATA. The HT PPDU consists of L-STF (8us), L-LTF (8us), L-SIG (4us), HT-SIG (8us), HT-STF (2.4us), HT-LTF (7.2us), followed by an ellipsis and another HT-LTF (4us) and HT-DATA. A bracket under the L-STF, L-LTF, and L-SIG fields of the HT PPDU is labeled 'This part of the HT preamble is identical to the Legacy preamble'. Another bracket under the HT-SIG, HT-STF, and HT-LTF fields is labeled 'This part of the HT preamble is specific to HT reception'. An arrow points to the boundary between L-SIG and HT-SIG with the text 'an auto-detect of the HT PPDU is required at this boundary'. Figure 4: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF).

Claim Elements	Disclosures in the TGN Sync Proposal
	Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next. Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-

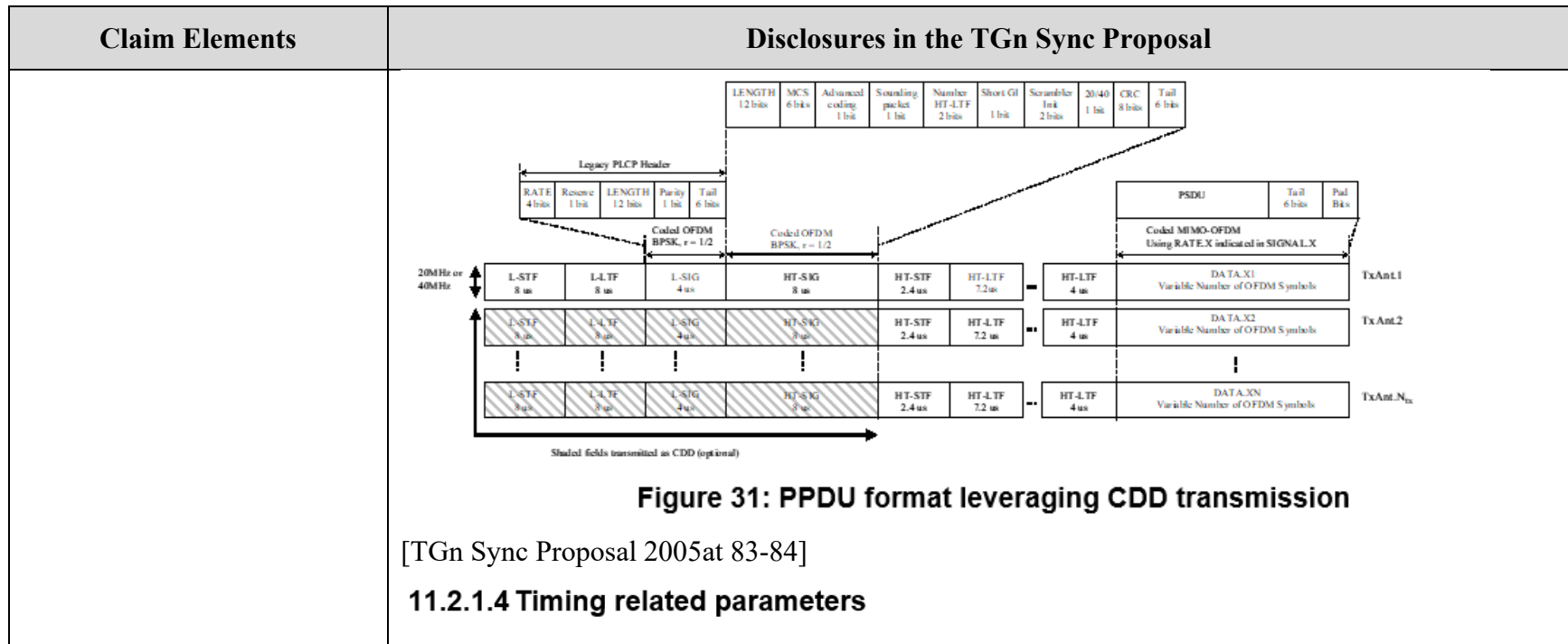
Claim Elements	Disclosures in the TGN Sync Proposal
	STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found.. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the

Claim Elements	Disclosures in the TGN Sync Proposal
	6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 5: Transmitter configuration for 6Mbps in 40MHz⁴ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:  Figure 6: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.).

⁴ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Figure 30: PPDU Format for N_{TX} antennas

Claim Elements	Disclosures in the TGn Sync Proposal
	L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31:



Claim Elements	Disclosures in the TGn Sync Proposal		
	Parameter	Value for 20 MHz Channel	Value for 40 MHz Channel
	N_{SD} : Number of data subcarriers	52	108
	N_{SP} : Number of pilot subcarriers	4	6
	N_{SN} : Number of center null subcarriers	1 (tone = 0)	3 (tones = -1,0,+1)
	N_{SR} : Subcarrier range (index range)	28 (-28 ... +28)	58 (-58 ... +58)
	Δ_F : Subcarrier frequency spacing	0.3125 MHz (= 20 MHz / 64)	0.3125 MHz (= 40 MHz / 128)
	T_{FFT} : IFFT/FFT period	3.2 μ sec	3.2 μ sec
	T_{GI} : GI duration	0.8 μ sec	0.8 μ sec
	$T_{ShortGI}$: Short GI duration	0.4 μ sec	0.4 μ sec
	T_{GI2} : Legacy LongTraining symbol GI duration	1.6 μ sec	1.6 μ sec
	T_{SYM} : Symbol interval	4 μ sec	4 μ sec
	T_{L-STF} : Legacy STF duration	8 μ sec	8 μ sec
	T_{L-LTF} : Legacy LTF duration	8 μ sec	8 μ sec
	T_{L-SIG} : Legacy Signal Field duration	4 μ sec	4 μ sec
	T_{HT-SIG} : HT Signal Field duration	8 μ sec	8 μ sec
	T_{HT-STF} : HT Short training field duration	2.4 μ sec	2.4 μ sec
	$T_{HT-LTF1}$: HT Long training field duration	7.2 μ sec	7.2 μ sec
	$T_{HT-LTF2}$: HT Long training field duration	4 μ sec	4 μ sec
	T_S : Nyquist sampling interval	50nsec	25nsec
Table 23: Timing Related Parameters [TGn Sync Proposal 2005 at 88]			

Disclosures in the TGn Sync Proposal

11.2.1.6.1 Legacy Short Training Field

The L-STTS is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is the L-STTS is

$$S_{-28,28} = \sqrt{1/2} \{0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0, \\ 0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0\} \quad (17)$$

The normalization factor $\sqrt{1/2}$ is the QPSK normalization.

The legacy short training OFDM symbol in 40MHz mode is:

$$S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0\} \quad (18)$$

The tones in the upper subchannel (see Figure 25) are obtained by phase rotating the 802.11a short OFDM training symbol tones by 90 degrees, whereas the tones in the lower subchannel are identical to the 802.11a short training OFDM symbol tones. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz.

The L-STF is

$$r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{L-STF}^{Tone}}} w_{L-STF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{TX}}^{L(k)} S_k \exp(j 2\pi k \Delta_F t) \quad (19)$$

where we recall that $\mathbf{q}^{L(k)}$ is the column vector that defines the antenna map for the legacy compatible part. Observe that equation (19) is identical to the general expression (15) with $X_k^{(i_N)} = q_{i_N}^{L(k)} S_k$.

Claim Elements	Disclosures in the TGn Sync Proposal
	The L-STs has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s, hence there are 10 L-STs in the L-STF. [TGn Sync Proposal 2005at 91] 11.2.1.6.2 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1\} \quad (20)$ The legacy long training OFDM signal in the 40MHz mode is given by: $L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,1,1,1,0,0,0,0,0, \\ 0,0,0,0,0,0,j,j,-j,-j,j,j,-j,j,-j,j,j,j,j,-j,-j,j,j,-j,j,-j,j,j,j,0, \\ j,-j,-j,j,j,-j,j,-j,j,-j,-j,-j,-j,-j,j,j,-j,-j,j,-j,j,j,j\} \quad (21)$

Claim Elements	Disclosures in the TGn Sync Proposal
	Tones in the upper subchannel (subcarriers +6 to +58) are obtained by phase rotating the 802.11a long OFDM training symbol tones by 90 degrees, whereas the tones within the lower subchannel (subcarriers -58 to -6) are identical to the 802.11a long OFDM training symbol tones. It should be noted that neither the legacy fields (L-STF, L-LTF, LSIG) nor the HT-SIG undergo any phase rotation in the lower subchannel. The subcarriers at ± 32 in 40MHz, which are the DC subcarriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is $r_{L-LTF}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{L-LTF}^{Tone}}} w_{L-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} L_k \exp(j 2 \pi k \Delta_F (t - T_{2GI})) \quad (22)$ where $T_{GI2} = 1.6 \mu \text{ sec}$. Observe that equation (22) is identical to the general expression (15) with $X_k^{(i_{rx})} = q_{i_{rx}}^{L(k)} L_k$. Since $T_{L-LTF} = 8.0 \mu \text{ sec}$ and the symbol duration is $T_{FFT} = 3.2 \mu \text{ sec}$, we see that the L-LTF consists of a double GI followed by two full symbols. [91-92] 11.2.1.6.3 HT-Short Training Field The HT-STF follows the HT-SIG (see Figure 30), whose purpose it to “fine tune” the AGC for HT MIMO reception. Note that the first AGC operation is performed on the L-STF. The HT-STF for 20MHz is

Claim Elements	Disclosures in the TGN Sync Proposal
	$HTS_{-26,26} = \frac{1}{\sqrt{2}} \left\{ \begin{array}{l} \{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 0\} \quad N_{rs} = 1 \\ \\ \{0, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, \} \quad N_{rs} = 2 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{rs} = 3 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \quad N_{rs} = 4 \end{array} \right. \quad (23)$ The HT-STS for 40 MHz consists of 48 tones, and is given by:

Claim Elements	Disclosures in the TGN Sync Proposal
	$HTS_{SS,58} = \frac{1}{\sqrt{2}}$ $\{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, N_{Tx} = 1$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, N_{Tx} = 2$ $0, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, N_{Tx} = 3$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ (24) In the duplicate 6Mbps mode in 40MHz, the HT-STF shown in (24) is used, except for a scaling factor change. The HT-STF signal is then generated by the following rule. $r_{HT-LTS}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sqrt{N_{TX}}$ $\sum_k q_{i_{TX}, (k+N_{HT-LTF}^{Tone}-u(k)) \% N_{SS}}^{(k)} HTS_k \exp(j2\pi k \Delta_F (t - T_{GI}))$ (25)

Claim Elements	Disclosures in the TGn Sync Proposal
	where $T_{GI} = 0.8 \mu s$, N_{HT-STF}^{Tone} is the number of active tones (= 24 for 20 MHz and 48 for 40 MHz), and $u(k)$ is the unit step function (= 0 for $k < 0$ and = 1 for $k \geq 0$). Tone interleaving across spatial streams works as follows. Define $i(k) = k + N_{HT-STF}^{Tone} - u(k)$, which appears in the column subscript of the Q-matrix. HTS_k is non-zero only for even values of the tone index k between $-N_{HT-STF}^{Tone}$ and $+N_{HT-STF}^{Tone}$, excluding $k = 0$. Thus, $i(k)$ runs through the integer values 0, ..., $N_{HT-STF}^{Tone} - 1$ as k runs through the even values $-N_{HT-STF}^{Tone}, \dots, -2, +2, \dots, +N_{HT-STF}^{Tone}$. The index $i(k)$ can be called the “interleaving index” because it is used to select the column of the Q-matrix, which define to spatial streams, that used on tone index k. We select spatial stream $i(k) \% N_{SS}$ for tone k. The HT-STF signal has a period of $1.6 \mu s$, which is deemed sufficient for power measurement purposes. Since the HT-STF is tone-interleaved at the transmitter, the power periodicity of the HT-STF is also $1.6 \mu s$. [TGn Sync Proposal 2005 at 92-94]

Claim Elements	Disclosures in the TGN Sync Proposal
	11.2.1.6.4 HT-Long Training Field The HT-LTFs are transmitted after the HT-STF. The number of HT-LTFs is equal to N_{LTF}. For any PPDU, there must be at least as many HT-LTFs as spatial streams in the HT Data portion of the PPDU, i.e. $N_{LTF} = N_{SS}$ (the number of spatial streams). For a sounding PPDU $N_{LTF} \geq N_{SS}$, because these PPDUs provide channel measurement capability for potentially more spatial dimensions than the number of spatial streams. In the case of a sounding packet, the HT-LTFs are partitioned as data HT-LTFs and extension HT-LTFs. The data HT-LTFs are the first N_{SS} fields, which are indexed $i_{LTF} = 0, \dots, N_{SS} - 1$. The last $N_{LTF} - N_{SS}$ HT-LTFs are the extension fields, which are indexed $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. The result is referred to as a segmented HT-LTF. As always, spatial streams are defined by columns of an orthogonal antenna map matrix $\mathbf{Q}^{(k)}$, with the first N_{SS} columns defining the spatial streams used for data transmission, and the last $N_{LTF} - N_{SS}$ columns defining the extension spatial streams. Thus, for the purpose of defining HT-LTFs, $\mathbf{Q}^{(k)}$ is an $N_{Tx} \times N_{LTF}$ dimension matrix. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second and all subsequent HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. To minimize the power fluctuation between the HT-LTF and the AGC setting (which is derived from the HT-STF), the HT-LTS is tone-interleaved across spatial streams, <u>similar to</u> the HT-STF definition. There are a total of 9 sequences. These sequences are defined to minimize PAPR for both direct MAP and spatial spreading, with tone-interleaving.

Claim Elements	Disclosures in the TGN Sync Proposal																																								
	Table 25: List of HT Long Training Fields <table><tr><th>Sequence Number</th><th>N_{TX}</th><th>BW</th><th>Comment</th></tr><tr><td>1</td><td>1</td><td>20MHz</td><td>56 tones</td></tr><tr><td>2</td><td>2</td><td>20MHz</td><td>56 tones</td></tr><tr><td>3</td><td>3</td><td>20MHz</td><td>56 tones</td></tr><tr><td>4</td><td>4</td><td>20MHz</td><td>56 tones</td></tr><tr><td>5</td><td>1</td><td>40MHz</td><td>Duplicate format, 6Mbps in 40MHz (104 Tones)</td></tr><tr><td>6</td><td>1</td><td>40MHz</td><td>114 tones</td></tr><tr><td>7</td><td>2</td><td>40MHz</td><td>114 tones</td></tr><tr><td>8</td><td>3</td><td>40MHz</td><td>114 tones</td></tr><tr><td>9</td><td>4</td><td>40MHz</td><td>114 tones</td></tr></table> In 20MHz, for $N_{TX} = 1$, sequence 1 is: $\text{HTL}_{-28:28}=[-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1, 1, 1, 1, -1, 1, 1, -1, 1, 0, -1, -1, -1, 1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1] \quad (26)$ In 20MHz, for $N_{TX} = 2$, sequence 2 is: $\text{HTL}_{-28:28}=[-1, -1, 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, -1, 1, 0, -1, -1, -1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, 1, 1, 1] \quad (27)$ In 20MHz, for $N_{TX} = 3$, sequence 3 is: $\text{HTL}_{-28:28}=[1, -1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, -1, 1, -1, -1, 1, -1, 0, 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, 1, -1, -1, 1, -1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1] \quad (28)$	Sequence Number	N _{TX}	BW	Comment	1	1	20MHz	56 tones	2	2	20MHz	56 tones	3	3	20MHz	56 tones	4	4	20MHz	56 tones	5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)	6	1	40MHz	114 tones	7	2	40MHz	114 tones	8	3	40MHz	114 tones	9	4	40MHz	114 tones
Sequence Number	N _{TX}	BW	Comment																																						
1	1	20MHz	56 tones																																						
2	2	20MHz	56 tones																																						
3	3	20MHz	56 tones																																						
4	4	20MHz	56 tones																																						
5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)																																						
6	1	40MHz	114 tones																																						
7	2	40MHz	114 tones																																						
8	3	40MHz	114 tones																																						
9	4	40MHz	114 tones																																						

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Claim Elements	Disclosures in the TGN Sync Proposal
	$HTL_{-58,+58} = \{-1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1$ $1 1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 \quad (33)$ $0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1$ $-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 \}$ The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets: In 40MHz, for $N_{TX} = 4$, sequence 9 is: $HTL_{-58,+58} = \{-1 1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 1 1 -1$ $1 -1 -1 -1 -1 1 1 -1 -1 -1 1 1 1 -1 1 -1 -1 1 1 1 1 1 -1 -1 -1 1 0 \quad (34)$ $0 0 -1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 1 1 -1 -1 -1 1 -1 -1 -1 1 1 -1$ $-1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 -1 -1 -1 -1 1 1 \}$ The HT-LTF is generated similarly to the HT-STF. For the data HT-LTFs $i_{LTF} = 0, \dots, N_{SS} - 1$, the signal is $r_{HT-LTF}^{(i_{TX}, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \quad (35)$ $\sum_{k=-N_{SR}}^{N_{SR}} Q_{i_{TX}, (k+i_{LTF}+N_{SR}-u(k)) \% N_{SS}}^{(k)} HTL_k \exp(j2\pi k \Delta_F (t - T_{GI}))$

Claim Elements	Disclosures in the TGN Sync Proposal
	where $N_{SR} = 28$ for 20 MHz and 58 for 40 MHz, $u(k) = \begin{cases} 1 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 20 MHz} \quad (36)$ and $u(k) = \begin{cases} 3 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 40 MHz.} \quad (37)$ In the case of a sounding packet, the extension HT-LTFs are tone interleaved over the extension spatial dimensions. Thus, the extension HT-LTFs are $r_{HT-LTF}^{(i_D, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_D, N_{SS} + (k + (i_{LTF} - N_{SS}) + N_{SR} - u(k)) \% (N_{LTF} - N_{SS})} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (38)$ for $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. Since the HT-LTF is tone interleaved across antennas, the 56 tones are partitioned across the antenna array during each OFDM symbol. Tone partitioning into sets for 20MHz is shown in Table 26. At each OFDM symbol interval, each set of tones maps to one transmit antenna. And over time, all sets get mapped to an antenna.

Claim Elements	Disclosures in the TGn Sync Proposal																													
	<table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-28:1:-1] [1:1:+28]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-28:2:-2] [2:2:28]</td><td>[-27:2:-1] [1:2:27]</td><td></td><td></td></tr><tr><td>3</td><td>[-28:3:-1] [2:3:26]</td><td>[-27:3:-3] [3:3:27]</td><td>[-26:3:-2] [1:3:28]</td><td></td></tr><tr><td>4</td><td>[-28:4:-4] [1:4:25]</td><td>[-27:4:-3] [2:4:26]</td><td>[-26:4:-2] [3:4:27]</td><td>[-25:4:-2] [4:4:28]</td></tr></table>					Nss	Set 0	Set 1	Set 2	Set 3	1	[-28:1:-1] [1:1:+28]				2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]			3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]		4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]
Nss	Set 0	Set 1	Set 2	Set 3																										
1	[-28:1:-1] [1:1:+28]																													
2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]																												
3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]																											
4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]																										
	Table 26: Tone partitioning into sets for 20MHz (56 tones)																													
	<table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-58:1:-2] [2:1:+58]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-58:2:-2] [2:2:+58]</td><td>[-57:2:-3] [3:2:57]</td><td></td><td></td></tr><tr><td>3</td><td>[-58:3:-4] [2:3:56]</td><td>[-57:3:-3] [3:3:57]</td><td>[-56:3:-2] [4:3:58]</td><td></td></tr><tr><td>4</td><td>[-58:4:-2] [5:4:57]</td><td>[-57:4:-5] [2:4:58]</td><td>[-56:4:-4] [3:4:55]</td><td>[-55:4:-3] [4:4:56]</td></tr></table>					Nss	Set 0	Set 1	Set 2	Set 3	1	[-58:1:-2] [2:1:+58]				2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]			3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]		4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]
Nss	Set 0	Set 1	Set 2	Set 3																										
1	[-58:1:-2] [2:1:+58]																													
2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]																												
3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]																											
4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]																										
	Table 27: Tone partitioning into sets for 40MHz (114 tones)																													
	An example of tone interleaving across 4 transmit antennas is shown in Figure 34.																													

Claim Elements	Disclosures in the TGn Sync Proposal
	time Figure 34: HT-LTF tone interleaving across 4 spatial streams [TGn Sync Proposal 2005at 94-98] 11.2.1.7.1 L-SIG Figure 36: SIGNAL field bit assignment In the 20MHz mode, the format of the LSIG field shall be the same as the SIGNAL field as defined in figure 111 in 17.3.4 in [1]. The combination of RATE and LENGTH is used to signal a station (OFDM mode only) the duration of a HT transmission. This duration does not have to be the actual duration of the HT frame. It can be used to reserve the medium beyond the actual transmission. The reservation of the medium through this kind of signalling is called “spoofing”.

Claim Elements	Disclosures in the TGn Sync Proposal
	To prevent a legacy station from accessing the medium during a HT frame transmission, the “duration” calculated from the RATE and LENGTH fields shall be at least as large as the actual duration of the HT frame, which is measured from the end of the L-SIG field to the end of the DATA field. During an HT transmission, the RATE field is set to 6Mbps, whereas the LENGTH field is set based on the “duration” value. In the 40MHz mode, the legacy signal field is duplicated such that tones are filled from -58 to -6 (lower-subchannel), and from +6 to +58 (upper-subchannel). The upper subchannel shall be phase rotated by 90 degrees, in the same way as the LTS as described in 11.2.1.6.2 The LSIG shall be transmitted in the same fashion as the legacy short and the legacy long training fields. If L-STF and L-LTF are transmitted from a single antenna, we index that antenna as $i_{Tx} = 1$ to be consistent with 11.2.1.6.2. Denote $LSIG_{-26,26}$ and $LSIG_{-58,58}$ as the LSIG OFDM symbol generated for 20 MHz and 40 MHz respectively. The L-SIG waveform is $r_{L-SIG}^{i_{Tx}}(t) = \frac{1}{\sqrt{N_{L-SIG}^{Tone}}} w_{L-SIG}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} LSIG_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (39)$ [TGn Sync Proposal 2005 at 98-99] 11.2.1.7.2 HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause 11.2.1.7.

Claim Elements	Disclosures in the TGn Sync Proposal
	In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in 11.2.1.6.2. Figure 37 shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t - nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t - T_{GI} - nT_{Symb})) \quad (40)$ where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration.

Claim Elements	Disclosures in the TGn Sync Proposal																																																																																																																																																																									
	<table><tr><td colspan="12">HTLENGTH (12 bits)</td><td colspan="5">RESERVED (5 bits)</td><td colspan="6">MCS (7 bits)</td></tr><tr><td colspan="12">LSB</td><td colspan="5"></td><td colspan="6">LSB</td><td colspan="1">MSB</td></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table> <table><tr><td colspan="12"></td><td colspan="12">HT-SIG₁</td></tr><tr><td colspan="1">ADV CODING (1 bit)</td><td colspan="1">RESERVED (1 bit)</td><td colspan="1">SOUNDING PACKET (1 bit)</td><td colspan="2">NUMBER HT-LTF (2 bit)</td><td colspan="1">SHORT GI (1 bit)</td><td colspan="1">RESERVED (1 bit)</td><td colspan="2">SCRAMBLER INIT (2 bits)</td><td colspan="1">20/40 BW (1 bit)</td><td colspan="1">LSB</td><td colspan="8">CRC (8 bits)</td><td colspan="1">MSB</td><td colspan="6">SIGNAL TAIL (6 bits)</td></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr><tr><td colspan="12"></td><td colspan="12">HT-SIG₂</td></tr></table> Transmit Order	HTLENGTH (12 bits)												RESERVED (5 bits)					MCS (7 bits)						LSB																	LSB						MSB	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23													HT-SIG ₁												ADV CODING (1 bit)	RESERVED (1 bit)	SOUNDING PACKET (1 bit)	NUMBER HT-LTF (2 bit)		SHORT GI (1 bit)	RESERVED (1 bit)	SCRAMBLER INIT (2 bits)		20/40 BW (1 bit)	LSB	CRC (8 bits)								MSB	SIGNAL TAIL (6 bits)						0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23													HT-SIG ₂											
HTLENGTH (12 bits)												RESERVED (5 bits)					MCS (7 bits)																																																																																																																																																									
LSB																	LSB						MSB																																																																																																																																																			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																																																																																																																																																			
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ADV CODING (1 bit)	RESERVED (1 bit)	SOUNDING PACKET (1 bit)	NUMBER HT-LTF (2 bit)		SHORT GI (1 bit)	RESERVED (1 bit)	SCRAMBLER INIT (2 bits)		20/40 BW (1 bit)	LSB	CRC (8 bits)								MSB	SIGNAL TAIL (6 bits)																																																																																																																																																						
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																																																																																																																																																			
												HT-SIG ₂																																																																																																																																																														

Figure 37: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment

[TGn Sync Proposal 2005 at 100-101]

11.2.1.7.2.10 SIGNALTAIL

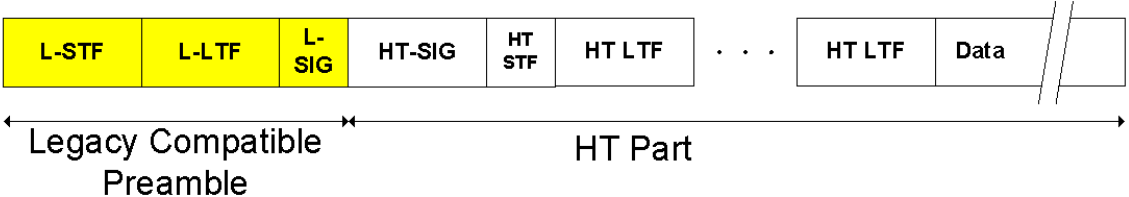
The bits 18-23 constitute the SIGNALTAIL field, and all 6 bits shall be set to zero.

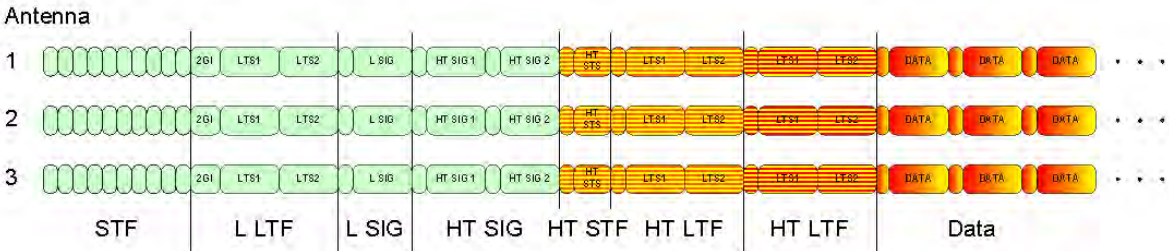
[TGn Sync Proposal 2005 at 104]

Claim Elements	Disclosures in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 Legacy Compatible Preamble ➔ Format remains unchanged from before The diagram illustrates the structure of the Legacy Compatible Preamble. It consists of six sequential fields, each represented by a rounded rectangle. Below each field is a double-headed arrow indicating its duration in microseconds (us). The fields and their durations are: L-STF (8 us), GI2 (1.6 us), L-LTS (3.2 us), L-LTS (3.2 us), GI (0.8 us), and L-SIG (3.2 us). The L-STF field is the largest, followed by the two L-LTS fields, and then the GI2, GI, and L-SIG fields. ➔ The legacy compatible preamble may be transmitted either from one antenna or from multiple antennas using CDD Submission Slide 8 Syed Aon Mujtaba, Agere Systems, et. al [2005 TGn Sync PHY Updates, at Slide 8]

Claim Elements	Disclosures in the TGN Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF The diagram illustrates the HT-LTF structure for different N_{ss} values. The structure is divided into four sections by vertical red lines, each labeled with a duration: 7.2us, 4us, 4us, and 4us. The blocks are arranged as follows: N_{ss}=1: GI, HT-LTS, HT-LTS (Total: 7.2us) N_{ss}=2: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS (Total: 4us) N_{ss}=3: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS (Total: 4us) N_{ss}=4: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS (Total: 4us) Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

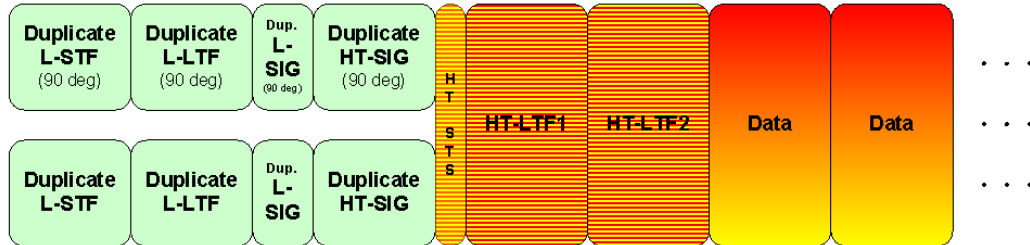
Claim Elements	Disclosures in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12]

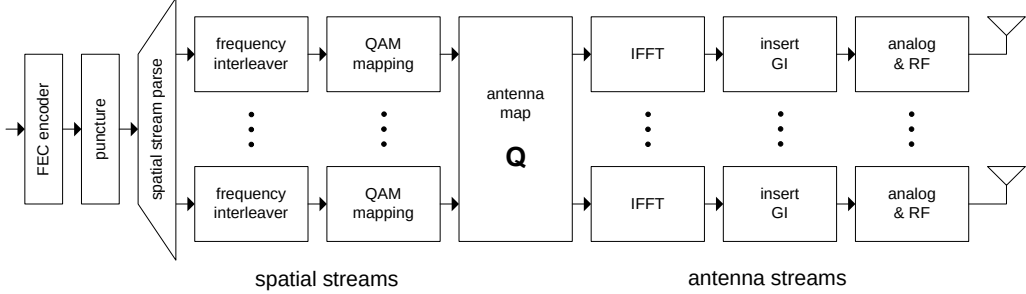
Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PPDU Format  <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead  These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. or single antenna Antenna Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al

[TGnSync 2004, slide 17]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header	TGn Sync Proposal 2005 disclosed demodulating, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers. <i>See, e.g.:</i>

Claim Elements	Disclosures in the TGN Sync Proposal
bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	MIMO Data Path Overview The general data path for MIMO transmission is shown in Figure 7.  Figure 7: MIMO datapath. The FEC architecture has a single encoder. For the convolutional code (CC), the mother code is rate 1/2. Encoded bits may be punctured to produce code rates 2/3, 3/4 or 5/6. For the LDPC code different code rates are produced within the encoder and external puncturing is not applied. Processing of bits following encoding/puncturing is identical for both CC and LDPC. The punctured bits are then distributed to N_{ss} spatial streams via the spatial stream parser. For each spatial stream, blocks of bits that map to a single OFDM symbol are interleaved. This interleaving step is called “frequency interleaving” because it results in bit interleaving across subcarriers. The frequency interleaver is similar to the 802.11a interleaver. The combination of the spatial stream parser and the frequency interleavers results in space-time interleaving. Interleaved bits are then mapped to QAM constellation points. The mapping may be BPSK, QPSK, 16 QAM, 64 QAM or 256 QAM.

Claim Elements	Disclosures in the TGn Sync Proposal																								
	The next step is the antenna map transformation. This transformation maps N_{SS} spatial streams to N_{Tx} transmit antenna streams. Note that MIMO transmission requires $N_{SS} \leq \min\{N_{Tx}, N_{Rx}\}$ where N_{Rx} is the number of active receiving antennas. In particular, we must always have $N_{SS} \leq N_{Tx}$ in the transmit datapath. This transformation is generically represented by the matrix $\mathbf{Q}$. In general, there may be a different $N_{Tx} \times N_{SS}$ transformation for each subcarrier. There are three standard types Q-transformations, which are described in the subsections below. After the antenna map, antenna streams are transformed to the time domain via the IFFT. The cyclically extended GI (guard interval) is added. Finally, time domain windowing (not shown) is applied to create a continuous time-domain signal, and analog and RF processing yields the signals that are applied to transmit antennas. Error! Reference source not found. summarizes the OFDM parameters for 20 and 40 MHz channels in comparison to the legacy 802.11 a/g formats. <table><tr><th></th><th>802.11a/g (20 MHz)</th><th>20 MHz Channel (Mandatory)</th><th>40 MHz Channel (Optional)</th></tr><tr><td>FFT size</td><td>64</td><td>64</td><td>128</td></tr><tr><td>Number of data subcarriers</td><td>48</td><td>52</td><td>108</td></tr><tr><td>Number of pilot subcarriers</td><td>4</td><td>4</td><td>6</td></tr><tr><td>Subcarrier separation</td><td>312.5 kHz</td><td>312.5 kHz</td><td>312.5 kHz</td></tr><tr><td>Approx. Bandwidth</td><td>16.25 MHz</td><td>17.5 MHz</td><td>36.6 MHz</td></tr></table> Table 1: Summary of OFDM parameters		802.11a/g (20 MHz)	20 MHz Channel (Mandatory)	40 MHz Channel (Optional)	FFT size	64	64	128	Number of data subcarriers	48	52	108	Number of pilot subcarriers	4	4	6	Subcarrier separation	312.5 kHz	312.5 kHz	312.5 kHz	Approx. Bandwidth	16.25 MHz	17.5 MHz	36.6 MHz
	802.11a/g (20 MHz)	20 MHz Channel (Mandatory)	40 MHz Channel (Optional)																						
FFT size	64	64	128																						
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Number of pilot subcarriers	4	4	6																						
Subcarrier separation	312.5 kHz	312.5 kHz	312.5 kHz																						
Approx. Bandwidth	16.25 MHz	17.5 MHz	36.6 MHz																						

Direct Map MIMO Overview

Direct map MIMO is the simplest antenna mapping transformation. The Q-matrix is simply the identity mapping, i.e. each spatial stream maps to one antenna. Hence, there is a one-to-one correspondence between spatial streams and transmit antennas. **Figure 8** illustrates the simplified datapath for direct map MIMO.

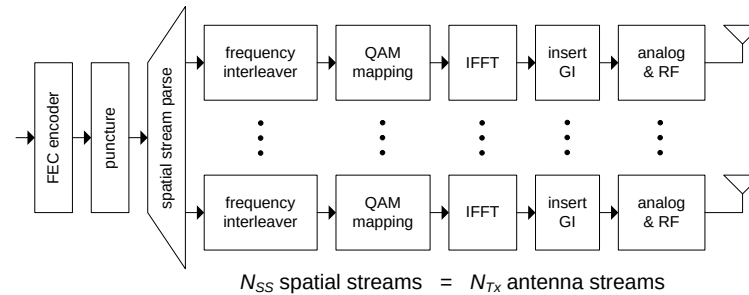
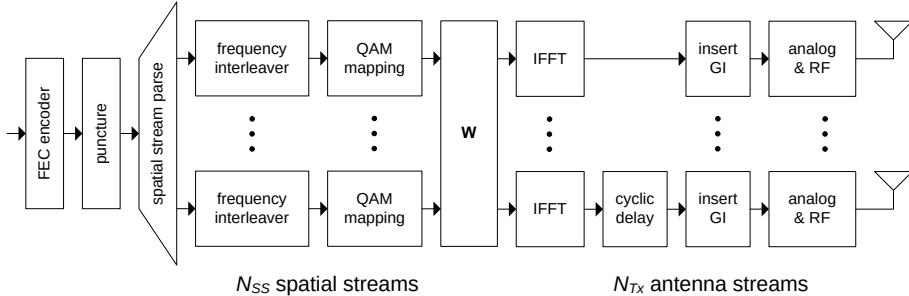


Figure 8: Direct Map MIMO.

Spatial Spreading

Direct map MIMO only utilizes as many antennas as there are spatial streams; that is $N_{SS} = N_{Tx}$. Spatial spreading is one way to map spatial streams when the number of spatial streams is less than the number of transmitting antennas; that is $N_{SS} \leq N_{Tx}$.

The basic spatial spreading function is achieved using the first N_{SS} columns of a fixed $N_{Tx} \times N_{Tx}$ unitary matrix $\mathbf{W}$. The same matrix $\mathbf{W}$ is used for all subcarriers. Typically one uses the Walsh matrix for $N_{Tx} = 2$ and 4, or the Fourier matrix for $N_{Tx} = 3$. A problem with this basic spatial spreading function is that it can result in undesired beamforming effects. To mitigate this effect, time-domain cyclic delays are applied to OFDM symbols prior to GI insertion. The first antenna is not delayed. Linearly increasing cyclic delays are then applied to the remaining antennas. In addition to mitigating undesired beamforming, the cyclic delays can also yield some performance improvement via transmit diversity. Thus, the method is referred to as Cyclic Delay Diversity

Claim Elements	Disclosures in the TGN Sync Proposal
	(CDD). Since the unitary spatial spreading matrix is typically the Walsh matrix, this method is often called “Walsh+CDD.”  N_{SS} spatial streams N_{TX} antenna streams Figure 9: Time domain implementation of spatial spreading cyclic delay. It is noted that since the $\mathbf{W}$ matrix is constant across subcarriers, yet another equivalent implementation would be to interchange the $\mathbf{W}$ matrix and the IFFT blocks. At first, the spatial spreading method described above may seem to be a deviation to the general structure of Figure 7. However, there is a mathematical equivalence. The time domain cyclic delays are equivalent to a frequency dependent phase shift in the frequency domain. Each antenna has a different phasing due to the different cyclic delays. The result is that spatial spreading with time domain cyclic delays is mathematically equivalent to Figure 7 with $\mathbf{Q} = \mathbf{\Phi}\mathbf{W}$ where $\mathbf{\Phi}$ is a frequency dependent diagonal phasing matrix. Transmit Beamforming In this case, the Q-transformation is designed specifically to pre-emphasize the dominant modes of transmission of the random MIMO channel. The optimal beamforming transformation is created from the right singular vectors of the SVD (singular value decomposition) of the observed channel.

Claim Elements	Disclosures in the TGn Sync Proposal
	Our proposal provides full capability to implement SVD beamforming, as well as other types of beamforming such as constant amplitude phasing or constant beamforming matrices across all subcarriers. In these cases, the optimized beamforming matrix is the Q-transformation. [TGn Sync Proposal 2005, 70-73] HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause Error! Reference source not found.. In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in Error! Reference source not found. Error! Reference source not found. shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{Tx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t-nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t-T_{GI}-nT_{Symb})) \quad (1)$

Claim Elements	Disclosures in the TGn Sync Proposal																																																																																																
	where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration. <table><tr><td colspan="12">HTLENGTH (12 bits)</td><td colspan="5">RESERVED (5 bits)</td><td colspan="7">MCS (7 bits)</td></tr><tr><td colspan="10">LSB</td><td colspan="2">MSB</td><td colspan="5"></td><td colspan="2">LSB</td><td colspan="5">MSB</td></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table> ADV CODING (1 bit) RESERVED (1 bit) SOUNDING PACKET (1 bit) NUMBER HT-LTF (2 bits) SHORT GI (1 bit) RESERVED (1 bit) SCRAMBLER INIT (2 bits) 20/40 BW (1 bit) CRC (8 bits) SIGNAL TAIL (6 bits) <table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table> HT-SIG₁ HT-SIG₂ Transmit Order Figure 10: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment [TGn Sync Proposal 2005, 100-101]	HTLENGTH (12 bits)												RESERVED (5 bits)					MCS (7 bits)							LSB										MSB							LSB		MSB					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
HTLENGTH (12 bits)												RESERVED (5 bits)					MCS (7 bits)																																																																																
LSB										MSB							LSB		MSB																																																																														
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																																																																										
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																																																																										

Claim Elements	Disclosures in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 Legacy Compatible Preamble ➔ Format remains unchanged from before The diagram illustrates the structure of the Legacy Compatible Preamble. It consists of six fields arranged horizontally: L-STF, GI2, L-LTS, L-LTS, GI, and L-SIG. Below each field, a double-headed arrow indicates its duration: 8 us for L-STF, 1.6 us for GI2, 3.2 us for the first L-LTS, 3.2 us for the second L-LTS, 0.8 us for GI, and 3.2 us for L-SIG. The L-STF field is depicted with a series of vertical lines, representing its multi-carrier structure. ➔ The legacy compatible preamble may be transmitted either from one antenna or from multiple antennas using CDD Submission Slide 8 Syed Aon Mujtaba, Agere Systems, et. al [2005 TGn Sync PHY Updates, at Slide 8]

Claim Elements	Disclosures in the TGN Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF The diagram illustrates the HT-LTF structure for different N_{ss} values. The structure is as follows: N_{ss}=1: GI, HT-LTS, HT-LTS. Total duration: 7.2us. N_{ss}=2: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS. Total duration: 7.2us + 4us = 11.2us. N_{ss}=3: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS. Total duration: 7.2us + 4us + 4us = 15.2us. N_{ss}=4: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS. Total duration: 7.2us + 4us + 4us + 4us = 19.2us. Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

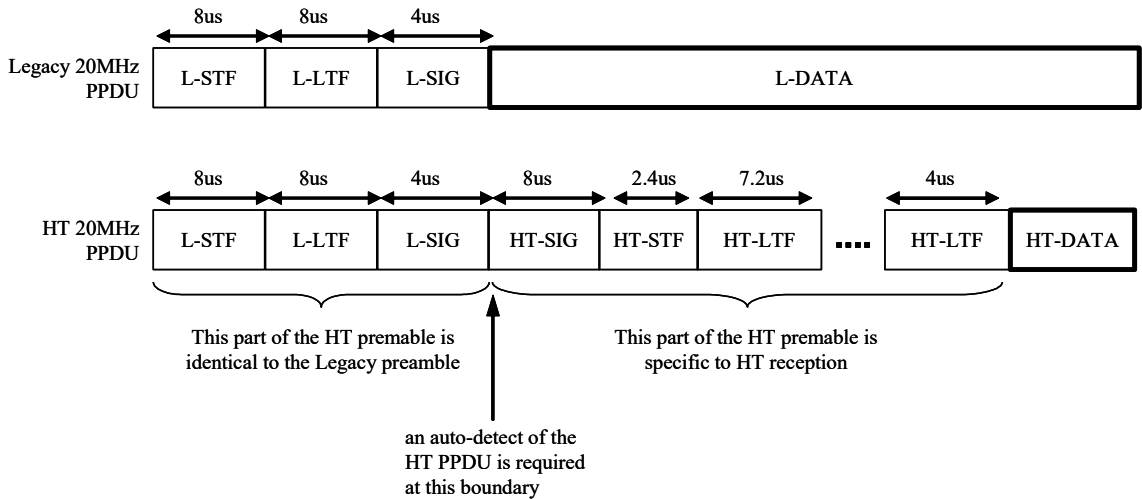
Claim Elements	Disclosures in the TGn Sync Proposal
	<u>May 2005</u> <u>doc.: IEEE 802.11-05/0418r0</u> HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12] <i>See also, e.g.,</i> claim element 1.A above.
[1.C] receive, in a second wider frequency band, by the	TGn Sync Proposal 2005 disclosed receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM

Claim Elements	Disclosures in the TGn Sync Proposal
receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. See, e.g.: PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:  Figure 11: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.

Claim Elements	Disclosures in the TGN Sync Proposal
	Figure 12: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

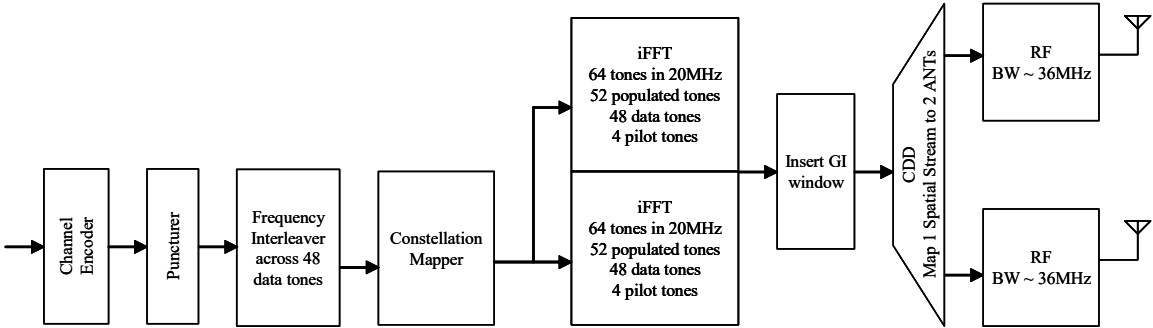
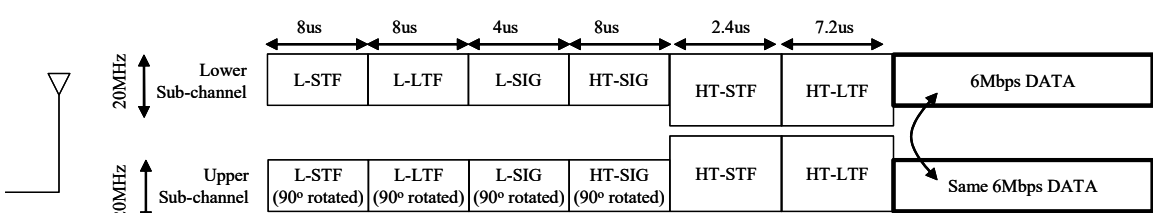
Claim Elements	Disclosures in the TGn Sync Proposal
	Figure 13: PPDU Format for 2x40 Basic MIMO Transmission⁵ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 0. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PCLP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 8. Start-of-Packet (SoP) detection 9. AGC 10. Coarse Frequency Offset Estimation 11. Coarse Timing Offset Estimation 12. Fine Timing Offset Estimation 13. Fine Frequency Offset Estimation 14. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:

⁵ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosures in the TGn Sync Proposal
	 The diagram illustrates the HT Preamble format by comparing a Legacy 20MHz PPDU with an HT 20MHz PPDU. The Legacy 20MHz PPDU consists of L-STF (8us), L-LTF (8us), L-SIG (4us), and L-DATA. The HT 20MHz PPDU consists of L-STF (8us), L-LTF (8us), L-SIG (4us), HT-SIG (8us), HT-STF (2.4us), HT-LTF (7.2us), followed by an ellipsis and another HT-LTF (4us) and HT-DATA. A bracket under the L-STF, L-LTF, and L-SIG fields of the HT PPDU is labeled 'This part of the HT preamble is identical to the Legacy preamble'. Another bracket under the HT-SIG, HT-STF, and HT-LTF fields is labeled 'This part of the HT preamble is specific to HT reception'. An arrow points to the boundary between L-SIG and HT-SIG with the text 'an auto-detect of the HT PPDU is required at this boundary'. Figure 14: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF).

Claim Elements	Disclosures in the TGn Sync Proposal
	Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next. Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-

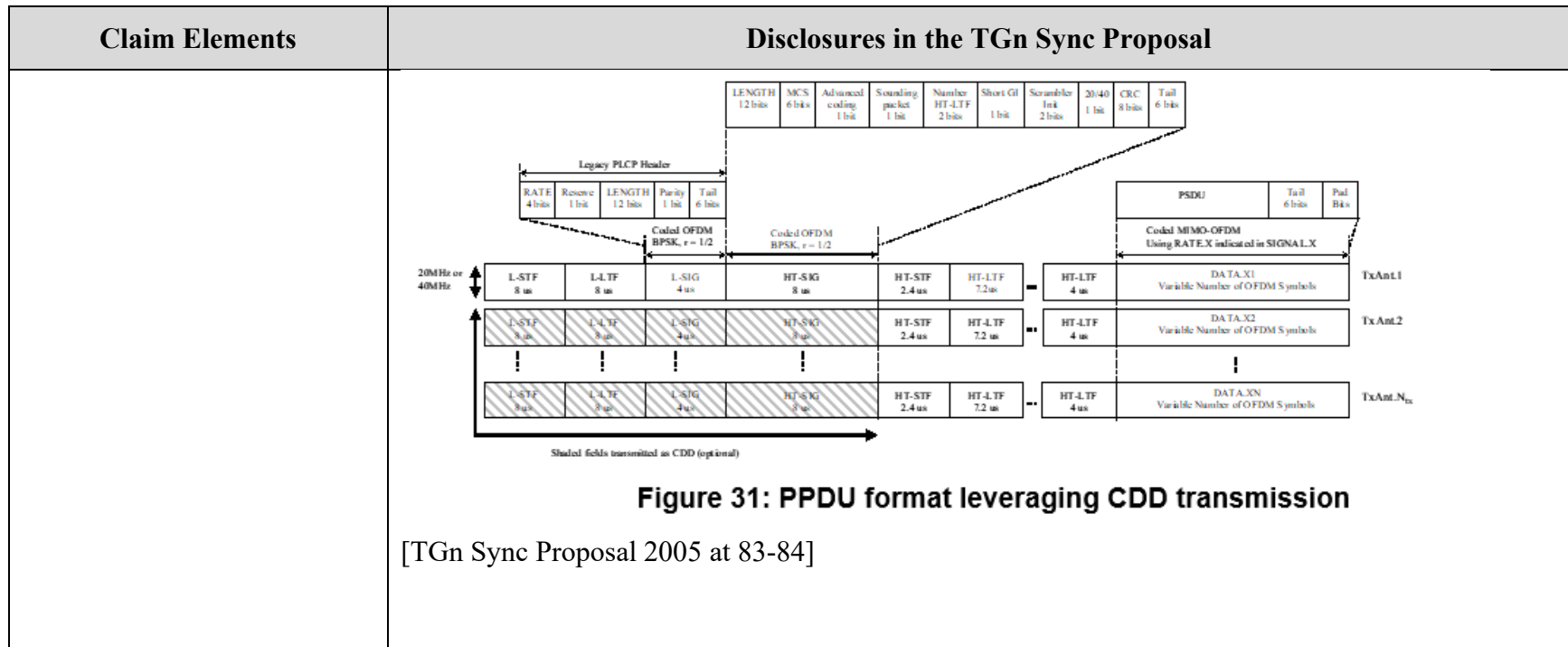
Claim Elements	Disclosures in the TGN Sync Proposal
	STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found.. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the

Claim Elements	Disclosures in the TGN Sync Proposal
	6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 15: Transmitter configuration for 6Mbps in 40MHz⁶ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:  Figure 16: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.).

⁶ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

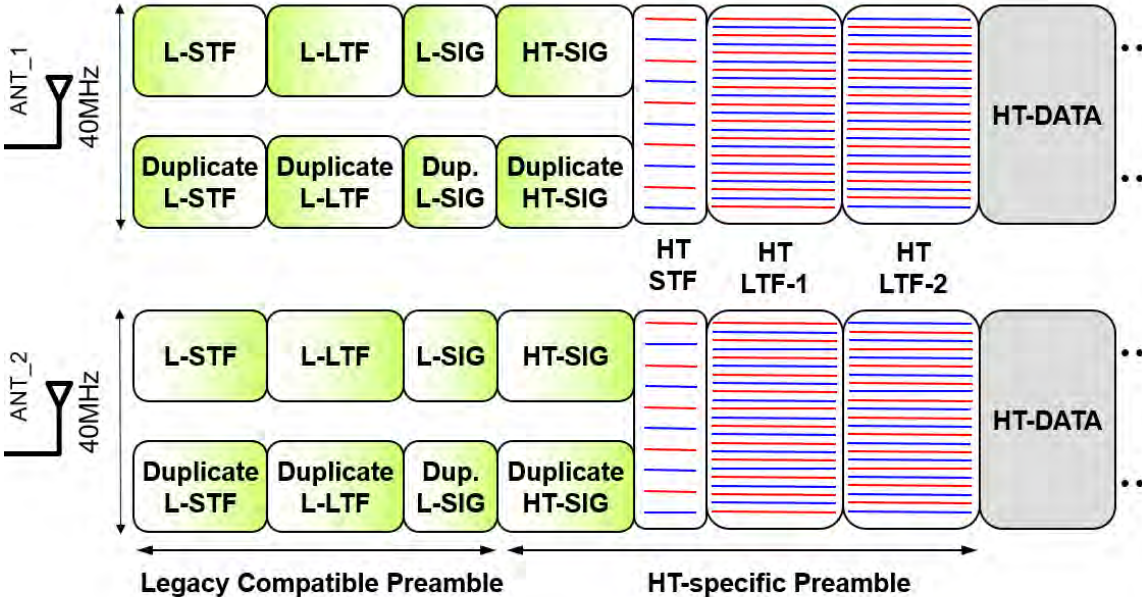
Claim Elements	Disclosures in the TGn Sync Proposal
	[TGn Sync Proposal 2005, 73-77] 11.2 PLCP Sublayer 11.2.1 Basic MIMO Mode As described in Table 20, the basic MIMO mode does not involve any spatial steering. The basic MIMO mode can operate in both 20MHz and 40MHz channel bandwidths. 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode: Figure 30: PPDU Format for N_{Tx} antennas

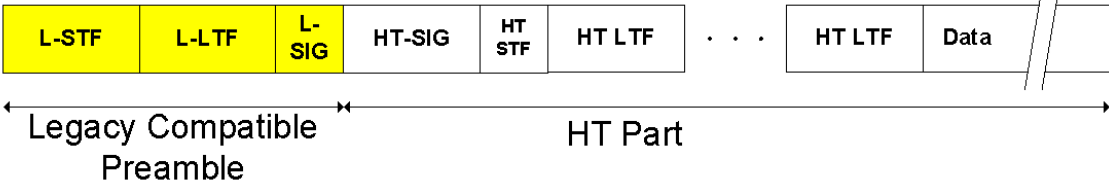
Claim Elements	Disclosures in the TGn Sync Proposal
	L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31:

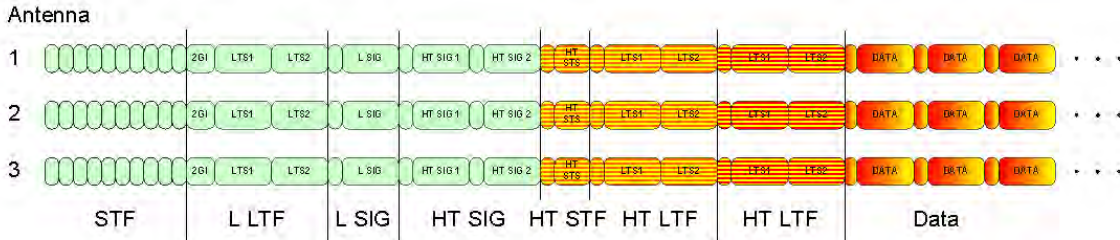


Claim Elements	Disclosures in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF N_{ss}=1 GI HT-LTS HT-LTS N_{ss}=2 GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS N_{ss}=3 GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS N_{ss}=4 GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

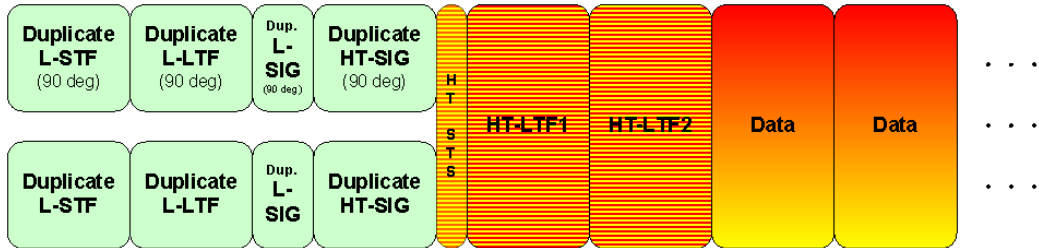
Claim Elements	Disclosures in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12]

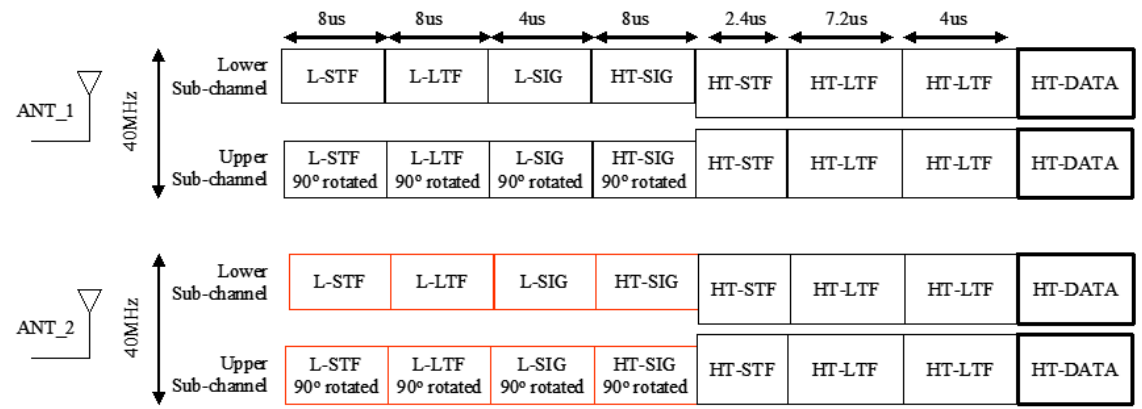
Claim Elements	Disclosures in the TGn Sync Proposal
	March 2005 doc.: IEEE 802.11-04/888r9 HT-PPDU Format in 40MHz  The diagram illustrates the HT-PPDU Format in 40MHz for two antennas, ANT_1 and ANT_2. Each antenna transmits a 40MHz signal. The format is divided into two main sections: the Legacy Compatible Preamble and the HT-specific Preamble. The Legacy Compatible Preamble consists of L-STF, L-LTF, L-SIG, and HT-SIG. The HT-specific Preamble consists of Duplicate L-STF, Duplicate L-LTF, Dup. L-SIG, Duplicate HT-SIG, HT STF, HT LTF-1, HT LTF-2, and HT-DATA. The diagram shows that the Legacy Compatible Preamble is duplicated across both antennas, while the HT-specific Preamble is transmitted only by ANT_1. The HT-specific Preamble is further divided into HT STF, HT LTF-1, and HT LTF-2, which are followed by HT-DATA. The diagram also shows that the Legacy Compatible Preamble is duplicated across both antennas, while the HT-specific Preamble is transmitted only by ANT_1. Submission Slide 50 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync Proposal Presentation, Slide 50]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PPDU Format  <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

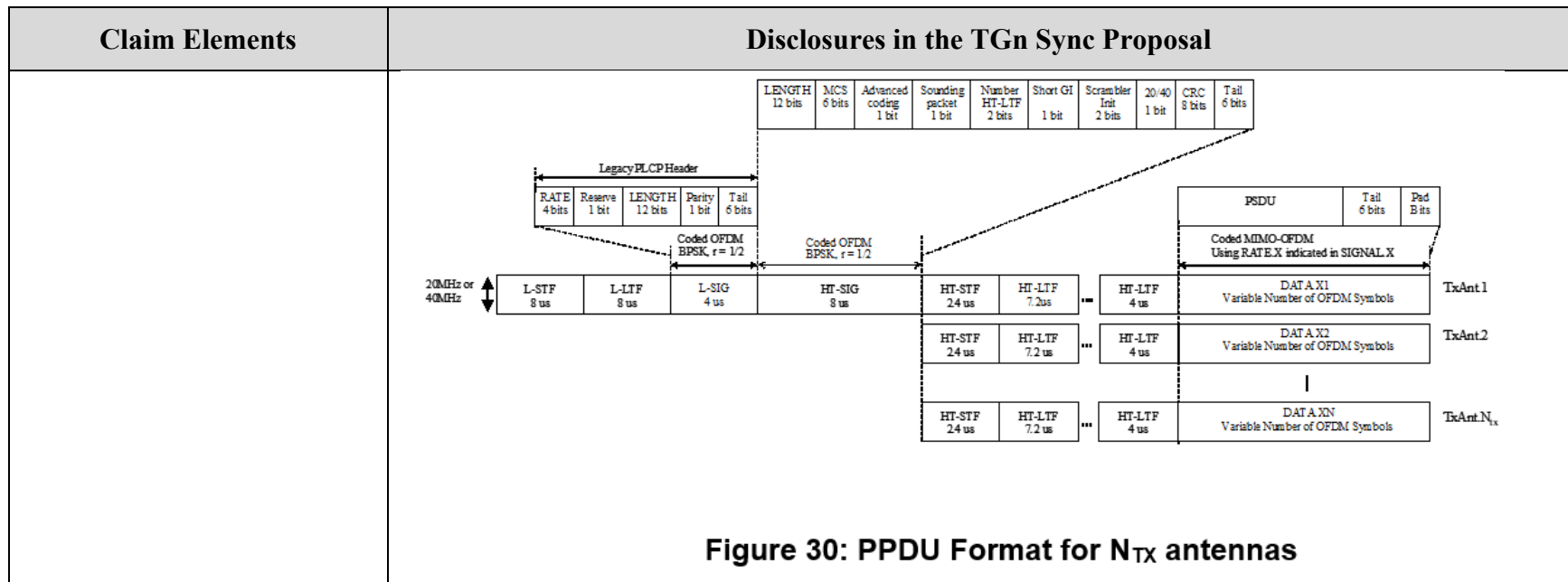
Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead  These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna 1 . . . 2 . . . 3 . . . L-STF L-LTF L-SIG HT-SIG The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. or single antenna Antenna 1 . . . 2 . . . 3 . . . L-STF L-LTF L-SIG HT-SIG Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

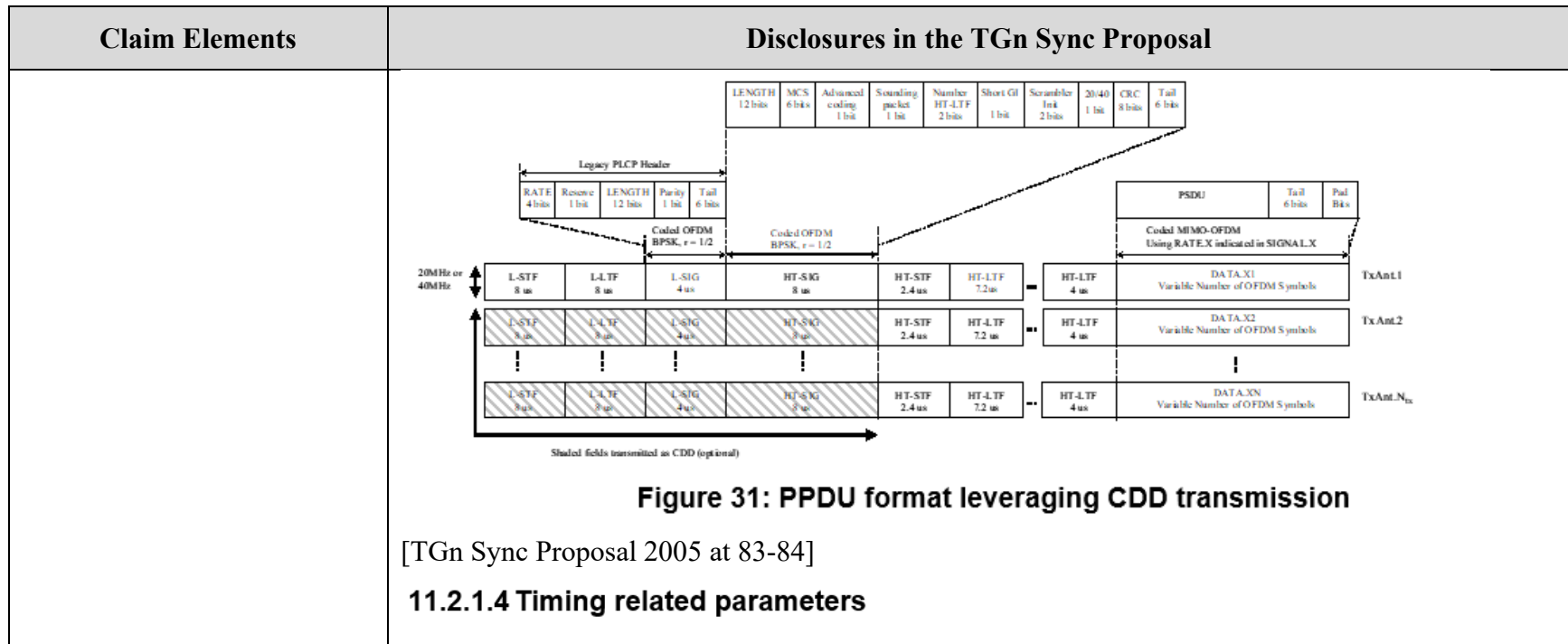
Claim Elements	Disclosures in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	The TGn Sync Proposal 2005 discloses demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bit. For example, the reference discloses the following:

Claim Elements	Disclosures in the TGn Sync Proposal
	The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 26.  Figure 26: PPDU Format for 2x40 Basic MIMO Transmission⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 11.1.1.2.2. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 26. [TGn Sync Proposal 2005 at 74] The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF).

Claim Elements	Disclosures in the TGn Sync Proposal
	Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. [TGn Sync Proposal 2005 at 75] 11.2 PLCP Sublayer 11.2.1 Basic MIMO Mode As described in Table 20, the basic MIMO mode does not involve any spatial steering. The basic MIMO mode can operate in both 20MHz and 40MHz channel bandwidths. 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode:



Claim Elements	Disclosures in the TGn Sync Proposal
	L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31:



Claim Elements	Disclosures in the TGn Sync Proposal		
	Parameter	Value for 20 MHz Channel	Value for 40 MHz Channel
	N_{SD} : Number of data subcarriers	52	108
	N_{SP} : Number of pilot subcarriers	4	6
	N_{SN} : Number of center null subcarriers	1 (tone = 0)	3 (tones = -1,0,+1)
	N_{SR} : Subcarrier range (index range)	28 (-28 ... +28)	58 (-58 ... +58)
	Δ_F : Subcarrier frequency spacing	0.3125 MHz (= 20 MHz / 64)	0.3125 MHz (= 40 MHz / 128)
	T_{FFT} : IFFT/FFT period	3.2 μ sec	3.2 μ sec
	T_{GI} : GI duration	0.8 μ sec	0.8 μ sec
	$T_{ShortGI}$: Short GI duration	0.4 μ sec	0.4 μ sec
	T_{GI2} : Legacy LongTraining symbol GI duration	1.6 μ sec	1.6 μ sec
	T_{SYM} : Symbol interval	4 μ sec	4 μ sec
	T_{L-STF} : Legacy STF duration	8 μ sec	8 μ sec
	T_{L-LTF} : Legacy LTF duration	8 μ sec	8 μ sec
	T_{L-SIG} : Legacy Signal Field duration	4 μ sec	4 μ sec
	T_{HT-SIG} : HT Signal Field duration	8 μ sec	8 μ sec
	T_{HT-STF} : HT Short training field duration	2.4 μ sec	2.4 μ sec
	$T_{HT-LTF1}$: HT Long training field duration	7.2 μ sec	7.2 μ sec
	$T_{HT-LTF2}$: HT Long training field duration	4 μ sec	4 μ sec
	T_S : Nyquist sampling interval	50nsec	25nsec
Table 23: Timing Related Parameters [TGn Sync Proposal 2005 at 88]			

Disclosures in the TGn Sync Proposal

11.2.1.6.1 Legacy Short Training Field

The L-STTS is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is the L-STTS is

$$S_{-28,28} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0\} \quad (17)$$

The normalization factor $\sqrt{1/2}$ is the QPSK normalization.

The legacy short training OFDM symbol in 40MHz mode is:

$$S_{-58,58} = \sqrt{1/2} \{0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,0,0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0,0,0,0,0,0,0,0,0,0,0,j-1,0,0,0,-j+1,0,0,0,j-1,0,0,0,-j+1,0,0,0,-j+1,0,0,0,j-1,0,0,0,-j+1,0,0,0,-j+1,0,0,0,j-1,0,0,0,j-1,0,0,0,j-1,0,0,0,j-1,0,0\} \quad (18)$$

The tones in the upper subchannel (see Figure 25) are obtained by phase rotating the 802.11a short OFDM training symbol tones by 90 degrees, whereas the tones in the lower subchannel are identical to the 802.11a short training OFDM symbol tones. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz.

The L-STF is

$$r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{L-STF}^{Tone}}} w_{L-STF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{TX}}^{L(k)} S_k \exp(j 2\pi k \Delta_F t) \quad (19)$$

where we recall that $\mathbf{q}^{L(k)}$ is the column vector that defines the antenna map for the legacy compatible part. Observe that equation (19) is identical to the general expression (15) with $X_{\hat{k}}^{(i_n)} = q_{i_n}^{L(k)} S_{\hat{k}}$.

Claim Elements	Disclosures in the TGn Sync Proposal
	The L-STs has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s, hence there are 10 L-STs in the L-STF. [91] 11.2.1.6.2 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1\} \quad (20)$ The legacy long training OFDM signal in the 40MHz mode is given by: $L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,1,1,1,0,0,0,0,0, \\ 0,0,0,0,0,0,0,j,j,-j,-j,j,j,-j,j,-j,j,j,j,j,-j,-j,j,j,-j,j,-j,j,j,j,0, \\ j,-j,-j,j,j,-j,j,-j,j,-j,-j,-j,-j,-j,j,j,-j,-j,j,-j,j,j,j\} \quad (21)$

Claim Elements	Disclosures in the TGn Sync Proposal
	Tones in the upper subchannel (subcarriers +6 to +58) are obtained by phase rotating the 802.11a long OFDM training symbol tones by 90 degrees, whereas the tones within the lower subchannel (subcarriers -58 to -6) are identical to the 802.11a long OFDM training symbol tones. It should be noted that neither the legacy fields (L-STF, L-LTF, LSIG) nor the HT-SIG undergo any phase rotation in the lower subchannel. The subcarriers at ± 32 in 40MHz, which are the DC subcarriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is $r_{L-LTF}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{L-LTF}^{Tone}}} w_{L-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} L_k \exp(j 2\pi k \Delta_F (t - T_{2GI})) \quad (22)$ where $T_{GI2} = 1.6 \mu \text{ sec}$. Observe that equation (22) is identical to the general expression (15) with $X_k^{(i_{rx})} = q_{i_{rx}}^{L(k)} L_k$. Since $T_{L-LTF} = 8.0 \mu \text{ sec}$ and the symbol duration is $T_{FFT} = 3.2 \mu \text{ sec}$, we see that the L-LTF consists of a double GI followed by two full symbols. [91-92] 11.2.1.6.3 HT-Short Training Field The HT-STF follows the HT-SIG (see Figure 30), whose purpose it to “fine tune” the AGC for HT MIMO reception. Note that the first AGC operation is performed on the L-STF. The HT-STF for 20MHz is

Claim Elements	Disclosures in the TGN Sync Proposal
	$HTS_{-26,26} = \frac{1}{\sqrt{2}} \left\{ \begin{array}{l} \{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 0\} \quad N_{rs} = 1 \\ \\ \{0, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, \} \quad N_{rs} = 2 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{rs} = 3 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \quad N_{rs} = 4 \end{array} \right. \quad (23)$ The HT-STS for 40 MHz consists of 48 tones, and is given by:

Claim Elements	Disclosures in the TGN Sync Proposal
	$HTS_{SS,58} = \frac{1}{\sqrt{2}}$ $\{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, N_{Tx} = 1$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, N_{Tx} = 2$ $0, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, N_{Tx} = 3$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 0\}$ (24)

(25)

Claim Elements	Disclosures in the TGn Sync Proposal
	where $T_{GI} = 0.8\mu s$, N_{HT-STF}^{Tone} is the number of active tones (= 24 for 20 MHz and 48 for 40 MHz), and $u(k)$ is the unit step function (= 0 for $k < 0$ and = 1 for $k \geq 0$). Tone interleaving across spatial streams works as follows. Define $i(k) = k + N_{HT-STF}^{Tone} - u(k)$, which appears in the column subscript of the Q-matrix. HTS_k is non-zero only for even values of the tone index k between $-N_{HT-STF}^{Tone}$ and $+N_{HT-STF}^{Tone}$, excluding $k = 0$. Thus, $i(k)$ runs through the integer values 0, ..., $N_{HT-STF}^{Tone} - 1$ as k runs through the even values $-N_{HT-STF}^{Tone}, \dots, -2, +2, \dots, +N_{HT-STF}^{Tone}$. The index $i(k)$ can be called the “interleaving index” because it is used to select the column of the Q-matrix, which define to spatial streams, that used on tone index k. We select spatial stream $i(k)\%N_{SS}$ for tone k. The HT-STF signal has a period of $1.6\mu s$, which is deemed sufficient for power measurement purposes. Since the HT-STF is tone-interleaved at the transmitter, the power periodicity of the HT-STF is also $1.6\mu s$. [TGn Sync Proposal 2005 at 92-94]

Claim Elements	Disclosures in the TGN Sync Proposal
	11.2.1.6.4 HT-Long Training Field The HT-LTFs are transmitted after the HT-STF. The number of HT-LTFs is equal to N_{LTF}. For any PPDU, there must be at least as many HT-LTFs as spatial streams in the HT Data portion of the PPDU, i.e. $N_{LTF} = N_{SS}$ (the number of spatial streams). For a sounding PPDU $N_{LTF} \geq N_{SS}$, because these PPDUs provide channel measurement capability for potentially more spatial dimensions than the number of spatial streams. In the case of a sounding packet, the HT-LTFs are partitioned as data HT-LTFs and extension HT-LTFs. The data HT-LTFs are the first N_{SS} fields, which are indexed $i_{LTF} = 0, \dots, N_{SS} - 1$. The last $N_{LTF} - N_{SS}$ HT-LTFs are the extension fields, which are indexed $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. The result is referred to as a segmented HT-LTF. As always, spatial streams are defined by columns of an orthogonal antenna map matrix $\mathbf{Q}^{(k)}$, with the first N_{SS} columns defining the spatial streams used for data transmission, and the last $N_{LTF} - N_{SS}$ columns defining the extension spatial streams. Thus, for the purpose of defining HT-LTFs, $\mathbf{Q}^{(k)}$ is an $N_{Tx} \times N_{LTF}$ dimension matrix. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second and all subsequent HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. To minimize the power fluctuation between the HT-LTF and the AGC setting (which is derived from the HT-STF), the HT-LTS is tone-interleaved across spatial streams, <u>similar to</u> the HT-STF definition. There are a total of 9 sequences. These sequences are defined to minimize PAPR for both direct MAP and spatial spreading, with tone-interleaving.

Claim Elements	Disclosures in the TGN Sync Proposal																																								
	Table 25: List of HT Long Training Fields <table><tr><th>Sequence Number</th><th>N_{TX}</th><th>BW</th><th>Comment</th></tr><tr><td>1</td><td>1</td><td>20MHz</td><td>56 tones</td></tr><tr><td>2</td><td>2</td><td>20MHz</td><td>56 tones</td></tr><tr><td>3</td><td>3</td><td>20MHz</td><td>56 tones</td></tr><tr><td>4</td><td>4</td><td>20MHz</td><td>56 tones</td></tr><tr><td>5</td><td>1</td><td>40MHz</td><td>Duplicate format, 6Mbps in 40MHz (104 Tones)</td></tr><tr><td>6</td><td>1</td><td>40MHz</td><td>114 tones</td></tr><tr><td>7</td><td>2</td><td>40MHz</td><td>114 tones</td></tr><tr><td>8</td><td>3</td><td>40MHz</td><td>114 tones</td></tr><tr><td>9</td><td>4</td><td>40MHz</td><td>114 tones</td></tr></table> In 20MHz, for $N_{TX} = 1$, sequence 1 is: $\text{HTL}_{-28:28}=[-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1, 1, 1, 1, -1, 1, 1, -1, 1, 0, -1, -1, -1, 1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1] \quad (26)$ In 20MHz, for $N_{TX} = 2$, sequence 2 is: $\text{HTL}_{-28:28}=[-1, -1, 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, -1, 1, 0, -1, -1, -1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, 1, 1, 1, 1, 1, 1, 1] \quad (27)$ In 20MHz, for $N_{TX} = 3$, sequence 3 is: $\text{HTL}_{-28:28}=[1, -1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, -1, 1, -1, -1, 1, -1, 0, 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, 1, -1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1] \quad (28)$	Sequence Number	N _{TX}	BW	Comment	1	1	20MHz	56 tones	2	2	20MHz	56 tones	3	3	20MHz	56 tones	4	4	20MHz	56 tones	5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)	6	1	40MHz	114 tones	7	2	40MHz	114 tones	8	3	40MHz	114 tones	9	4	40MHz	114 tones
Sequence Number	N _{TX}	BW	Comment																																						
1	1	20MHz	56 tones																																						
2	2	20MHz	56 tones																																						
3	3	20MHz	56 tones																																						
4	4	20MHz	56 tones																																						
5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)																																						
6	1	40MHz	114 tones																																						
7	2	40MHz	114 tones																																						
8	3	40MHz	114 tones																																						
9	4	40MHz	114 tones																																						

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In 20MHz, for $N_{TX} = 4$, sequence 4 is:

(30)

In 40MHz, for $N_{TX} = 2$, sequence 7 is:

(31)

(32)

In 40MHz, for $N_{TX} = 3$, sequence 8 is:

Claim Elements	Disclosures in the TGN Sync Proposal
	$HTL_{-58,+58} = \{-1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1$ $1 1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 \quad (33)$ $0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1$ $-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 \}$ The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets: In 40MHz, for $N_{TX} = 4$, sequence 9 is: $HTL_{-58,+58} = \{-1 1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 1 -1 1 -1$ $1 -1 -1 -1 -1 1 1 -1 -1 -1 1 1 1 -1 1 -1 -1 1 1 1 1 1 -1 -1 -1 1 0 \quad (34)$ $0 0 -1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 1 1 -1 -1 -1 1 -1 -1 -1 1 -1 1 -1$ $-1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 -1 -1 1 -1 1 -1 1 1 \}$ The HT-LTF is generated similarly to the HT-STF. For the data HT-LTFs $i_{LTF} = 0, \dots, N_{SS} - 1$, the signal is $r_{HT-LTF}^{(i_{TX}, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \quad (35)$ $\sum_{k=-N_{SR}}^{N_{SR}} Q_{i_{TX}, (k+i_{LTF}+N_{SR}-u(k)) \% N_{SS}}^{(k)} HTL_k \exp(j2\pi k \Delta_F (t - T_{GI}))$

Claim Elements	Disclosures in the TGN Sync Proposal
	where $N_{SR} = 28$ for 20 MHz and 58 for 40 MHz, $u(k) = \begin{cases} 1 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 20 MHz} \quad (36)$ and $u(k) = \begin{cases} 3 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 40 MHz.} \quad (37)$ In the case of a sounding packet, the extension HT-LTFs are tone interleaved over the extension spatial dimensions. Thus, the extension HT-LTFs are $r_{HT-LTF}^{(i_D, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_D, N_{SS} + (k + (i_{LTF} - N_{SS}) + N_{SR} - u(k)) \% (N_{LTF} - N_{SS})} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (38)$ for $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. Since the HT-LTF is tone interleaved across antennas, the 56 tones are partitioned across the antenna array during each OFDM symbol. Tone partitioning into sets for 20MHz is shown in Table 26. At each OFDM symbol interval, each set of tones maps to one transmit antenna. And over time, all sets get mapped to an antenna.

Claim Elements	Disclosures in the TGn Sync Proposal																																																						
	<table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-28:1:-1] [1:1:+28]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-28:2:-2] [2:2:28]</td><td>[-27:2:-1] [1:2:27]</td><td></td><td></td></tr><tr><td>3</td><td>[-28:3:-1] [2:3:26]</td><td>[-27:3:-3] [3:3:27]</td><td>[-26:3:-2] [1:3:28]</td><td></td></tr><tr><td>4</td><td>[-28:4:-4] [1:4:25]</td><td>[-27:4:-3] [2:4:26]</td><td>[-26:4:-2] [3:4:27]</td><td>[-25:4:-2] [4:4:28]</td></tr></table> Table 26: Tone partitioning into sets for 20MHz (56 tones) <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-58:1:-2] [2:1:+58]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-58:2:-2] [2:2:+58]</td><td>[-57:2:-3] [3:2:57]</td><td></td><td></td></tr><tr><td>3</td><td>[-58:3:-4] [2:3:56]</td><td>[-57:3:-3] [3:3:57]</td><td>[-56:3:-2] [4:3:58]</td><td></td></tr><tr><td>4</td><td>[-58:4:-2] [5:4:57]</td><td>[-57:4:-5] [2:4:58]</td><td>[-56:4:-4] [3:4:55]</td><td>[-55:4:-3] [4:4:56]</td></tr></table> Table 27: Tone partitioning into sets for 40MHz (114 tones) An example of tone interleaving across 4 transmit antennas is shown in Figure 34.					Nss	Set 0	Set 1	Set 2	Set 3	1	[-28:1:-1] [1:1:+28]				2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]			3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]		4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]	Nss	Set 0	Set 1	Set 2	Set 3	1	[-58:1:-2] [2:1:+58]				2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]			3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]		4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]
Nss	Set 0	Set 1	Set 2	Set 3																																																			
1	[-28:1:-1] [1:1:+28]																																																						
2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]																																																					
3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]																																																				
4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]																																																			
Nss	Set 0	Set 1	Set 2	Set 3																																																			
1	[-58:1:-2] [2:1:+58]																																																						
2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]																																																					
3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]																																																				
4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]																																																			

Claim Elements	Disclosures in the TGn Sync Proposal																																																																											
		HT-LTF 0	HT-LTF 1	HT-LTF 2	HT-LTF 3																																																																							
	SS 0	Set 0	Set 3	Set 2	Set 1																																																																							
	SS 1	Set 1	Set 0	Set 3	Set 2																																																																							
	SS 2	Set 2	Set 1	Set 0	Set 3																																																																							
	SS 3	Set 3	Set 2	Set 1	Set 0																																																																							
		Figure 34: HT-LTF tone interleaving across 4 spatial streams [TGn Sync Proposal 2005 at 94-98] 11.2.1.7.1 L-SIG <table> <tr> <th colspan="5">RATE (4 bits)</th> <th colspan="12">LENGTH (12 bits)</th> <th colspan="6">SIGNAL TAIL (6 bits)</th> </tr> <tr> <td>R1</td><td>R2</td><td>R3</td><td>R4</td><td>R</td> <td colspan="12">LSB</td> <td>MSB</td> <td>P</td> <td colspan="5">0⁰ 0¹ 0² 0³ 0⁴ 0⁵</td> </tr> <tr> <td>0</td><td>1</td><td>2</td><td>3</td><td>4</td> <td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td> <td>17</td> <td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td> </tr> </table> Figure 36: SIGNAL field bit assignment In the 20MHz mode, the format of the LSIG field shall be the same as the SIGNAL field as defined in figure 111 in 17.3.4 in [1]. The combination of RATE and LENGTH is used to signal a station (OFDM mode only) the duration of a HT transmission. This duration does not have to be the actual duration of the HT frame. It can be used to reserve the medium beyond the actual transmission. The reservation of the medium through this kind of signalling is called “spoofing”.				RATE (4 bits)					LENGTH (12 bits)												SIGNAL TAIL (6 bits)						R1	R2	R3	R4	R	LSB												MSB	P	0 ⁰ 0 ¹ 0 ² 0 ³ 0 ⁴ 0 ⁵					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
RATE (4 bits)					LENGTH (12 bits)												SIGNAL TAIL (6 bits)																																																											
R1	R2	R3	R4	R	LSB												MSB	P	0 ⁰ 0 ¹ 0 ² 0 ³ 0 ⁴ 0 ⁵																																																									
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																																																					

Claim Elements	Disclosures in the TGn Sync Proposal
	To prevent a legacy station from accessing the medium during a HT frame transmission, the “duration” calculated from the RATE and LENGTH fields shall be at least as large as the actual duration of the HT frame, which is measured from the end of the L-SIG field to the end of the DATA field. During an HT transmission, the RATE field is set to 6Mbps, whereas the LENGTH field is set based on the “duration” value. In the 40MHz mode, the legacy signal field is duplicated such that tones are filled from -58 to -6 (lower-subchannel), and from +6 to +58 (upper-subchannel). The upper subchannel shall be phase rotated by 90 degrees, in the same way as the LTS as described in 11.2.1.6.2 The LSIG shall be transmitted in the same fashion as the legacy short and the legacy long training fields. If L-STF and L-LTF are transmitted from a single antenna, we index that antenna as $i_{Tx} = 1$ to be consistent with 11.2.1.6.2. Denote $LSIG_{-26,26}$ and $LSIG_{-58,58}$ as the LSIG OFDM symbol generated for 20 MHz and 40 MHz respectively. The L-SIG waveform is $r_{L-SIG}^{i_{Tx}}(t) = \frac{1}{\sqrt{N_{L-SIG}^{Tone}}} w_{L-SIG}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} LSIG_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (39)$ [TGn Sync Proposal 2005 at 98-99] 11.2.1.7.2 HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause 11.2.1.7.

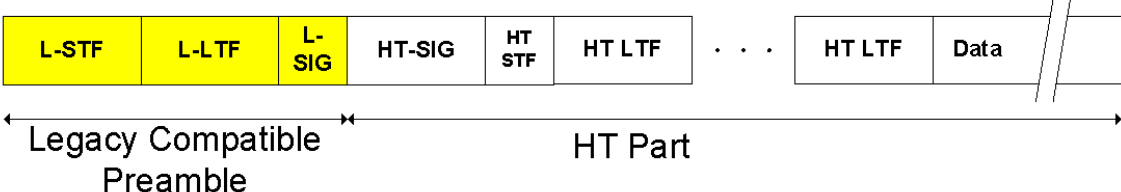
Claim Elements	Disclosures in the TGn Sync Proposal
	In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in 11.2.1.6.2. Figure 37 shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t - nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t - T_{GI} - nT_{Symb})) \quad (40)$ where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration.

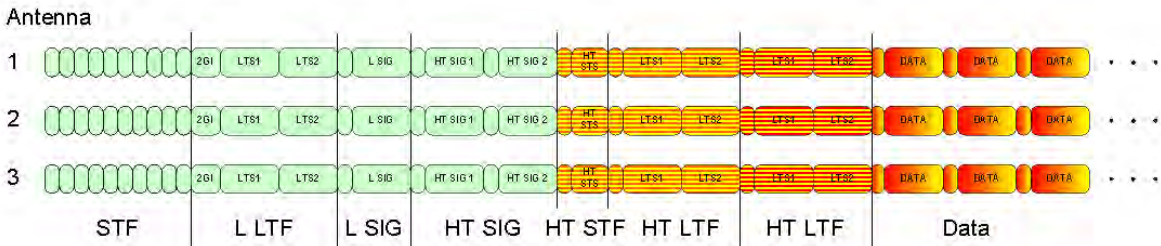
Claim Elements	Disclosures in the TGn Sync Proposal
	Figure 37: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment [TGn Sync Proposal 2005 at 100-101] 11.2.1.7.2.10 SIGNALTAIL The bits 18-23 constitute the SIGNALTAIL field, and all 6 bits shall be set to zero. [TGn Sync Proposal 2005 at 104] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would have been obvious in view of the combination with PHY Updates to TGn Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005)(“2005 TGn Sync PHY Updates”). One of ordinary skill in the art would have been motivated to combine the TGn Sync Proposal 2005 with the 2005 TGn Sync PHY Updates. For example, the documents were disclosed by the same group

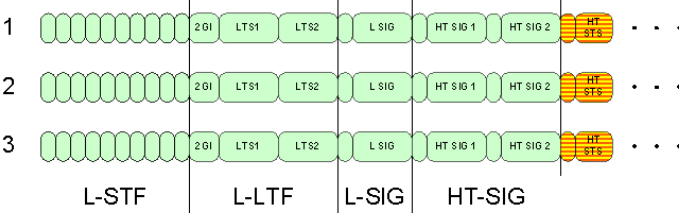
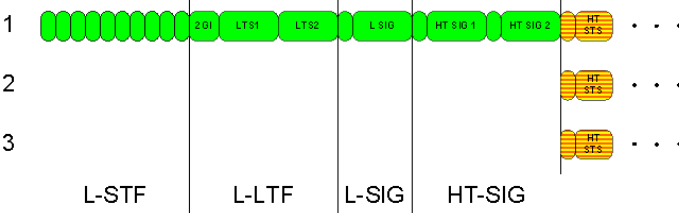
Claim Elements	Disclosures in the TGn Sync Proposal
	at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync PHY Updates disclosed, for example: <u>May 2005</u> <u>doc.: IEEE 802.11-05/0418r0</u> HT-LTF The diagram illustrates the HT-LTF structure for different values of N_{ss} (Number of Spatial Streams). The structure is defined by the following durations and field sequences: 7.2us: Duration of the first three fields (GI, HT-LTS, HT-LTS) for $N_{ss}=1$. 4us: Duration of the fourth field (GI) for $N_{ss}=1, 2, 3, 4$. 4us: Duration of the fifth field (Tone interleaved HT-LTS) for $N_{ss}=1, 2, 3, 4$. 4us: Duration of the sixth field (GI) for $N_{ss}=2, 3, 4$. 4us: Duration of the seventh field (Tone interleaved HT-LTS) for $N_{ss}=2, 3, 4$. The field sequences for each N_{ss} are as follows: $N_{ss}=1$: GI, HT-LTS, HT-LTS $N_{ss}=2$: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS $N_{ss}=3$: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS $N_{ss}=4$: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

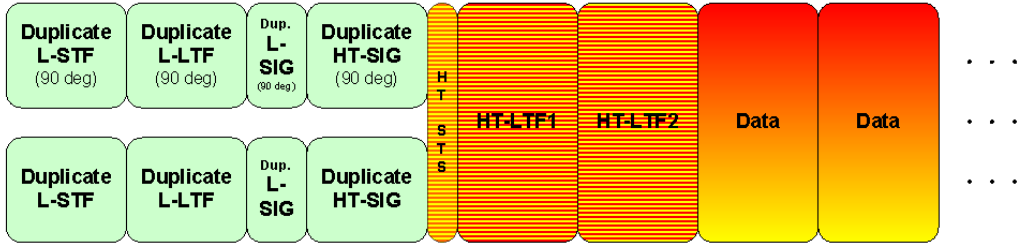
Claim Elements	Disclosures in the TGn Sync Proposal
	<u>May 2005</u> <u>doc.: IEEE 802.11-05/0418r0</u> HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would also have been obvious in view of the combination with TGn Sync Complete Proposal, Document No. IEEE.11-04/888r9 (March 4, 2005)(“2005 TGn Sync Proposal Presentation”). One

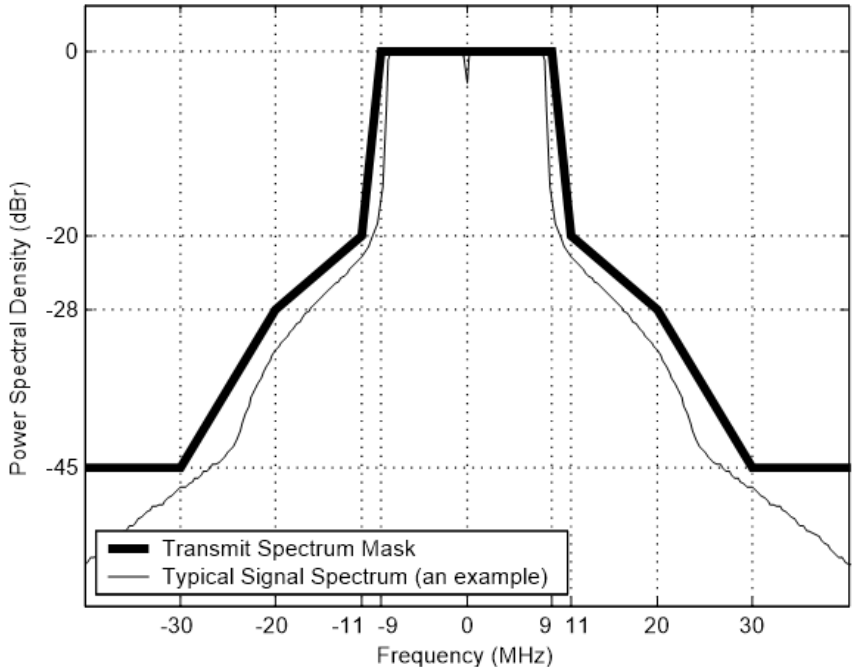
Claim Elements	Disclosures in the TGn Sync Proposal
	of ordinary skill in the art would have been motivated to combine the TGn Sync Proposal 2005 and/or 2005 TGn Sync PHY Updates with the 2005 TGn Sync Proposal Presentation. For example, the documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync Proposal Presentation disclosed, for example: <u>March 2005</u> <u>doc.: IEEE 802.11-04/888r9</u> HT-PPDU Format in 40MHz Submission Slide 50 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync Proposal Presentation, Slide 50]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PPDU Format  <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

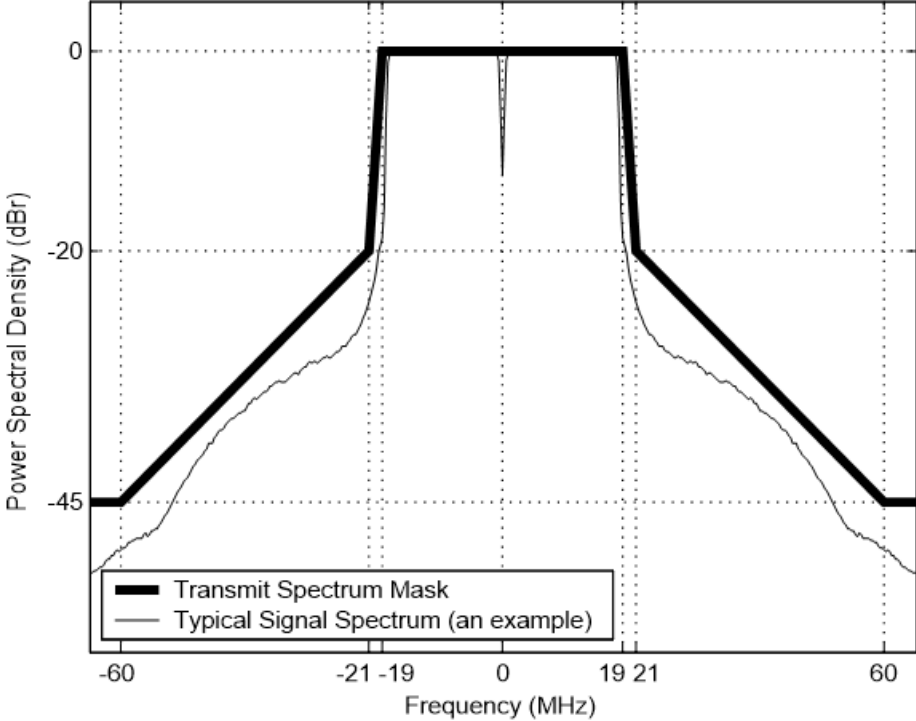
Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead  These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna  or single antenna Antenna  The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	The TGn Sync Proposal 2005 discloses that the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following:

Claim Elements	Disclosures in the TGN Sync Proposal
	11.2.1.10.1 Transmit spectral mask 11.2.1.10.1.1 20MHz channel spacing In the 20 MHz bandwidth mode the HT PHY shall follow 17.3.9.2 in ref [1]. The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18MHz, -20dBr at 11 MHz frequency offset, -28dBr at 20MHz frequency offset and -45dBr at 30MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 1. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. 20 MHz 802.11n Transmit Spectrum Mask  Figure 43: Transmit Spectrum Mask for 20MHz channelization

Claim Elements	Disclosures in the TGn Sync Proposal
	11.2.1.10.1.2 40MHz channel spacing The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 38MHz, -20dBr at 21 MHz frequency offset, and -45dBr at 60MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 2. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth.

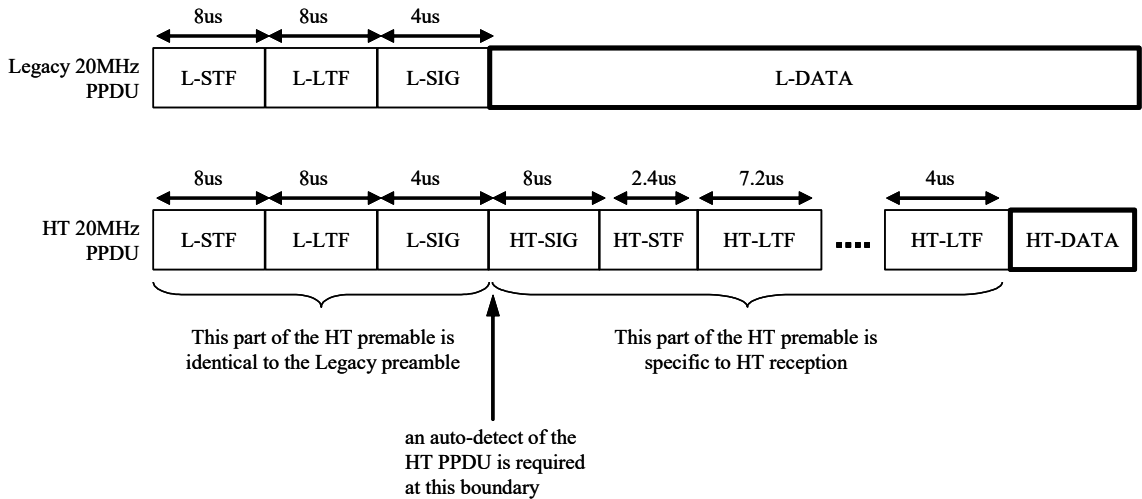
Claim Elements	Disclosures in the TGn Sync Proposal
	40 MHz 802.11n Transmit Spectrum Mask  Figure 44: Transmit spectrum mask for 40MHz channelization A HT device transmitting a 20MHz signal in a 40MHz BSS shall conform to the spectral mask shown in Figure 44. [TGn Sync Proposal 2005 at 114-116]

Claim Elements	Disclosures in the TGn Sync Proposal
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	TGn Sync Proposal 2005 disclosed a wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. See, e.g.: PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:  Figure 17: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.

Claim Elements	Disclosures in the TGN Sync Proposal
	Figure 18: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3. Figure 3 illustrates the PPDU format for two transmit antennas (ANT_1 and ANT_2), each operating on a 40MHz sub-channel. The format is divided into two sub-channels: Lower Sub-channel and Upper Sub-channel. The timing intervals for the fields are as follows: - Lower Sub-channel: L-STF (8us), L-LTF (8us), L-SIG (4us), HT-SIG (8us), HT-STF (2.4us), HT-LTF (7.2us), HT-LTF (4us), HT-DATA. - Upper Sub-channel: L-STF (90° rotated), L-LTF (90° rotated), L-SIG (90° rotated), HT-SIG (90° rotated), HT-STF, HT-LTF, HT-LTF, HT-DATA.

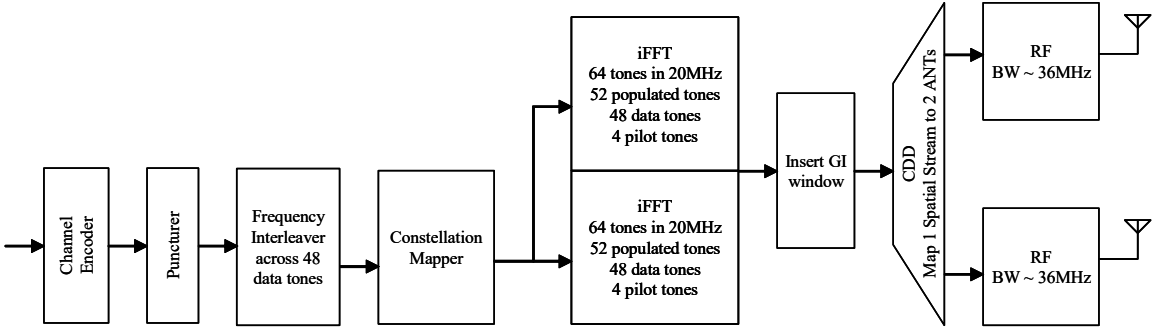
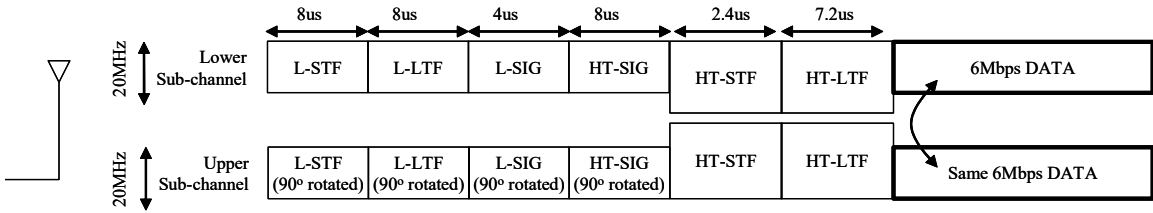
Claim Elements	Disclosures in the TGn Sync Proposal
	Figure 19: PPDU Format for 2x40 Basic MIMO Transmission⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 0. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PCLP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 15. Start-of-Packet (SoP) detection 16. AGC 17. Coarse Frequency Offset Estimation 18. Coarse Timing Offset Estimation 19. Fine Timing Offset Estimation 20. Fine Frequency Offset Estimation 21. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:

⁷ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosures in the TGN Sync Proposal
	 The diagram illustrates the HT Preamble format by comparing a Legacy 20MHz PPDU with an HT 20MHz PPDU. The Legacy PPDU consists of L-STF (8us), L-LTF (8us), L-SIG (4us), and L-DATA. The HT PPDU consists of L-STF (8us), L-LTF (8us), L-SIG (4us), HT-SIG (8us), HT-STF (2.4us), HT-LTF (7.2us), followed by an ellipsis and another HT-LTF (4us) and HT-DATA. A bracket under the L-STF, L-LTF, and L-SIG fields of the HT PPDU is labeled 'This part of the HT preamble is identical to the Legacy preamble'. Another bracket under the HT-SIG, HT-STF, and HT-LTF fields is labeled 'This part of the HT preamble is specific to HT reception'. An arrow points to the boundary between L-SIG and HT-SIG with the text 'an auto-detect of the HT PPDU is required at this boundary'. Figure 20: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF).

Claim Elements	Disclosures in the TGN Sync Proposal
	Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next. Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-

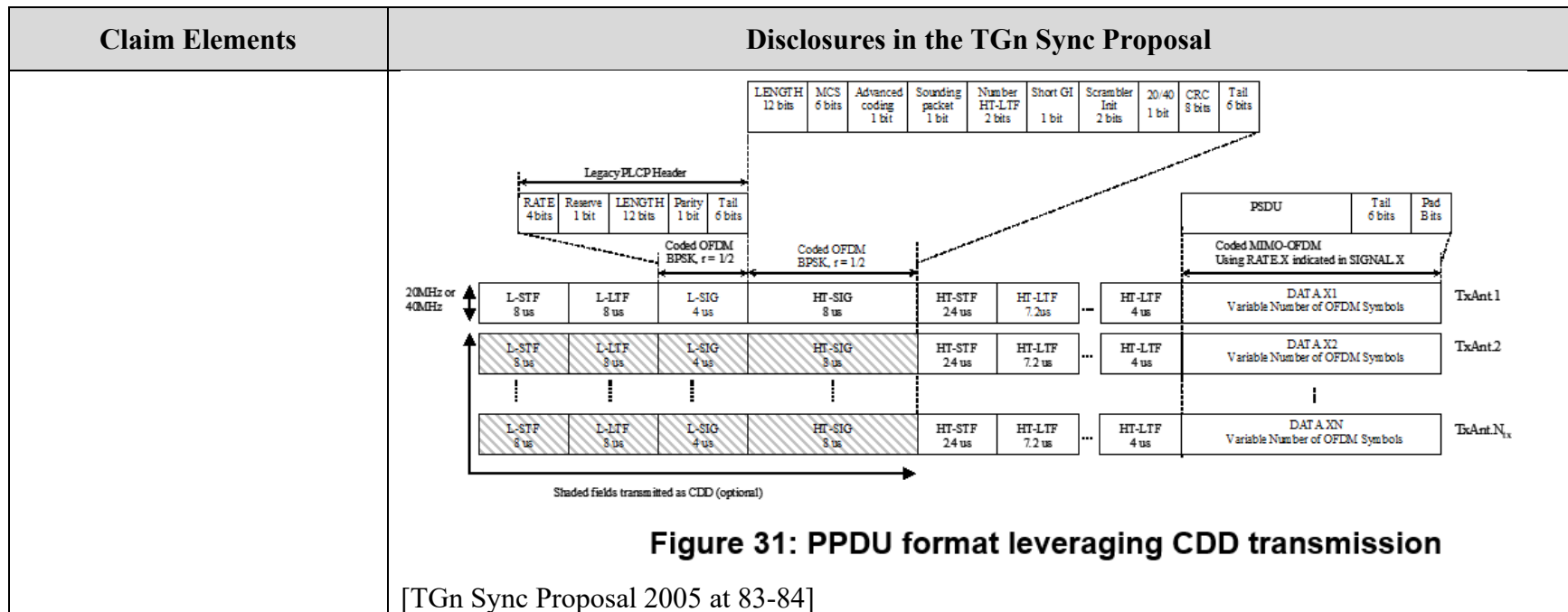
Claim Elements	Disclosures in the TGN Sync Proposal
	STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found.. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped

Claim Elements	Disclosures in the TGN Sync Proposal
	as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 21: Transmitter configuration for 6Mbps in 40MHz⁸ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:  Figure 22: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGN Sync Proposal2005, 73-77]

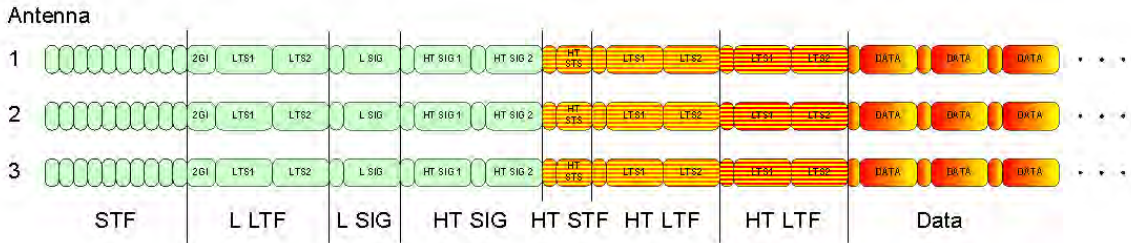
⁸ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosures in the TGN Sync Proposal
	11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode: Figure 30: PPDU Format for N_{Tx} antennas L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1.

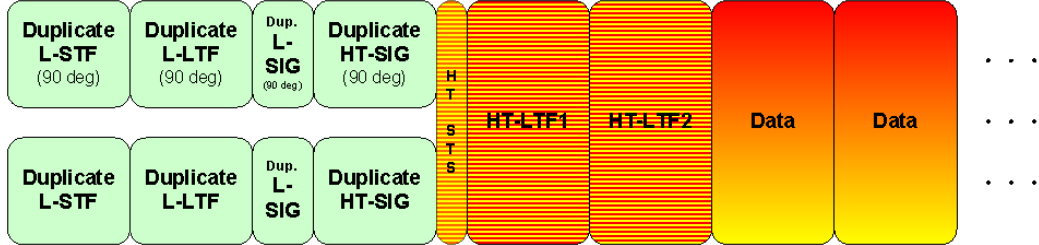
Claim Elements	Disclosures in the TGn Sync Proposal
	The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31:



Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PPDU Format The diagram illustrates the PPDU Format. It is divided into two main sections: the Legacy Compatible Preamble and the HT Part. The Legacy Compatible Preamble consists of three yellow boxes labeled L-STF, L-LTF, and L-SIG. The HT Part consists of a series of white boxes: HT-SIG, HT STF, HT LTF, followed by an ellipsis, then another HT LTF, and finally Data. A double slash indicates that the Data field can be of arbitrary length. A double-headed arrow spans the entire structure, with 'Legacy Compatible Preamble' centered under the first three boxes and 'HT Part' centered under the remaining boxes. <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead  These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

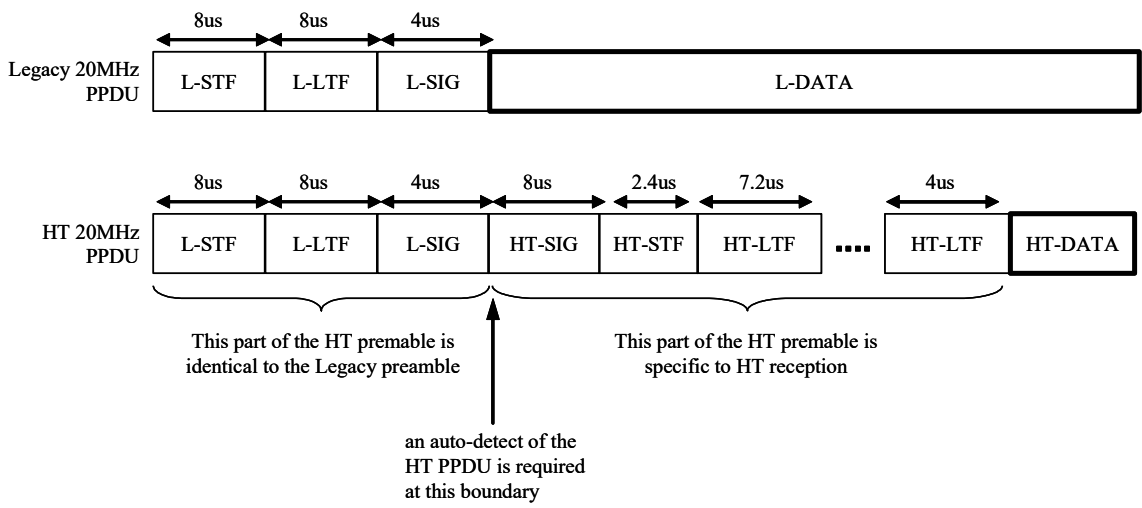
Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The diagram illustrates CDD transmission across three antennas. Each antenna transmits the same sequence of fields: L-STF, L-LTF, L-SIG, HT-SIG 1, HT-SIG 2, and HT-STF. The fields are represented by colored blocks: L-STF (green), L-LTF (green), L-SIG (green), HT-SIG 1 (green), HT-SIG 2 (green), and HT-STF (orange). The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. or single antenna Antenna The diagram illustrates single antenna transmission. Only the first antenna transmits the sequence of fields: L-STF, L-LTF, L-SIG, HT-SIG 1, HT-SIG 2, and HT-STF. The other two antennas are idle. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosures in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGN Sync 2004, slide 24]
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header	TGN Sync Proposal 2005 disclosed a wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower. See, e.g.:

Claim Elements	Disclosures in the TGN Sync Proposal
information of the first packet in the first narrower frequency band.	PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1: Figure 23: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active. Figure 24: Upper and Lower sub-channel specification in 40MHz

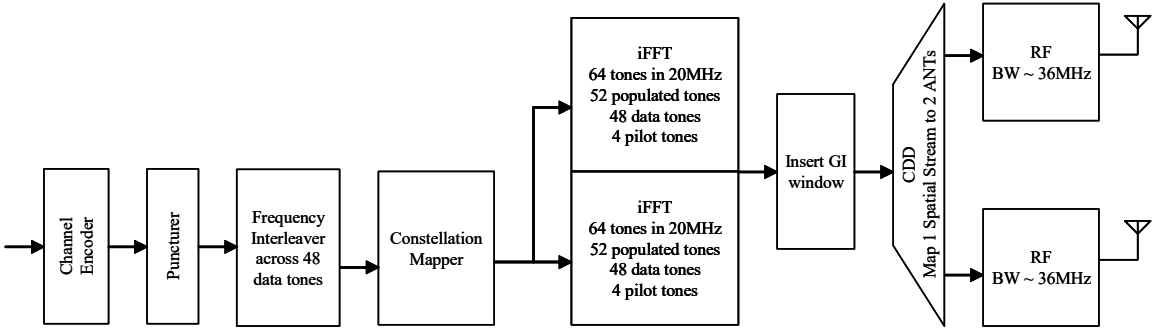
Claim Elements	Disclosures in the TGN Sync Proposal
	The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3. Figure 25: PPDU Format for 2x40 Basic MIMO Transmission⁹ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 0. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PCLP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 22. Start-of-Packet (SoP) detection 23. AGC

⁹ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

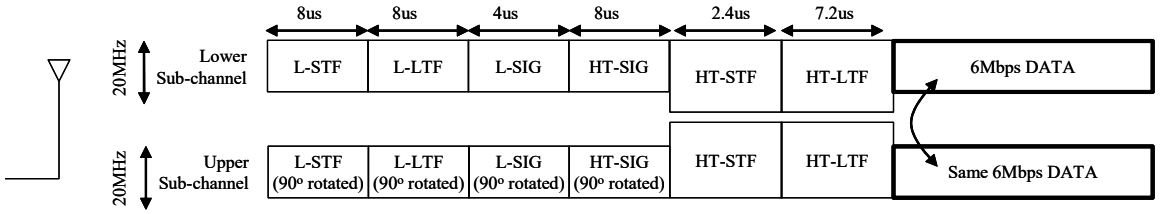
Claim Elements	Disclosures in the TGN Sync Proposal
	24. Coarse Frequency Offset Estimation 25. Coarse Timing Offset Estimation 26. Fine Timing Offset Estimation 27. Fine Frequency Offset Estimation 28. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 26: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosures in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosures in the TGn Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8us, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6us portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found.. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two

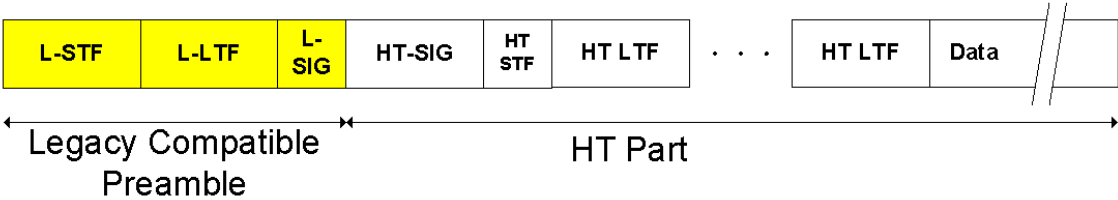
Claim Elements	Disclosures in the TGn Sync Proposal
	antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 27: Transmitter configuration for 6Mbps in 40MHz¹⁰ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

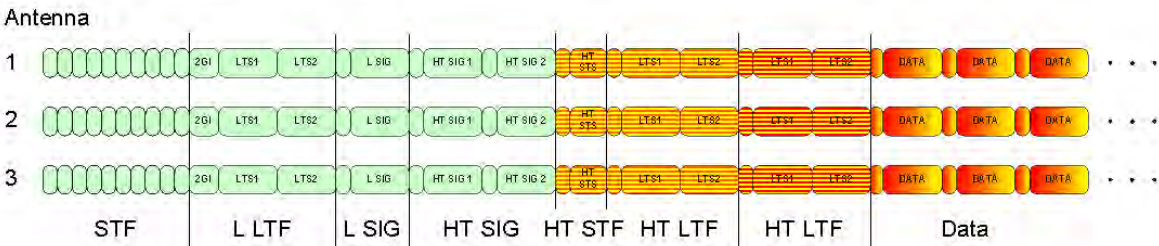
¹⁰ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosures in the TGn Sync Proposal
	 Figure 28: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77] 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode:

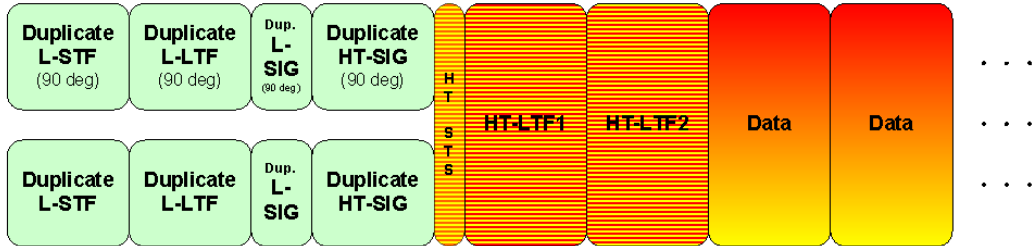
Claim Elements	Disclosures in the TGN Sync Proposal
	Figure 30: PPDU Format for N_{Tx} antennas L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of

Claim Elements	Disclosures in the TGN Sync Proposal
	the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31: Figure 31: PPDU format leveraging CDD transmission [TGN Sync Proposal 2005 at 83-84]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PPDU Format  <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability <u>Submission</u> <u>Slide 12</u> <u>Aon Mujtaba, Agere Systems, et al</u> [TGnSync 2004, slide 12]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead  These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. or single antenna Antenna Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosures in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[4] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	TGn Sync Proposal 2005 disclosed the wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band. <i>See, e.g.:</i> “The PHY techniques used to achieve the higher data rates involve a MIMO evolution of 802.11 OFDM PHY with spatial division multiplexing of spatial streams, wider bandwidth options (either

Claim Elements	Disclosures in the TGn Sync Proposal
	20MHz or 40MHz) and an optimized interleaver for both the 20 MHz and 40MHz channelizations. Additionally, optional enhancements include advanced FEC coding techniques (LDPC), transmit beamforming with negligible additional cost in the receiving client device and/or additional RF chains. These options provide extra scalability if additional robustness and/or throughput is required.” [TGn Sync Proposal 2005, 3] “Managed Mixed Mode Operation (Informative) This section describes a coexistence mechanism that permits a legacy network and an 802.11 HT network to operate co-channel without requiring the 802.11 HT devices to be able to communicate directly with the legacy devices. The mode is operated by an HT AP in managed mixed mode that has both legacy and HT STAs associated with it. Its HT STAs operate in pure mode. In this mode, the AP manages coexistence of legacy devices in its control channel with HT devices occupying the HT channel, which may be 20 or 40MHz wide depending on the operating mode of the AP. One way to do this is for the AP to periodically transmit a legacy CTS-to-self to start the HT phase and an HT CTS to start the legacy phase. Alternatively, the AP may combine setting the NAV with transmission of a beacon that contains a contention-free period element, and transmission of a matching CF-end at the end of the phase. The legacy beacon transmitted by an HT AP in managed mixed mode contains an element which causes any HT STA scanning for a network to ignore the duplicate legacy beacon. HT devices in pure mode should ignore legacy PPDU they may receive, so they do not receive NAV reservations intended for legacy devices. The case of a 40MHz channel where both 20MHz halves are overlapped by legacy devices is managed using the 20 MHz-base managed mixed mode which is described in section 0.

20 MHz-Base Managed Operation

This section describes a coexistence mechanism where a BSS operates in 20 MHz mode and switches to a 40 MHz capable phase under the control of an HT AP. Due to the protection of the 40 MHz period in both channels, it is tolerant of overlapping BSSs.

Assumptions

Legacy STAs and 20 MHz HT STAs may coexist with the 40 MHz capable HT STAs. An HT AP provides legacy protection against legacy STAs and 20 MHz HT STAs.

Description of 20MHz-Base Managed Operation

The 40 MHz capable HT AP divides time into 20 MHz and 40 MHz phases. In a 20 MHz phase, it ensures that the NAV of 40 MHz mode operation in 40 MHz capable HT STAs is set and STAs associated with the HT AP operate on the control channel. In the 40 MHz phase, the NAV of legacy STAs and 20 MHz HT STAs is set and the 40 MHz capable HT STAs associated with the HT AP operate in 40 MHz mode. The transition between 20 and 40 MHz phases is as follows:

Transition to 40 MHz phase

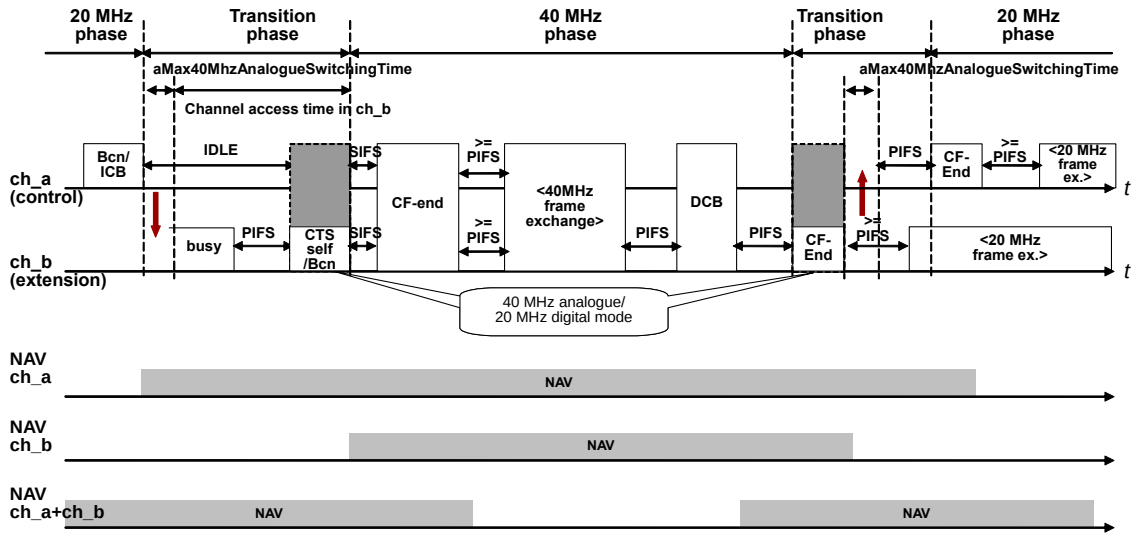
To start a 40 MHz phase, the HT AP first reserves the control channel by setting NAV of legacy and 20 MHz HT STAs with a legacy Beacon frame or an ICB frame. The CFP of the Beacon sent or the Duration/ID field of the ICB frame will be set to cover the 40 MHz phase plus the transition periods between 20 and 40 MHz operation. If the HT AP intends to continue the CFP after the 40 MHz phase, it may do so by setting longer values for the Duration/ID field. The transmission rate of the ICB frame shall be selected from the BSSBasicRateSet.

A 40 MHz capable HT STA associated with the HT AP extends its channel bandwidth to 40 MHz when it receives a Beacon frame including the channel extension indication information element or an ICB frame.

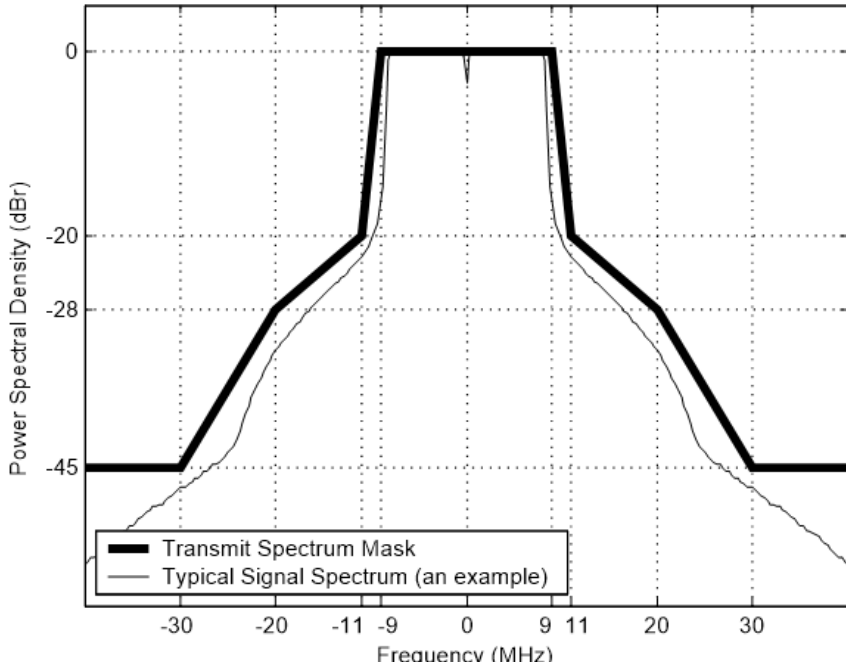
Then the AP may switch to 40 MHz analogue and 20 MHz digital mode and transmits a CTS-to-self or legacy Beacon in the extension channel by performing carrier sense across both control channel and extension channel.¹¹ The NAV shall cover the intended duration of the 40 MHz phase and the transition time back to 20 MHz phase.

Claim Elements	Disclosures in the TGn Sync Proposal
	After setting the NAV in the extension channel, the HT AP resets the NAV of 40 MHz capable HT STAs by sending a CF-end frame and thereby the 40 MHz phase is started. Transition to 20 MHz phase To end the 40 MHz phase, the HT AP first sets the NAV of 40 MHz mode operation in 40 MHz capable HT STAs by transmitting an DCB frame. The transmission rate of the DCB frame shall be selected from the Basic MCS set, considering only the 40MHz PPDU types. The 40 MHz capable HT STAs may switch back to the control channel in 20 MHz. Then the AP resets the NAV in the extension channel by transmitting a CF-End frame. The CF-End frame may be transmitted in 40 MHz analogue and 20 MHz digital mode. The AP may then reset the NAV in the control channel by a CF-End frame in 20 MHz analogue mode but it may also continue the CFP that was set in the last Beacon frame or the ICB frame on the control channel. The AP has to wait at least aMax40MhzAnalogueSwitchingTime before starting the 40 MHz phase or ending the 40 MHz phase in order to account for the STA with the slowest possible switching time. The recovery from unexpectedly long channel access delay to the 40 MHz phase is avoided by the extension channel access timeout value in Beacon and Probe Response frames. When the HT AP transmits the Beacon frame or ICB frame on the control channel to transit to the 40 MHz phase, it starts a timer with a timeout value equal to the extension channel access timeout minus the duration of the Beacon or ICB frame. A 40 MHz capable HT STA shall also start this timer when it receives this transmission. If the timer at the AP expires while attempting to transmit CTS-to-self or Beacon, the AP shall abandon switching to the 40 MHz bandwidth and may try again at a later time. The AP shall transmit a CF-end frame on the 20 MHz control channel in order to re-set the NAV of the legacy STAs on the control channel. 40 MHz capable HT STAs will also switch back to 20 MHz mode on the control channel by the expiry of the associated timer.

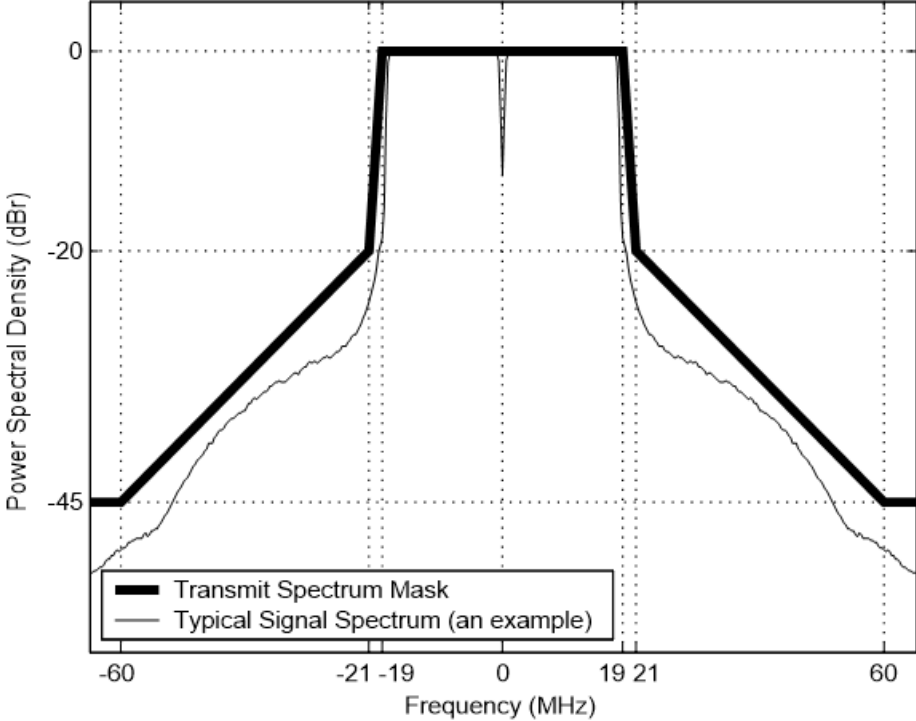
¹¹ Transmission of the Beacon on the extension channel may avoid other BSSs being created, since other STAs will detect the presence of the HT BSS. Furthermore, NAV can be set longer by a Beacon than by a CTS-to-self.

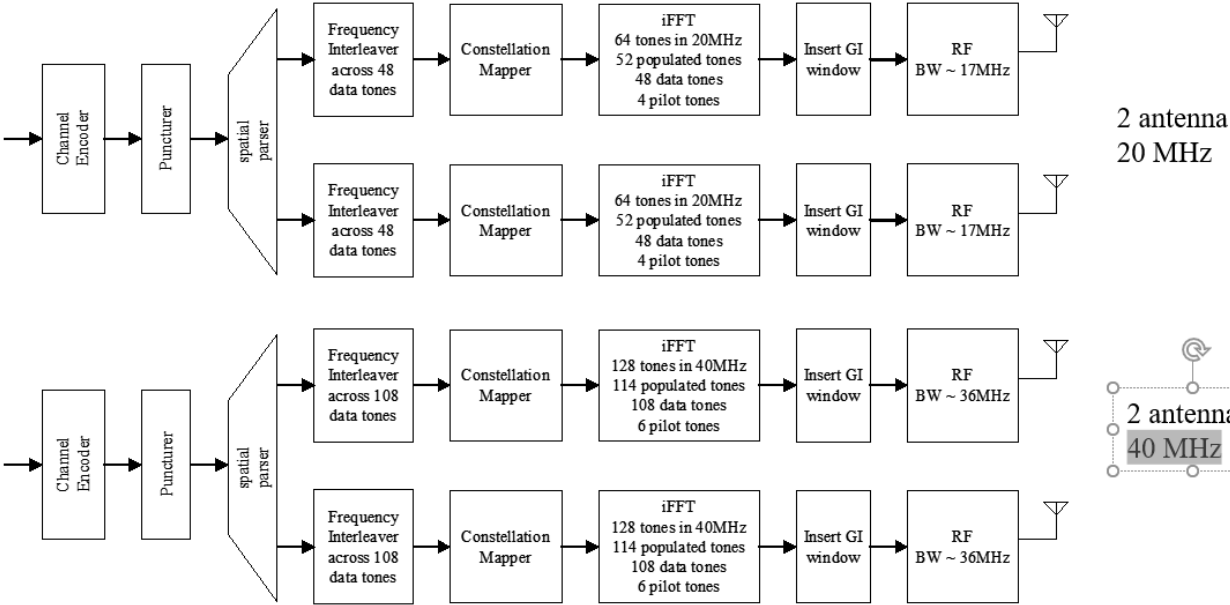
Claim Elements	Disclosures in the TGN Sync Proposal
	To avoid the influence of missing the DCB frame, a 40 MHz capable HT STA shall extract the NAV value from the ICB frame or from the Beacon frame at the start of the transition to a 40 MHz phase. In case of NAV extracted from these frames expires before the 40 MHz capable HT STA receives the DCB frame, it shall set the NAV by the maximum duration value of a DCB frame for 40 MHz mode operation and may switch back to 20 MHz mode on the control channel. One cycle of the process is illustrated in Figure 29. The ratio between the 40 MHz and 20 MHz phase may be adjusted according to types of traffic and priority.  Figure 29 – 20 MHz-Base Managed Mixed Mode Rules for Operation at HT AP A HT AP exchanges frames with 40 MHz capable HT STAs using 40 MHz HT MCS in a 40 MHz phase. In a 20 MHz phase, it exchanges frames with legacy STAs using legacy rate and with both

Claim Elements	Disclosures in the TGn Sync Proposal
	20 MHz HT STAs and 40 MHz capable HT STAs using 20 MHz HT MCS. Frame exchanges may be in EDCA or HCCA in both phases. Rules for Operation at 40 MHz capable HT STAs A 40 MHz capable HT STA shall only operate on the control channel in 20 MHz mode . A 40 MHz capable HT STA that obtains a TXOP shall only transmit frames during the 40MHz phase using 40 MHz HT MCS and shall only transmit frames during the 20MHz phase using a 20MHz (HT or legacy) PPDU type. When a 40 MHz capable HT STA receives a CF-end frame, its NAV for the 40 MHz channel will be reset and it becomes free to access in 40 MHz mode. The HT STA may send frames not only in EDCA but also in HCCA, which is enabled by QoS CF-Poll to it. By the reception of a DCB frame, a 40 MHz capable HT STA may switch back to 20 MHz mode if it wishes to communicate in the 20 MHz phase when receiving the DCB frame. A 40 MHz capable HT STA including a HT AP that is attempting an EDCA channel access during a 40MHz phase either freezes the backoff counter during 20MHz operation and resumes the interrupted backoff during the next 40MHz phase or selects a new random backoff at the start of the 40 MHz phase. Likewise, if it is attempting a channel access during a 20MHz phase, it either freezes the backoff counter during 40MHz operation and resumes the interrupted backoff during the next 20MHz phase or it selects a new random backoff at the start of the 20 MHz phase.” [TGn Sync Proposal 2005, 53-56]

Claim Elements	Disclosures in the TGN Sync Proposal
	11.2.1.10.1 Transmit spectral mask 11.2.1.10.1.1 20MHz channel spacing In the 20 MHz bandwidth mode the HT PHY shall follow 17.3.9.2 in ref [1]. The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18MHz, -20dBr at 11 MHz frequency offset, -28dBr at 20MHz frequency offset and -45dBr at 30MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 1. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. 20 MHz 802.11n Transmit Spectrum Mask  Figure 43: Transmit Spectrum Mask for 20MHz channelization

Claim Elements	Disclosures in the TGn Sync Proposal
	11.2.1.10.1.2 40MHz channel spacing The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 38MHz, -20dBr at 21 MHz frequency offset, and -45dBr at 60MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 2. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth.

Claim Elements	Disclosures in the TGn Sync Proposal
	40 MHz 802.11n Transmit Spectrum Mask  Figure 44: Transmit spectrum mask for 40MHz channelization A HT device transmitting a 20MHz signal in a 40MHz BSS shall conform to the spectral mask shown in Figure 44. [TGn Sync Proposal 2005 at 114-116]

Claim Elements	Disclosures in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Basic Tx Data Path  Submission Slide 9 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 9]

Claim Elements	Disclosures in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 40/20 MHz Interoperability • 20 MHz PPDU ⇒ 40 MHz receiver – Combine modulation symbols from upper & lower sub-channels – 20 MHz PPDU in lower sub-channel • Zero combining weights in upper subchannel • No loss in performance relative to a 20 MHz receiver – Use differential sub-channel energy to detect 20 vs. 40 MHz signals • 40 MHz PPDU ⇒ 20 MHz receiver – One sub-channel is sufficient to decode the L-SIG – Detects only half of the 40 MHz signal ⇒ 3 dB performance penalty for 20 MHz clients • See MAC slides for additional information on 40/20 inter-op Submission Slide 26 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 26] <i>See also, e.g., claim elements 1.A, 1.B above.</i>
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports	TGn Sync Proposal 2005 disclosed a wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards. See, e.g.:

Claim Elements	Disclosures in the TGn Sync Proposal
one or more wireless standards.	Abstract This document presents the technical specification for the MAC and the PHY layer of the TGn Sync proposal to IEEE 802.11 TGn [TGnSync Proposal 2005 at 1] Notice: This document has been prepared to assist IEEE 802.11. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. Release: The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.11. Patent Policy and Procedures: The contributor is familiar with the IEEE 802 Patent Policy and Procedures <http://ieee802.org/guides/bylaws/sb-bylaws.pdf>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <stuart.kerry@philips.com> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.11 Working Group. If you have questions, contact the IEEE Patent Committee Administrator at <patcom@ieee.org>. [TGnSync Proposal 2005 at 1]

Executive Summary

The TGn Sync team respectfully submits its complete proposal. The team is comprised of 802.11 WG participants whose companies represent a broad range of markets, including, PC, Enterprise, Consumer Electronics, Handset, Semiconductor and Public Access. Since these companies are based in the US, Europe and Asia Pacific, the team has had the benefit of a worldwide perspective, both in terms of perceived market demand as well as regulatory concerns (including channel bandwidth limitations, limited channel access, restricted transmission times, etc.).

Our goal has been to align (or “sync” with) 802.11n members to a single set of core positions prior to the TGn down selection phase. By aligning before entrenched positions form, we hope to increase the possibility of a more rapid introduction of an 802.11n standard.

The team has worked as a technical group for many months to develop a TGn proposal, recognizing that whatever decisions were made had to ultimately survive the TGn process and therefore be based solely on technical merit. There were no signed agreements involved in joining the TGn Sync team. There was no attempt to develop joint IP and each company was expected to abide by the same reasonable and non-discriminatory terms that the IEEE bylaws require.

The technical approach balances market expectations with design practicality. The solution is a robust, scalable architecture targeting the least amount of complexity. In fact, the basic configuration delivers a maximum rate of 243 Mbps using only two antennas. This rate is consistent with the historical trend of 5x with each generation of 802.11 (802.11/2Mbps, 802.11b/11Mbps, and finally 802.11a/ 54Mbps). The proposal also incorporates options for rates up to 720 Mbps. This choice of higher peak data rates was seen as critical for future proofing this next generation of WLAN.

The PHY techniques used to achieve the higher data rates involve a MIMO evolution of 802.11 OFDM PHY with spatial division multiplexing of spatial streams, wider bandwidth options (either 20MHz or 40MHz) and an optimized interleaver for both the 20 MHz and 40MHz channelizations. Additionally, optional enhancements include advanced FEC coding techniques (LDPC), transmit beamforming with negligible additional cost in the receiving client device and/or additional RF

Claim Elements	Disclosures in the TGn Sync Proposal
	chains. These options provide extra scalability if additional robustness and/or throughput is required. The TGn Sync proposal also offers seamless interoperability with 802.11 legacy devices. This interoperability is achieved with an enhanced 802.11 preamble design and efficient PHY and MAC level mechanisms, which also provide robustness and cost-effectiveness. The features added to improve MAC efficiency – for higher throughput and overall system performance – include aggregation, bi-directional data flow, enhanced Block Ack, channel management (including a receiver assisted channel training protocol) and feedback mechanisms that enable rate adaptation. Protection mechanisms are also added to achieve the seamless interoperability and coexistence with legacy devices mentioned above. The approach supports 802.11e and proposes new features for further enhancement. Proposal Structure The TGn Sync complete proposal meets the IEEE 802.11n PAR, meets all functional requirements, and addresses all mandatory requirements of the comparison criteria. This document contains a technical specification of the proposed MAC and PHY enhancements. Error! Reference source not found. contains the presentation of the proposal in powerpoint format. (Please note that the summary presentation Error! Reference source not found. is no longer up to date). Error! Reference source not found. contains a statement of compliance to the IEEE 802.11 TGn FRCC requirements. Error! Reference source not found. and Error! Reference source not found. contain FRCC results (and others) for the PHY and MAC respectively.

Claim Elements	Disclosures in the TGn Sync Proposal
	Error! Reference source not found. and Error! Reference source not found. are Excel spreadsheets containing detailed FRCC results from MAC simulations, and Error! Reference source not found. describes the methodology used in these simulations. [TGnSync Proposal 2005 at 3-4]
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim 1.PRE above.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	See, e.g., claim 1, limitation 1.A above.
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is	See, e.g., claim 1, limitation 1.B above.

Claim Elements	Disclosures in the TGn Sync Proposal
repeated on a plurality of OFDM subcarriers;	
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the	<i>See, e.g.</i> , Claim 2 above.

Claim Elements	Disclosures in the TGn Sync Proposal
first packet in the first narrower frequency band.	
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, limitation 1.PRE above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless	<i>See, e.g.</i> , claim 1, limitation 1.A above.

Claim Elements	Disclosures in the TGn Sync Proposal
OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	<i>See, e.g.</i> , claim 1, limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[17.D] demodulating, by the demodulator, the second	<i>See, e.g.</i> , claim 1, limitation 1.D above.

Claim Elements	Disclosures in the TGn Sync Proposal
number of OFDM symbols to determine the second plurality of header bits,	
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[24] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosures in the TGn Sync Proposal
information of the first packet in the first narrower frequency band.	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g., claim 1, limitation 1.PRE above.</i>
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g., claim 1, limitation 1.A above.</i>
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g., claim 1, limitation 1.B above.</i>
[25.C] receiving, a second packet in a second wider	<i>See, e.g., claim 1, limitation 1.C above.</i>

Claim Elements	Disclosures in the TGn Sync Proposal
frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.

Claim Elements	Disclosures in the TGn Sync Proposal
[27] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.,</i> Claim 3 above.
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.,</i> Claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.,</i> Claim 8 above.

Exhibit A2

**Defendant's Invalidity Contentions Comparing the Asserted Claims of U.S. Patent No. 9,584,262
to IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No.
IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by the 2006 802.11n Joint PHY Proposal¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of the 2006 802.11n Joint PHY Proposal standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of the 2006 802.11n Joint PHY Proposal in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA

¹ The 2006 802.11n Joint PHY Proposal was published and made publicly available at least as early as January 13, 2006.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
 - U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
 - U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
 - U.S. Patent No. 8,675,754 to Yonge, III et al. (“Yonge”);
 - U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
 - U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
 - U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
 - U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
 - U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
 - U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

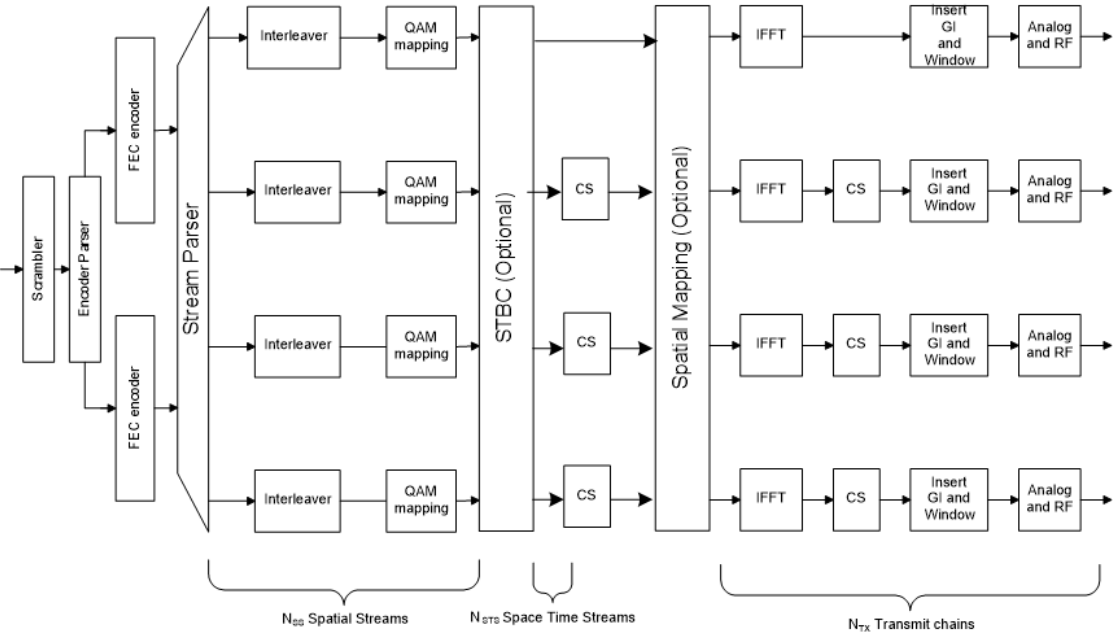
One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

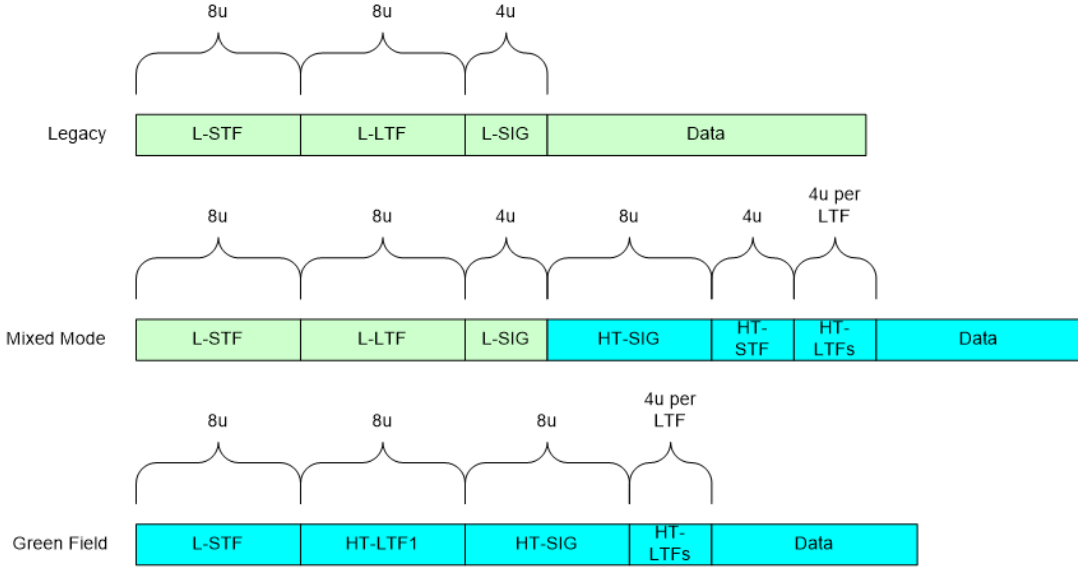
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	The 2006 802.11n Joint PHY Proposal disclosed a wireless OFDM transceiver. For example, the reference disclosed the following:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	3.3 Transmitter Block Diagram (this section is informative) The transmitter is composed of the following blocks: • Scrambler – scrambles the data to prevent long sequences of zeros or ones – see section 4.2. • Encoder Parser – de-multiplexes the scrambled bits among N_{ES} FEC encoders, in a round robin manner. • FEC encoders – encodes the data to enable error correction – an FEC encoder may include a binary convolutional encoder followed by a puncturing device, or an LDPC encoder • Stream Parser – divides the output of the encoders into blocks that will be sent to different interleaver and mapping devices. The sequences of the bits sent to the interleaver are called spatial streams. • Interleaver – interleaves the bits of each spatial stream (changes order of bits) to prevent long sequences of noisy bits from entering the FEC decoder.

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	• QAM mapping – maps the sequence of bit in each spatial stream to constellation points (complex numbers). • Spatial Mapping – maps spatial streams to different transmit chains. This may include one of the following: ○ Direct mapping – each sequence of constellation points is sent to a different transmit chain. ○ Spatial expansion – each vector of constellation points from all the sequences is multiplied by a matrix to produce the input to the transmit chains. ○ Space Time Block coding – constellation points from one spatial stream are spread into two spatial streams using a space time block code. ○ Beam Forming - similar to spatial expansion: each vector of constellation points from all the sequences is multiplied by a matrix of steering vectors to produce the input to the transmit chains. • Inverse Fast Fourier Transform – converts a block of constellation points to a time domain block. • Cyclic shift insertion – inserts the cyclic shift into the time domain block. In the case that spatial expansion is applied that increases the number of transmit chains, the cyclic shift may be applied in the frequency domain as part of spatial expansion. • Guard interval insertion – inserts the guard interval. • Optional windowing – smoothing the edges of each symbol to increase spectral decay

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	 Figure 2 - Transmitter block diagram Figure 2 shows a block diagram of the transmitter. Different implementation are possible as long as they are mathematically equivalent. [2006 802.11n Joint PHY Proposal at 13-15] 4.7 OFDM Modulation The time domain signal is composed from the stream of complex numbers $\tilde{d}_{k,l,n}, k = 0, 1, \dots, N_{SD} - 1, l = 1, \dots, N_{STS}, n = 0, 1, \dots, N_{SYM} - 1$

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	and from the pilot signals. In the case of 40MHz transmission the upper sub-carriers are rotated 90° relative to the lower subcarriers [2006 802.11n Joint PHY Proposal at 50-51]
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	The 2006 802.11n Joint PHY Proposal disclosed receiving in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference disclosed the following: 3 PLCP packet format Two new formats are defined for the PLCP (PHY Layer Convergence Protocol): Mixed mode and Green Field. These two formats are called HT formats. Figure 1 shows the legacy format and the HT formats. In addition to the HT formats, there is a legacy duplicate format (specified in section 4.8) that duplicates the 20MHz legacy packet in two 20MHz halves of a 40MHz channel.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	 The diagram illustrates three PLCP packet formats: Legacy, Mixed Mode, and Green Field. Each format is shown as a horizontal bar divided into segments, with brackets above indicating durations in microseconds (u). Legacy: Consists of L-STF (8u), L-LTF (8u), L-SIG (4u), and Data. Mixed Mode: Consists of L-STF (8u), L-LTF (8u), L-SIG (4u), HT-SIG (8u), HT-STF (4u), HT-LTFs (4u per LTF), and Data. Green Field: Consists of L-STF (8u), HT-LTF1 (8u), HT-SIG (8u), HT-LTFs (4u per LTF), and Data. Figure 1- PLCP packet format

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	The elements of the PCLP packet are: L-STF: Legacy Short Training Field L-LTF: Legacy Long Training Field L-SIG: Legacy Signal Field HT-SIG: High Throughput Signal Field HT-STF: High Throughput Short Training Field HT-LTF1: First High Throughput Long Training Field HT-LTF's: Additional High Throughput Long Training Fields Data – The data field includes the PSDU (PHY sub-layer Service Data Unit) The HT-SIG, HT-STF and HT-LTF's exist only in HT packets. In legacy and legacy duplicate formats only the L-STF, L-LTF, L-SIG and Data fields exist. 3.1 Operating Mode The PHY will operate in one of 3 modes – • Legacy Mode – in this mode packets are transmitted in the legacy 802.11a/g format. • Mixed Mode – in this mode packets are transmitted with a preamble compatible with the legacy 802.11a/g – the legacy Short Training Field (STF), the legacy Long Training Field (LTF) and the legacy signal field are transmitted so they can be decoded by legacy 802.11a/g devices. The rest of the packet has a new format. In this mode the receiver shall be able to decode both the Mixed Mode packets and legacy packets.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	• Green Field – in this mode high throughput packets are transmitted without a legacy compatible part. This mode is optional. In this mode the receiver shall be able to decode both Green Field mode packets, Mixed Mode packets and legacy format packets. An HT device which does not support the reception of a GF packet shall be able to detect that GF transmissions are HT transmissions (as opposed to legacy transmissions) and treat them as HT packets with a failing HT-SIG CRC. The operation of PHY in the frequency domain is divided to the following modes: • LM – Legacy Mode – equivalent to 802.11a/g • HT-Mode – In HT mode the device operates in either 40MHz bandwidth or 20MHz bandwidth and with one to four spatial streams. This mode includes the HT-duplicate mode. • Duplicate Legacy Mode – in this mode the device operates in a 40MHz channel composed of two adjacent 20MHz channel. The packets to be sent are in the legacy 11a format in each of the 20MHz channels. To reduce the PAPR the upper channel (higher frequency) is rotated by 90° relative to the lower channel. • 40 MHz Upper Mode – used to transmit a legacy or HT packet in the upper 20MHz channel of a 40MHz channel. 40 MHz Lower Mode – used to transmit a legacy or HT packet in the lower 20MHz channel of a 40MHz channel LM is mandatory and HT-Mode for 1 and 2 spatial streams at 20MHz are mandatory at the AP. LM is mandatory and HT-Mode for 1 spatial stream at 20MHz is mandatory for non-AP STAs. [2006 802.11n Joint PHY Proposal at 10-12]

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	3.4 Mathematical description of signals For the description of the convention on mathematical description of signals see section 17.3.2.4 of [1] In the case of a legacy mode and HT mode transmission over a 20MHz channel, the channel is divided into 64 sub-carriers. In the legacy mode, signal is transmitted on sub-carriers -26 to -1 and 1 to 26, with 0 being the center (DC) carrier. In the HT modes signal is transmitted on sub-carriers -28 to -1 and 1 to 28. In the case of a 40MHz HT transmission, two adjacent 20MHz channels are used. The channel is divided into 128 sub-carriers. Signal is transmitted on sub-carriers -58 to -2 and 2 to 58. In the case of the legacy duplicate mode over 40MHz, the same data are transmitted over two adjacent 20MHz channels. In this case the 40MHz channel is divided into 128 sub-carriers and the data are transmitted on carriers -58 to -6 and 6 to 58.

Table 1 - Timing related constants

Parameter	Value in legacy 20MHz channel	Value in 20MHz HT channel	Value in 40MHz channel	
			HT format	Legacy Duplicate
N_{SD}: Number of data subcarriers	48	52	108	48 ²
N_{SP}: Number of pilot subcarriers	4	4	6	4 ¹
N_{ST}: Total Number of subcarriers	52	56	114	
N_{SR}: Number of subcarriers occupying half of the overall BW	26	28	58	
Δ_f: subcarrier frequency spacing	312.5kHz (20MHz/64)	312.5kHz	312.5kHz (40MHz/128)	
T_{FFT}: IFFT/FFT period	3.2μsec	3.2μsec	3.2μsec	
T_{GI}: Guard Interval length	0.8μsec= T _{FFT} /4	0.8μsec	0.8μsec	
T_{GI2}: Double GI	1.6μsec	1.6μsec	1.6μsec	
T_{GIS}: Short Guard Interval length	0.4μsec= T _{FFT} /8	0.4μsec	0.4μsec	
T_{L-STF}: Legacy Short training sequence length	8μsec=10× T _{FFT} /4	8μsec	8μsec	
T_{L-LTF}: Legacy Long training sequence length	8μsec=2× T _{FFT} +T _{GI2}	8μsec	8μsec	
T_{SYM}: Symbol	4μsec= T _{FFT} +T _{GI}	4μsec	4μsec	

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal")				
	Parameter	Value in legacy 20MHz channel	Value in 20MHz HT channel	Value in 40MHz channel	
				HT format	Legacy Duplicate
	Interval				
	T _{SYMS} : Short GI Symbol Interval	3.6μsec= T _{FFT} +T _{GIS}	3.6μsec	3.6μsec	
	T _{L-SIG}	4μsec= T _{SYM}	4μsec	4μsec	
	T _{HT-SIG}	NA	8μsec= 2T _{SYM}	8μsec	
	T _{HT-STF} : HT STF time	NA	4μsec	4μsec	
	T _{HT-LTF1} : HT first long training field length	NA	4μsec in mixed mode, 8μsec in green field	4μsec in mixed mode, 8μsec in green field	
	T _{HT-LTFs} : HT second, and subsequent, long training fields length	NA	4μsec	4μsec	
[2006 802.11n Joint PHY Proposal at 15-17]					

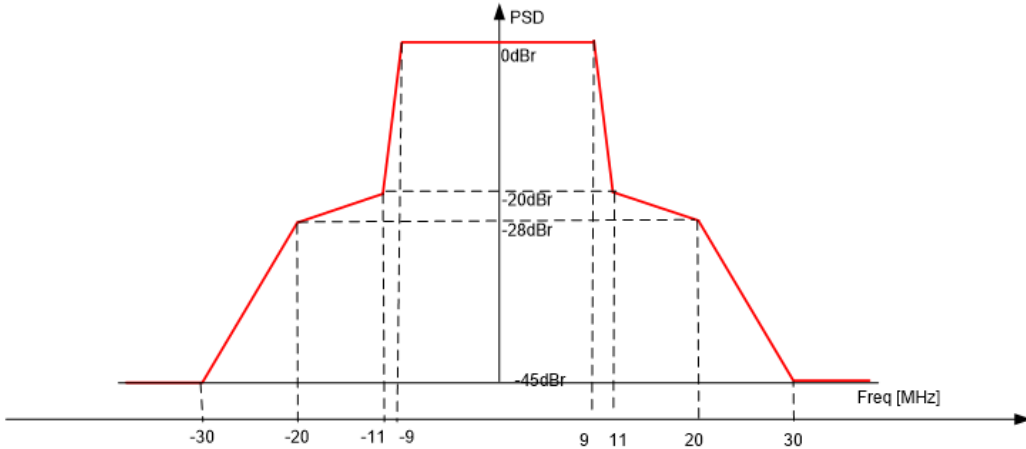
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)		
	Field	<i>N_{Tone}</i> <i>N_{Field}</i>	
		20 MHz	40 MHz
	L-STF	12	24
	L-LTF	52	104
	L-SIG	52	104
	HT-SIG	52/56*	104/114*
	HT-STF	12	24
	HT-LTF	56	114
	HT-Data	56	114
	HT-Data- 40 MHz Dup. Format	-	104

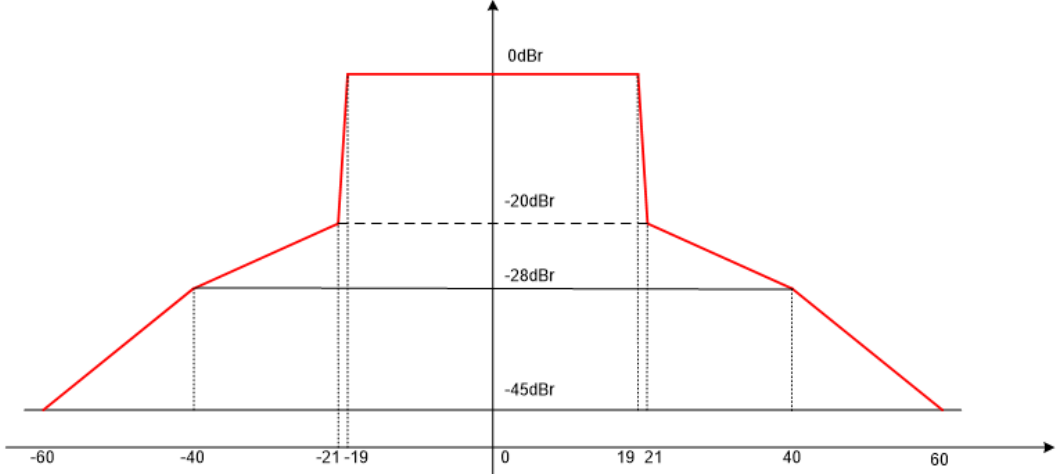
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	<table><tr><th>Field</th><th colspan="2">N_{Field}^{Tone}</th></tr><tr><th></th><th>20 MHz</th><th>40 MHz</th></tr></table> Notes: *56 and 114 are for green field mode, 52 and 104 are for mixed mode. The numbers in the table refer only to the value of N_{Field}^{Tone} as it appears in equation (12) and in subsequent specification of various fields. It may be different from the actual number of tones being transmitted. Table 3 - number of tones in each field [2006 802.11n Joint PHY Proposal at 20-21] 5 Channel Numbering and Channelization The device operates both in the 5GHz band and 2.4GHz band. When using 20MHz channels it uses the same channels as in the 11a/11g. When using the 40MHz channel, it can operate in the channels defined in sections 5.1 and 5.2.	Field	N_{Field}^{Tone}			20 MHz	40 MHz
Field	N_{Field}^{Tone}						
	20 MHz	40 MHz					

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	5.1 Channel Allocation in the 5 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz (for 20 MHz channels). The relationship between center frequency and channel number is given by the following equation: Channel center frequency = $5000 + 5 \cdot n_{ch}$ (MHz), Where $n_{ch} = 0, 1, \dots, 200$. The 40MHz channels in 5GHz are specified by two fields: ($N_{control\ ch}$, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 36 and 40 where channel 36 is the control channel shall be specified as (36,1). The following table lists the valid settings of these two fields in the 5 GHz band.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																																
	Table 18 - 40MHz channel allocation in the 5GHz band <table><tr><th rowspan="2">Regulatory domain</th><th rowspan="2">Band (GHZ)</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII lower band (5.15-5.25)</td><td>36</td><td>40</td><td>5190</td></tr><tr><td>44</td><td>48</td><td>5230</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII middle band (5.25-5.35)</td><td>52</td><td>56</td><td>5270</td></tr><tr><td>60</td><td>64</td><td>5310</td></tr><tr><td rowspan="5">Europe</td><td rowspan="5">ETSI (5.5-5.7)</td><td>100</td><td>104</td><td>5510</td></tr><tr><td>108</td><td>112</td><td>5550</td></tr><tr><td>116</td><td>120</td><td>5590</td></tr><tr><td>124</td><td>128</td><td>5630</td></tr><tr><td>132</td><td>136</td><td>5670</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII upper band (5.725-5.825)</td><td>149</td><td>153</td><td>5755</td></tr><tr><td>157</td><td>161</td><td>5795</td></tr></table> 5.2 Channel Allocation in the 2.4 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz in the 2.4 GHz band. The relationship between center frequency and channel number	Regulatory domain	Band (GHZ)	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States	U-NII lower band (5.15-5.25)	36	40	5190	44	48	5230	United States	U-NII middle band (5.25-5.35)	52	56	5270	60	64	5310	Europe	ETSI (5.5-5.7)	100	104	5510	108	112	5550	116	120	5590	124	128	5630	132	136	5670	United States	U-NII upper band (5.725-5.825)	149	153	5755	157	161	5795
Regulatory domain	Band (GHZ)			N _{control_ch}			Center Frequency (MHz)																																										
		Extension=1	Extension=-1																																														
United States	U-NII lower band (5.15-5.25)	36	40	5190																																													
		44	48	5230																																													
United States	U-NII middle band (5.25-5.35)	52	56	5270																																													
		60	64	5310																																													
Europe	ETSI (5.5-5.7)	100	104	5510																																													
		108	112	5550																																													
		116	120	5590																																													
		124	128	5630																																													
		132	136	5670																																													
United States	U-NII upper band (5.725-5.825)	149	153	5755																																													
		157	161	5795																																													

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																												
	is given by the following equation: Channel center frequency = 2407 + 5 · n_{ch} (MHz), Where n_{ch} = 1,2,...11. The 40MHz channels in 2.4GHz are specified in the same way as in 5GHz: (N_{control_ch}, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 2 and channel 6 where channel 6 is the control channel shall be specified as (6, -1). The following table lists the valid settings of these two fields in the 2.4 GHz band. Table 19 - 40Mhz channel allocation in the 2.4GHz and <table><tr><th rowspan="2">Regulatory domain</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="7">United States Canada Europe</td><td>1</td><td>5</td><td>2422</td></tr><tr><td>2</td><td>6</td><td>2427</td></tr><tr><td>3</td><td>7</td><td>2432</td></tr><tr><td>4</td><td>8</td><td>2437</td></tr><tr><td>5</td><td>9</td><td>2442</td></tr><tr><td>6</td><td>10</td><td>2447</td></tr><tr><td>7</td><td>11</td><td>2452</td></tr></table>	Regulatory domain	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States Canada Europe	1	5	2422	2	6	2427	3	7	2432	4	8	2437	5	9	2442	6	10	2447	7	11	2452
Regulatory domain	N _{control_ch}		Center Frequency (MHz)																										
	Extension=1	Extension=-1																											
United States Canada Europe	1	5	2422																										
	2	6	2427																										
	3	7	2432																										
	4	8	2437																										
	5	9	2442																										
	6	10	2447																										
	7	11	2452																										

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	6 Transmit Spectrum Mask When transmitting in a 20MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, -20 dBr at 11 MHz frequency offset, -28 dBr at 20 MHz frequency offset and -45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 15. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.  Figure 15 - Transmit spectral mask for 20MHz Transmission

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	When transmitting in a 40MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz offset and -45 dBr at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 16. The transmit spectral mask for 20MHz transmission in upper or lower 20Mhz channels of a 40MHz is the same mask as that used for the 40MHz channel.  Figure 16 - Transmit spectral mask for a 40MHz channel [2006 802.11n Joint PHY Proposal at 56-59]
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine	The 2006 802.11n Joint PHY Proposal disclosed demodulating, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	in the first packet is repeated on a plurality of OFDM subcarriers. For example, the reference disclosed the following: 3.5.2 Legacy Short Training Field The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is $S_{-26,26} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0\} \quad (13)$ The normalization factor $\sqrt{1/2}$ is the QPSK normalization. The legacy short training OFDM symbol in 40MHz mode is based on: $S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, +1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, +1 + j, 0, 0, 0\} \quad (14)$ The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90°. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	In mixed mode the L-STF on the i_{TX}'th transmit chain is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-STF}^{Tone}}} w_{L-STF}(t) \cdot \left(\sum_{k=-N_{SR}}^0 S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{TX}})) + \Upsilon \sum_{k=1}^{N_{SR}} S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{TX}})) \right) \quad (15)$ In green field the L-STF on the i_{TX}'th transmit chain is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{L-STF}^{Tone}}} w_{L-STF}(t) \cdot \left(\sum_{k=-N_{SR}}^0 \sum_{i_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{i_{TX} i_{STS}} [P_{HILTF}]_{i_{STS},1} S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) + \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{i_{TX} i_{STS}} [P_{HILTF}]_{i_{STS},1} S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) \right) \quad (16)$ In the case of Mixed Mode operation $T_{CS}^{i_{TX}}$ takes values from Table 4. In the case of Green Field operation $T_{CS}^{i_{STS}}$ takes values from Table 6. The value of Υ is 1 for 20MHz and j in 40MHz. $\mathcal{Q}_k$ is defined in section 4.7.1. The L-STF has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	[22-23] 3.5.3 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1\} \quad (17)$ The legacy long training OFDM signal in the 40MHz mode is based on: $L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,0,0,0,0,0,0,0,0,0,0,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,0,1,-1,-1,1,1,-1,1,-1,1,-1,1,-1,1,1,1\} \quad (18)$ The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90° (see equation (19)). The sub-carriers at ±32 in 40MHz, which are the DC sub-carriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is

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	$r_{L-LTF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-LTF}^{Tone}}} w_{T_{L-LTF}}(t) \cdot$$\left(\sum_{k=-N_{SR}}^0 L_k \exp\left(j 2\pi k \Delta_F (t - T_{GI2} - T_{CS}^{i_{TX}}) \right) + \right. \tag{19}$$\left. \gamma \sum_{k=1}^{N_{SR}} L_k \exp\left(j 2\pi k \Delta_F (t - T_{GI2} - T_{CS}^{i_{TX}}) \right) \right)$ where $T_{GI2} = 1.6 \mu \text{ sec}$. The value of γ is 1 for 20MHz and j in 40MHz. [2006 802.11n Joint PHY Proposal at 23-24] 3.5.4 The Legacy Signal Field The signal field is used to transfer rate and length information. It has different meaning when used in legacy transmission and when used in a non legacy transmission. When transmitted in a legacy 20MHz mode, it is transmitted using the same method and meaning as specified in section 17.3.4 of the IEEE 802.11a standard [1]. <table><tr><th colspan="4">Rate (4 bits)</th><th rowspan="2">R</th><th colspan="12">Length (12 bits)</th><th rowspan="2">P</th><th colspan="6">Tail 6bits</th></tr><tr><th>R1</th><th>R2</th><th>R3</th><th>R4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>"0"</th><th>"0"</th><th>"0"</th><th>"0"</th><th>"0"</th><th>"0"</th></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table> Figure 4 - The signal field	Rate (4 bits)				R	Length (12 bits)												P	Tail 6bits						R1	R2	R3	R4	5	6	7	8	9	10	11	12	13	14	15	16	"0"	"0"	"0"	"0"	"0"	"0"	0	1	2	3	4																	
Rate (4 bits)				R	Length (12 bits)												P	Tail 6bits																																																			
R1	R2	R3	R4		5	6	7	8	9	10	11	12	13	14	15	16		"0"	"0"	"0"	"0"	"0"	"0"																																														
0	1	2	3	4																																																																	

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	When the transmission is not a legacy transmission the fields in the signal field have different meaning. The bits in the rate field are [1,1,0,1] – corresponding to a rate of 6Mbps in legacy representation. The value in the length field is given through the TX vector. This value is used to spoof legacy devices to defer transmission for a period of corresponding to the length of the rest of the packet. When L-SIG TXOP Protection is not used (see “L-SIG TXOP Protection” section of the MAC spec), the value to be transmitted is $l = 3(\lceil N_{data} \rceil + N_{LTF} + 3) - 3$ where N_{data} is the number of 4usec symbols in the data part of the packet. While using short GI N_{data} is equal to the actual number of symbols in the data part of the packet multiplied by $\frac{9}{10}$. N_{LTF} is the number of HT training symbols. The symbol $\lceil x \rceil$ denotes the lowest integer greater or equal to x. When L-SIG TXOP Protection is used the value of l is defined in the “L-SIG TXOP Protection” section of the MAC spec. If the Length field of the HT-SIG (see Table 7) is set to zero N_{data} shall be set zero in the formula for calculating l. The length field is transmitted LSB first. The reserved bit shall be set to 0. The parity field has the even parity of bits 0-16. The signal field shall be encoded, interleaved and mapped, and have pilots inserted following the steps described in sections 17.3.5.5, 17.3.5.6, 17.3.5.8 of the IEEE802.11a standard [1]. The stream of 48, complex numbers generated by these steps is d_k, $k = 0 \dots 47$. The conversion of these into a time domain signal is described in the following table

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	9 Table 5 - generation of the signal field <table border="1"> <thead> <tr> <th>Modulation Method</th><th>Conversion to Time Domain signal</th></tr> </thead> <tbody> <tr> <td>20MHz transmission on several transmit chains – i_{TX}’th tx chain</td><td> $r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi M(k) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right)$ </td></tr> <tr> <td>40MHz transmission on several transmit chains – i_{TX}’th Tx chain.</td><td> $r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi (M(k) - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $+ j \sum_{k=0}^{47} d_k \exp(j2\pi (M(k) + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) +$ $p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp(j2\pi (k - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. \left. j \exp(j2\pi (k + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right) \right)$ </td></tr> </tbody> </table> $M(k), P_k$ are defined in section 17.3.5.9 of the 802.11a standard [1]. p_0 is the first pilot value in the sequence defined in section 17.3.5.9 of the 802.11a standard [1]. [2006 802.11n Joint PHY Proposal at 24-25]	Modulation Method	Conversion to Time Domain signal	20MHz transmission on several transmit chains – i_{TX}’th tx chain	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi M(k) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right)$	40MHz transmission on several transmit chains – i_{TX}’th Tx chain.	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi (M(k) - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $+ j \sum_{k=0}^{47} d_k \exp(j2\pi (M(k) + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) +$ $p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp(j2\pi (k - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. \left. j \exp(j2\pi (k + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right) \right)$
Modulation Method	Conversion to Time Domain signal						
20MHz transmission on several transmit chains – i_{TX}’th tx chain	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi M(k) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right)$						
40MHz transmission on several transmit chains – i_{TX}’th Tx chain.	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi (M(k) - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $+ j \sum_{k=0}^{47} d_k \exp(j2\pi (M(k) + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) +$ $p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp(j2\pi (k - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. \left. j \exp(j2\pi (k + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right) \right)$						

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)												
	3.6.2 The High Throughput Signal Field The high throughput signal field is used to carry information required to interpret the HT packet formats. The high throughput signal field (HT_SIG) includes the following fields: Table 7 - Fields of High Throughput Signal Field <table><tr><th>Field Name</th><th>Num of Bits</th><th>Explanation and coding</th></tr><tr><td>Modulation and Coding Scheme</td><td>7</td><td>Index into The MCS table, LSB first</td></tr><tr><td>BW 20/40</td><td>1</td><td>0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz</td></tr><tr><td>Length</td><td>16</td><td>The number of bytes of data in the PSDU – 0*-65535</td></tr></table>	Field Name	Num of Bits	Explanation and coding	Modulation and Coding Scheme	7	Index into The MCS table, LSB first	BW 20/40	1	0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz	Length	16	The number of bytes of data in the PSDU – 0*-65535
Field Name	Num of Bits	Explanation and coding											
Modulation and Coding Scheme	7	Index into The MCS table, LSB first											
BW 20/40	1	0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz											
Length	16	The number of bytes of data in the PSDU – 0*-65535											

Field Name	Num of Bits	Explanation and coding
Smoothing	1	1 – channel estimate smoothing is allowed 0 – Only per-carrier independent (unsmoothed) channel estimate is recommended.
Not Sounding	1	Indicates that the packet is a sounding packet. 0 –Sounding Packet 1 – Not a sounding packet
reserved one	1	set to 1
Aggregation	1	Set to 1 to indicate that the PPDU in the data portion of the packet contains an A-MPDU. Set to 0 otherwise
STBC	2	Indicates the difference between either the number of space time streams N_{STS} and the number of spatial streams N_{SS} indicated by the MCS 00 – No STBC ($N_{STS}=N_{SS}$)
Advanced Coding	1	1 - LDPC 0 - BCC.
Short GI	1	Set to 1 to Indicate that the short GI is used after the HT training. Set to 0 otherwise
Number of extension HT-LTF	2	Number of extension spatial stream(s) N_{ESS} . –b'00 – no extension spatial stream, b'01 – 1 additional spatial stream, b'10 2 additional spatial streams, b'11 3 additional spatial streams.
CRC	8	CRC of bits 0-23 in HT-SIG1 and bits 0-9 in HT-SIG2 – see section 3.6.3. The first bit to be transmitted is bit C7 as explained in aforementioned section .
Tail Bits	6	Used to terminate the trellis of the convolution coder. Set to 0.
Integer fields are transmitted least significant bit first. A value of 0 in the Length Field indicates a PPDU which does not include a data field. The packets <u>ends</u> after the last HT-LTF or the HT-SIG.		

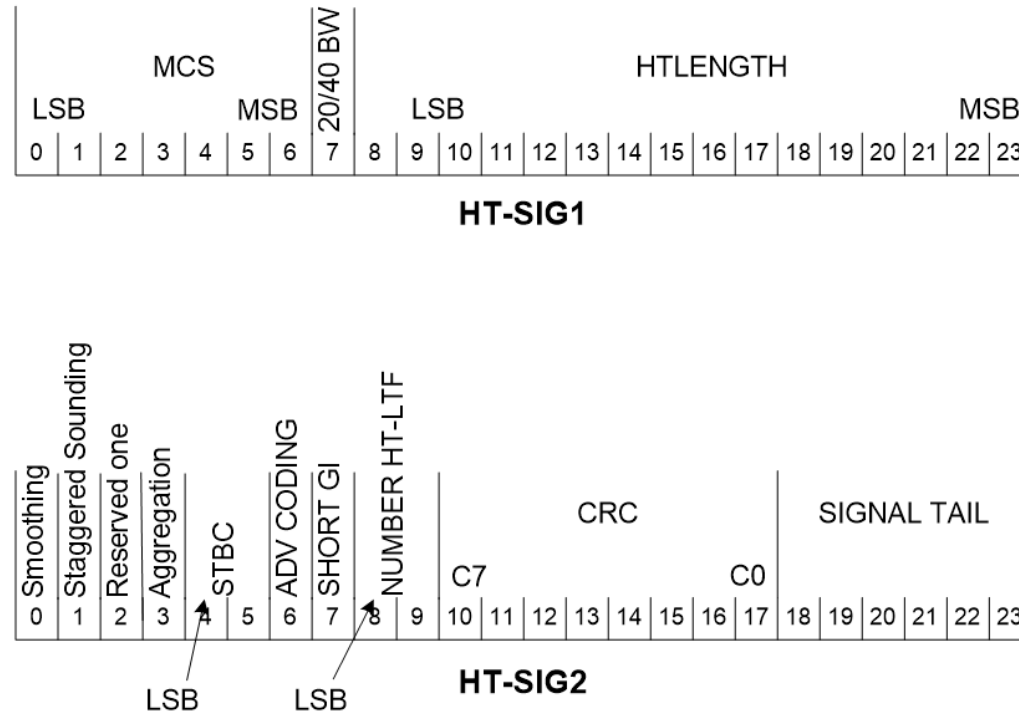


Figure 5 - HT SIG breakdown to HT-SIG1 and HT-SIG2

The HT-SIG is composed of two parts HTSIG₁ and HTSIG₂ each containing 24 bits. All the fields in the HT-SIG are transmitted LSB first.

The HT-SIG parts are encoded, interleaved, mapped, and have pilots inserted following the steps described in sections 17.3.5.5, 17.3.5.6, 17.3.5.8 of the IEEE802.11a standard [1]. The stream of 96, complex numbers generated by these steps are divided into two groups of 48 complex numbers:

$d_{k,n}$, $k = 0 \dots 47$, $n = 0,1$ see Figure 5. The conversion of these into the time domain signal is according to the next tables:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	1 Table 8 - Modulation for the High Throughput Signal Field in a Mixed Mode Packet <table border="1"> <thead> <tr> <th>Modulation Method</th><th>Conversion to Time Domain signal</th></tr> </thead> <tbody> <tr> <td>20MHz transmission - i_{TX}'th stream</td><td> $r_{HT\_SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$ </td></tr> <tr> <td>40MHz Tx on several streams - i_{TX}'th stream</td><td> $r_{HT\_SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. - \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$ </td></tr> </tbody> </table>	Modulation Method	Conversion to Time Domain signal	20MHz transmission - i_{TX}'th stream	$r_{HT\_SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$	40MHz Tx on several streams - i_{TX}'th stream	$r_{HT\_SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. - \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$
Modulation Method	Conversion to Time Domain signal						
20MHz transmission - i_{TX}'th stream	$r_{HT\_SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$						
40MHz Tx on several streams - i_{TX}'th stream	$r_{HT\_SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. - \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$						

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	3 Table 9 - Modulation for the High Throughput Signal Field in a Green Field Packet <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #000080; color: white;"> <th style="width: 25%;">Modulation Method</th><th style="width: 75%;">Conversion to Time Domain signal</th></tr> </thead> <tbody> <tr> <td style="vertical-align: top; padding: 5px;">20MHz transmission - i_{TX}'th stream</td><td style="padding: 5px;"> $r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$ </td></tr> <tr> <td style="vertical-align: top; padding: 5px;">40MHz Tx on several streams - i_{TX}'th stream</td><td style="padding: 5px;"> $r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. - \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$ </td></tr> </tbody> </table>	Modulation Method	Conversion to Time Domain signal	20MHz transmission - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$	40MHz Tx on several streams - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. - \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$
Modulation Method	Conversion to Time Domain signal						
20MHz transmission - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$						
40MHz Tx on several streams - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. - \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$						

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	$M(k), p_n, P_k$ are defined in section 17.3.5.9 of the 802.11a standard. [1] N^{Tones} is equal to the number of tones in the HT-SIG. The value of z is zero in a GF packet and 1 in a mixed mode packets. Values for $T_{CS}^{I_{TX}}$ are taken from Table 4 in the case of MM. In the case of a GF packet the values of $T_{CS}^{I_{STS}}$ are taken from Table 6. P_{HTLTF} is defined in section 3.6.5. Q_k is defined in section 4.7.1. The value of N_{SR} used in these equations, both for 20MHz and 40MHz, is 26 tones. Note: this definition results in a BPSK modulation in which the constellation of the data tones is rotated by 90° relative to the legacy signal field. Figure 6 - constellation for the legacy signal field and the HT signal field

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	[2006 802.11n Joint PHY Proposal at 26-31] 3.6.4 The HT STF training symbol The purpose of the HT STF training field is to improve AGC training in a multi-transmit and multi-receive system. The duration of the HT-STF is 4μsec; the frequency sequence used to construct the HT-STF in 20MHz transmission is identical to legacy STF; in 40MHz transmission the HT-STF is constructed from the 20MHz version by frequency shifting and duplicating, and rotating the upper sub-carriers by 90°. The frequency sequences are: For 20MHz: $HTS_{-28,28} = \sqrt{1/2} \{0, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0\}$ The HT-STF in 40MHz is based on: $HTS_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, +1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, +1 + j, 0, 0\}$

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	The time domain representation of the transmission in the i_{TX} <i>th</i> transmit chain is: $r_{HT-STF}^{i_{TX}}(t) = w_{HT-STF}(t) \frac{1}{\sqrt{N_{STS} N_{HT-STF}^{Tones}}} \cdot \left(\sum_{k=-N_{SR}}^0 \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} HTS(k) \exp(j2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) \right. \\ \left. + \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} HTS(k) \exp(j2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) \right)$ The value of Υ is 1 for 20MHz and j in 40MHz. The values for $T_{CS}^{i_{STS}}$ are given in Table 6. Q_k is defined in section 4.7.1. [2006 802.11n Joint PHY Proposal at 32-33] 3.6.5 The HT-LTF long training Field The HT long training field provides means for the receiver to estimate the channel between each spatial mapper input (or spatial stream transmitter if no STBC is applied) and receive chain; the number of training symbols N_{LTF} is equal or greater than the number of space time streams (with an exception in the case of 3 space time streams). The number of training symbols is greater than the number of space time streams if the transmitter is providing training for more spatial streams (spatial mapper inputs) than the number used for the transmission of the PSDU. This happens in a sounding PPDU.

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	The HT long training field portion has one or two parts. The first part consists of from one to four HT long training fields (HT-LTFs) that are necessary for demodulation of the HT-Data portion of the PPDU. These HT-LTFs are referred to as Data HT-LTFs. The optional second part consists of from zero to four HT-LTFs that may be used to probe extra spatial dimensions of the MIMO channel that are not utilized by the HT-Data portion of the PPDU. These HT-LTFs are referred to as Extension HT-LTFs. If a receiver has not advertised its ability to receive Extension HT-LTFs, it may discard a frame including Extension HT-LTFs as an unknown frame type. The number of Data HT-LTFs is denoted N_{DLTF}. The number of extension HT-LTFs is denoted N_{ELTF}. The total number of HT-LTFs is $N_{LTF} = N_{DLTF} + N_{ELTF}$. N_{LTF} shall not exceed 5. Table 10 shows the determination of the number of space time streams from the MCS and STBC HT-SIG fields. Table 11 shows the number of data and extension LTFs as a function of either number of space time streams N_{STS} or number of extension spatial streams N_{ESS}.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																					
	<table><tr><th>Number of Spatial Streams (from MCS) N_{SS}</th><th>STBC field</th><th>Number of space time streams N_{STS}</th></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>2</td></tr><tr><td>2</td><td>0</td><td>2</td></tr><tr><td>2</td><td>1</td><td>3</td></tr><tr><td>2</td><td>2</td><td>4</td></tr><tr><td>3</td><td>0</td><td>3</td></tr><tr><td>3</td><td>1</td><td>4</td></tr><tr><td>4</td><td>0</td><td>4</td></tr></table> Table 10 - Determining the number of space time streams <table><tr><th>N_{STS} or N_{ESS}</th><th>N_{DLTF} or N_{ELTFs}</th></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>2</td></tr><tr><td>3</td><td>4</td></tr><tr><td>4</td><td>4</td></tr></table> Table 11 - Number of LTFs required to probe spatial streams	Number of Spatial Streams (from MCS) N_{SS}	STBC field	Number of space time streams N_{STS}	1	0	1	1	1	2	2	0	2	2	1	3	2	2	4	3	0	3	3	1	4	4	0	4	N_{STS} or N_{ESS}	N_{DLTF} or N_{ELTFs}	1	1	2	2	3	4	4	4
Number of Spatial Streams (from MCS) N_{SS}	STBC field	Number of space time streams N_{STS}																																				
1	0	1																																				
1	1	2																																				
2	0	2																																				
2	1	3																																				
2	2	4																																				
3	0	3																																				
3	1	4																																				
4	0	4																																				
N_{STS} or N_{ESS}	N_{DLTF} or N_{ELTFs}																																					
1	1																																					
2	2																																					
3	4																																					
4	4																																					

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When Extension HT-LTFs are used, the result is referred to as a segmented HT-LTF. When a PPDU includes a segmented HT-LTF, or if the number of LTF is greater than the number of space time streams it is optional for a receiver to decode the data portion of the PPDU.

The following HT-LTF sequence is transmitted in the case of 20MHz operation:

$$HTLTF_{-28:28} = \begin{bmatrix} 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, \\ 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1, -1, -1 \end{bmatrix}$$

Note that this sequence is an extension of the legacy LTF where the 4 extra sub-carriers are filled with +1 for negative frequencies and -1 for positive frequencies

In a 40MHz transmission the sequence to be transmitted is based on:

$$\begin{aligned} HTLTF_{-58:58} &= \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, \\ &\quad 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, 0 \\ &\quad 0, 0, -1, 1, 1, -1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, 1, 1, \\ &\quad 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\} \end{aligned}$$

Note that this sequence is also constructed by extending the legacy LTF in the following way: first of all, the legacy LTF is shifted and duplicated as explained in 3.5.3 for the duplicate legacy mode; then the missing sub-carriers are filled: sub-carriers [-32 -5 -4 -3 -2 2 3 4 5 32] are filled with the values [1 -1 -1 -1 1 -1 1 1 -1 1] respectively.

This sequence is used even if the HT-duplicate mode (MCS 32) is used in the data.

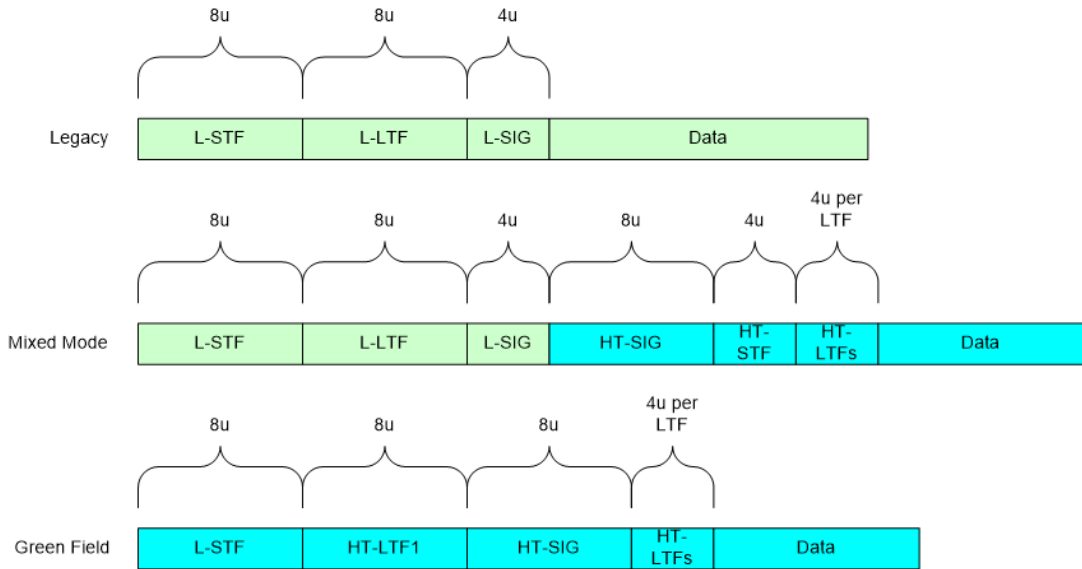
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	The duration of each long training field HT-LTF is 4 μsec and it consists of a single occurrence of the sequence plus a GI insertion. An exception is the first HT-LTF in a GF packet which is 8μsec long consisting of two instances of the sequence plus a double GI insertion. In case of multiple space time streams cyclic shift is invoked as specified in Table 6 [2006 802.11n Joint PHY Proposal at 33-35] 4.7.4 Transmission in HT duplicate mode. HT duplicate mode provides the lowest transmission rate in 40MHz. It may only be used for one spatial stream and only with BPSK coding and rate ½ coding. Under HT duplicate mode, the following equation defines the signal: $r_{HT-Data}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM})$ $\left(\sum_{k=0}^{47} [Q_{M(k)-32}]_{i_{TX}-1} d_{k,n} \exp(j2\pi(M(k)-32)\Delta_F(t - nT_{SYM} - T_{GI})) + \right.$ $j \sum_{k=0}^{47} [Q_{M(k)+32}]_{i_{TX}-1} d_{k,n} \exp(j2\pi(M(k)+32)\Delta_F(t - nT_{SYM} - T_{GI})) +$ $p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k-32}]_{i_{TX}-1} P_k \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI})) +$ $j p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k+32}]_{i_{TX}-1} P_k \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI})) \Bigg)$

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	z is defined in section 4.7.2. $M(k)$, P_k is defined in section 17.3.5.9 of the 802.11a standard [1]. N_{SR} has the value defined for legacy 20MHz transmission. $[Q_k]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $[Q_k]_{i_{TX}}$ [2006 802.11n Joint PHY Proposal at 55] 3.6 The High Throughput Preamble The high throughput preamble consists of the HT signal field, the HT short training field and the HT long training fields. 3.6.1 Cyclic shift for the High Throughput preamble Throughout the high throughput preamble, cyclic shift is applied to prevent beamforming when similar signals are transmitted in different spatial streams. The same cyclic shift is applied to these streams during the transmission of the data portion of the packet. The values of the cyclic shift to be used during the HT preamble and the data portion of the packet (except the HT-SIG in a MM packet), are specified in Table 6:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																														
	<table><tr><th colspan="5">T_{CS}^{LSTS} values for HT portion of the packet</th></tr><tr><th>Number of spatial streams</th><th>Cyclic shift for Spatial stream 1</th><th>Cyclic shift for spatial stream 2</th><th>Cyclic shift for spatial stream 3</th><th>Cyclic shift for spatial stream 4</th></tr><tr><td>1</td><td>0ns</td><td>-</td><td>-</td><td>-</td></tr><tr><td>2</td><td>0ns</td><td>-400ns</td><td>-</td><td>-</td></tr><tr><td>3</td><td>0ns</td><td>-400ns</td><td>-200ns</td><td>-</td></tr><tr><td>4</td><td>0ns</td><td>-400ns</td><td>-200ns</td><td>-600ns</td></tr></table> Table 6 – Cyclic shift values of HT portion of the packet [2006 802.11n Joint PHY Proposal at 26] 3.5 Legacy Field Transmission The following section describes the transmission of the legacy training field and the legacy signal field as part of a mixed mode packet. 3.5.1 Cyclic shift definition for the legacy fields. In the rest of the document cyclic shift is used to prevent unintentional beamforming when the same signal or similar signals are transmitted through different spatial streams. A cyclic shift of length τ on a signal $s(t)$ on interval $0 \leq t \leq T$ is defined by replacing $s(t)$ with $s(t - \tau)$ when $\tau < t \leq T^3$ and with $s(t - \tau + T)$ when $0 \leq t \leq \tau$. Cyclic shift is applied to each OFDM symbol in the packet separately. The following table specifies the values for the cyclic shift that is applied in the legacy short training field (in a MM packet), the legacy long training field, and legacy signal field. It also applies to the HT signal field in a mixed mode packet.	T_{CS}^{LSTS} values for HT portion of the packet					Number of spatial streams	Cyclic shift for Spatial stream 1	Cyclic shift for spatial stream 2	Cyclic shift for spatial stream 3	Cyclic shift for spatial stream 4	1	0ns	-	-	-	2	0ns	-400ns	-	-	3	0ns	-400ns	-200ns	-	4	0ns	-400ns	-200ns	-600ns
T_{CS}^{LSTS} values for HT portion of the packet																															
Number of spatial streams	Cyclic shift for Spatial stream 1	Cyclic shift for spatial stream 2	Cyclic shift for spatial stream 3	Cyclic shift for spatial stream 4																											
1	0ns	-	-	-																											
2	0ns	-400ns	-	-																											
3	0ns	-400ns	-200ns	-																											
4	0ns	-400ns	-200ns	-600ns																											

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																			
	<table><tr><td colspan="5">$T_{CS}^{i_{TX}}$ values for the legacy portion of the packet</td></tr><tr><td>Number of Tx</td><td>cyclic shift for</td><td>cyclic shift for</td><td>cyclic shift for</td><td>cyclic shift for</td></tr></table> <table><tr><td>Chains</td><td>Tx chain 1</td><td>Tx chain 2</td><td>Tx chain 3</td><td>Tx chain 4</td></tr><tr><td>1</td><td>0ns</td><td>-</td><td>-</td><td>-</td></tr><tr><td>2</td><td>0ns</td><td>-200ns</td><td>-</td><td>-</td></tr><tr><td>3</td><td>0ns</td><td>-100ns</td><td>-200ns</td><td>-</td></tr><tr><td>4</td><td>0ns</td><td>-50ns</td><td>-100ns</td><td>-150ns</td></tr></table> Table 4 - Cyclic shift for legacy portion of the packet $^3 s_{CS}(t) = \begin{cases} s(t-\tau) & \tau < t \leq T \\ s(t-\tau+T) & 0 \leq t \leq \tau \end{cases}$ [2006 802.11n Joint PHY Proposal at 21-22] 4.8 Legacy duplicate transmission Legacy duplicate transmission is used to transmit to legacy 802.11a devices that may be present in either the upper and lower channels of the 40MHz channel. The L-STF, L-LTF and L-SIG are transmitted in the same way as in the HT 40MHz transmission. There is no HT-SIG, HT-STF or HT-LTF. Data transmission is defined in the following equation:	$T_{CS}^{i_{TX}}$ values for the legacy portion of the packet					Number of Tx	cyclic shift for	cyclic shift for	cyclic shift for	cyclic shift for	Chains	Tx chain 1	Tx chain 2	Tx chain 3	Tx chain 4	1	0ns	-	-	-	2	0ns	-200ns	-	-	3	0ns	-100ns	-200ns	-	4	0ns	-50ns	-100ns	-150ns
$T_{CS}^{i_{TX}}$ values for the legacy portion of the packet																																				
Number of Tx	cyclic shift for	cyclic shift for	cyclic shift for	cyclic shift for																																
Chains	Tx chain 1	Tx chain 2	Tx chain 3	Tx chain 4																																
1	0ns	-	-	-																																
2	0ns	-200ns	-	-																																
3	0ns	-100ns	-200ns	-																																
4	0ns	-50ns	-100ns	-150ns																																

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	$r_{LEG-DUP}^{i_{TX}}(t - nT_{SYM}) = \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} w_{T_{SYM}}(t - nT_{SYM})$ $\left(\sum_{k=0}^{47} [Q_{M(k)-32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)-32)(\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) + \right.$ $j \sum_{k=0}^{47} [Q_{M(k)+32}]_{i_{TX},1} d_k \exp(j2\pi(M(k)+32)(\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) +$ $p_n \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k-32}]_{i_{TX},1} P_k \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) +$ $\left. jp_n \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k+32}]_{i_{TX},1} P_k \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) \right)$ $P_k, M(k)$ are the ones defined at 11a standard at section 17.3.5.9. $T_{CS}^{i_{TX}}$ are defined in Table 4. $[Q_k]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $[Q_k]_{i_{TX}}$ [2006 802.11n Joint PHY Proposal at 56]
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a	The 2006 802.11n Joint PHY Proposal disclosed receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference disclosed the following:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
second plurality of header bits, different than the first plurality of header bits;	3 PLCP packet format Two new formats are defined for the PLCP (PHY Layer Convergence Protocol): Mixed mode and Green Field. These two formats are called HT formats. Figure 1 shows the legacy format and the HT formats. In addition to the HT formats, there is a legacy duplicate format (specified in section 4.8) that duplicates the 20MHz legacy packet in two 20MHz halves of a 40MHz channel.  The diagram illustrates three PLCP packet formats: Legacy, Mixed Mode, and Green Field. Each format is shown as a horizontal bar divided into segments, with brackets above indicating durations in microseconds (u). Legacy: Consists of L-STF (8u), L-LTF (8u), L-SIG (4u), and Data. Mixed Mode: Consists of L-STF (8u), L-LTF (8u), L-SIG (4u), HT-SIG (8u), HT-STF (4u), HT-LTFs (4u per LTF), and Data. Green Field: Consists of L-STF (8u), HT-LTF1 (8u), HT-SIG (8u), HT-LTFs (4u per LTF), and Data. Figure 1- PLCP packet format

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	The elements of the PCLP packet are: L-STF: Legacy Short Training Field L-LTF: Legacy Long Training Field L-SIG: Legacy Signal Field HT-SIG: High Throughput Signal Field HT-STF: High Throughput Short Training Field HT-LTF1: First High Throughput Long Training Field HT-LTF's: Additional High Throughput Long Training Fields Data – The data field includes the PSDU (PHY sub-layer Service Data Unit) The HT-SIG, HT-STF and HT-LTF's exist only in HT packets. In legacy and legacy duplicate formats only the L-STF, L-LTF, L-SIG and Data fields exist. 3.1 Operating Mode The PHY will operate in one of 3 modes – • Legacy Mode – in this mode packets are transmitted in the legacy 802.11a/g format. • Mixed Mode – in this mode packets are transmitted with a preamble compatible with the legacy 802.11a/g – the legacy Short Training Field (STF), the legacy Long Training Field (LTF) and the legacy signal field are transmitted so they can be decoded by legacy 802.11a/g devices. The rest of the packet has a new format. In this mode the receiver shall be able to decode both the Mixed Mode packets and legacy packets.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	• Green Field – in this mode high throughput packets are transmitted without a legacy compatible part. This mode is optional. In this mode the receiver shall be able to decode both Green Field mode packets, Mixed Mode packets and legacy format packets. An HT device which does not support the reception of a GF packet shall be able to detect that GF transmissions are HT transmissions (as opposed to legacy transmissions) and treat them as HT packets with a failing HT-SIG CRC. The operation of PHY in the frequency domain is divided to the following modes: • LM – Legacy Mode – equivalent to 802.11a/g • HT-Mode – In HT mode the device operates in either 40MHz bandwidth or 20MHz bandwidth and with one to four spatial streams. This mode includes the HT-duplicate mode. • Duplicate Legacy Mode – in this mode the device operates in a 40MHz channel composed of two adjacent 20MHz channel. The packets to be sent are in the legacy 11a format in each of the 20MHz channels. To reduce the PAPR the upper channel (higher frequency) is rotated by 90° relative to the lower channel. • 40 MHz Upper Mode – used to transmit a legacy or HT packet in the upper 20MHz channel of a 40MHz channel. 40 MHz Lower Mode – used to transmit a legacy or HT packet in the lower 20MHz channel of a 40MHz channel LM is mandatory and HT-Mode for 1 and 2 spatial streams at 20MHz are mandatory at the AP. LM is mandatory and HT-Mode for 1 spatial stream at 20MHz is mandatory for non-AP STAs. [2006 802.11n Joint PHY Proposal at 10-12]

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	3.4 Mathematical description of signals For the description of the convention on mathematical description of signals see section 17.3.2.4 of [1] In the case of a legacy mode and HT mode transmission over a 20MHz channel, the channel is divided into 64 sub-carriers. In the legacy mode, signal is transmitted on sub-carriers -26 to -1 and 1 to 26, with 0 being the center (DC) carrier. In the HT modes signal is transmitted on sub-carriers -28 to -1 and 1 to 28. In the case of a 40MHz HT transmission, two adjacent 20MHz channels are used. The channel is divided into 128 sub-carriers. Signal is transmitted on sub-carriers -58 to -2 and 2 to 58. In the case of the legacy duplicate mode over 40MHz, the same data are transmitted over two adjacent 20MHz channels. In this case the 40MHz channel is divided into 128 sub-carriers and the data are transmitted on carriers -58 to -6 and 6 to 58.

Table 1 - Timing related constants

Parameter	Value in legacy 20MHz channel	Value in 20MHz HT channel	Value in 40MHz channel	
			HT format	Legacy Duplicate
N_{SD}: Number of data subcarriers	48	52	108	48 ²
N_{SP}: Number of pilot subcarriers	4	4	6	4 ¹
N_{ST}: Total Number of subcarriers	52	56	114	
N_{SR}: Number of subcarriers occupying half of the overall BW	26	28	58	
Δ_f: subcarrier frequency spacing	312.5kHz (20MHz/64)	312.5kHz	312.5kHz (40MHz/128)	
T_{FFT}: IFFT/FFT period	3.2μsec	3.2μsec	3.2μsec	
T_{GI}: Guard Interval length	0.8μsec= T _{FFT} /4	0.8μsec	0.8μsec	
T_{GI2}: Double GI	1.6μsec	1.6μsec	1.6μsec	
T_{GIS}: Short Guard Interval length	0.4μsec= T _{FFT} /8	0.4μsec	0.4μsec	
T_{L-STF}: Legacy Short training sequence length	8μsec=10× T _{FFT} /4	8μsec	8μsec	
T_{L-LTF}: Legacy Long training sequence length	8μsec=2× T _{FFT} +T _{GI2}	8μsec	8μsec	
T_{SYM}: Symbol	4μsec= T _{FFT} +T _{GI}	4μsec	4μsec	

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal")				
	Parameter	Value in legacy 20MHz channel	Value in 20MHz HT channel	Value in 40MHz channel	
				HT format	Legacy Duplicate
	Interval				
	T _{SYMS} : Short GI Symbol Interval	3.6μsec= T _{FFT} +T _{GIS}	3.6μsec	3.6μsec	
	T _{L-SIG}	4μsec= T _{SYM}	4μsec	4μsec	
	T _{HT-SIG}	NA	8μsec= 2T _{SYM}	8μsec	
	T _{HT-STF} : HT STF time	NA	4μsec	4μsec	
	T _{HT-LTF1} : HT first long training field length	NA	4μsec in mixed mode, 8μsec in green field	4μsec in mixed mode, 8μsec in green field	
	T _{HT-LTFs} : HT second, and subsequent, long training fields length	NA	4μsec	4μsec	
[2006 802.11n Joint PHY Proposal at 15-17]					

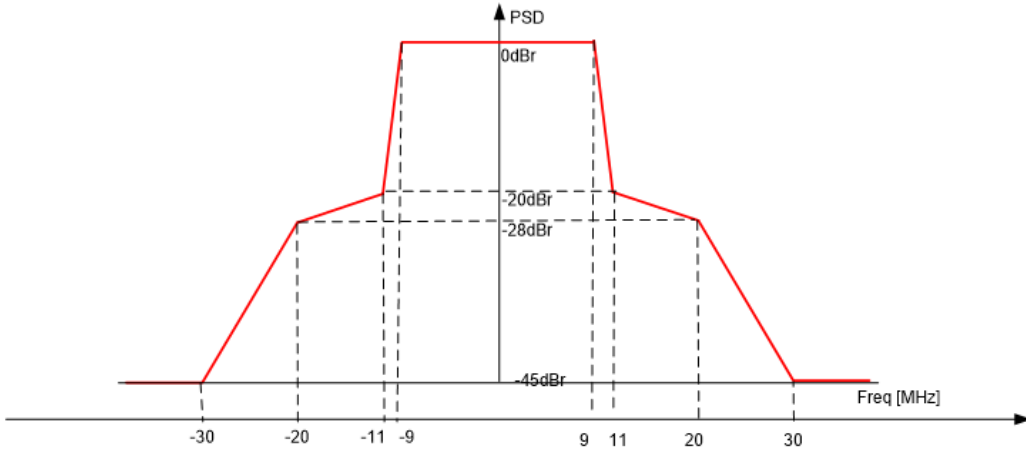
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal")		
	Field	<i>N_{Tone}</i> <i>N_{Field}</i>	
		20 MHz	40 MHz
	L-STF	12	24
	L-LTF	52	104
	L-SIG	52	104
	HT-SIG	52/56*	104/114*
	HT-STF	12	24
	HT-LTF	56	114
	HT-Data	56	114
	HT-Data- 40 MHz Dup. Format	-	104

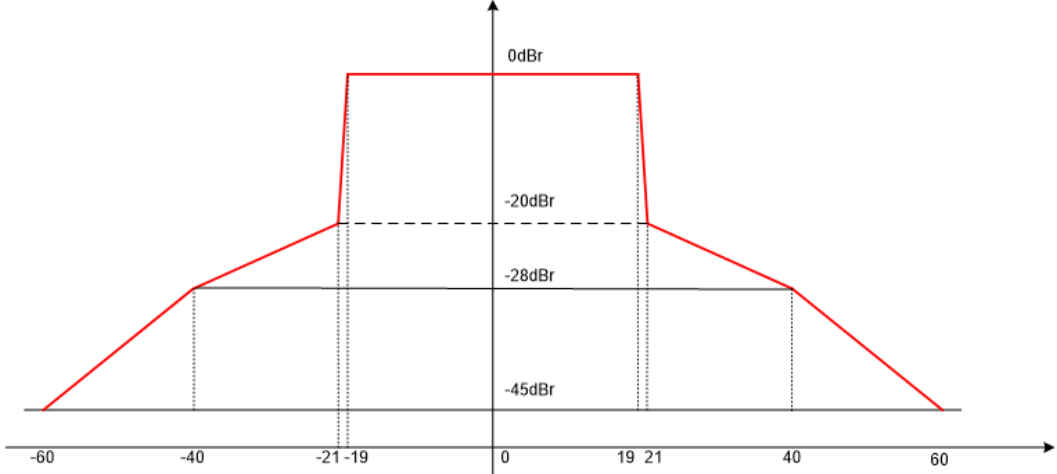
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	<table><tr><th>Field</th><th colspan="2">N_{Field}^{Tone}</th></tr><tr><th></th><th>20 MHz</th><th>40 MHz</th></tr></table> Notes: *56 and 114 are for green field mode, 52 and 104 are for mixed mode. The numbers in the table refer only to the value of N_{Field}^{Tone} as it appears in equation (12) and in subsequent specification of various fields. It may be different from the actual number of tones being transmitted. Table 3 - number of tones in each field [2006 802.11n Joint PHY Proposal at 20-21] 5 Channel Numbering and Channelization The device operates both in the 5GHz band and 2.4GHz band. When using 20MHz channels it uses the same channels as in the 11a/11g. When using the 40MHz channel, it can operate in the channels defined in sections 5.1 and 5.2.	Field	N_{Field}^{Tone}			20 MHz	40 MHz
Field	N_{Field}^{Tone}						
	20 MHz	40 MHz					

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	5.1 Channel Allocation in the 5 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz (for 20 MHz channels). The relationship between center frequency and channel number is given by the following equation: Channel center frequency = $5000 + 5 \cdot n_{ch}$ (MHz), Where $n_{ch} = 0, 1, \dots, 200$. The 40MHz channels in 5GHz are specified by two fields: ($N_{control\ ch}$, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 36 and 40 where channel 36 is the control channel shall be specified as (36,1). The following table lists the valid settings of these two fields in the 5 GHz band.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																																
	Table 18 - 40MHz channel allocation in the 5GHz band <table><tr><th rowspan="2">Regulatory domain</th><th rowspan="2">Band (GHZ)</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII lower band (5.15-5.25)</td><td>36</td><td>40</td><td>5190</td></tr><tr><td>44</td><td>48</td><td>5230</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII middle band (5.25-5.35)</td><td>52</td><td>56</td><td>5270</td></tr><tr><td>60</td><td>64</td><td>5310</td></tr><tr><td rowspan="5">Europe</td><td rowspan="5">ETSI (5.5-5.7)</td><td>100</td><td>104</td><td>5510</td></tr><tr><td>108</td><td>112</td><td>5550</td></tr><tr><td>116</td><td>120</td><td>5590</td></tr><tr><td>124</td><td>128</td><td>5630</td></tr><tr><td>132</td><td>136</td><td>5670</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII upper band (5.725-5.825)</td><td>149</td><td>153</td><td>5755</td></tr><tr><td>157</td><td>161</td><td>5795</td></tr></table> 5.2 Channel Allocation in the 2.4 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz in the 2.4 GHz band. The relationship between center frequency and channel number	Regulatory domain	Band (GHZ)	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States	U-NII lower band (5.15-5.25)	36	40	5190	44	48	5230	United States	U-NII middle band (5.25-5.35)	52	56	5270	60	64	5310	Europe	ETSI (5.5-5.7)	100	104	5510	108	112	5550	116	120	5590	124	128	5630	132	136	5670	United States	U-NII upper band (5.725-5.825)	149	153	5755	157	161	5795
Regulatory domain	Band (GHZ)			N _{control_ch}			Center Frequency (MHz)																																										
		Extension=1	Extension=-1																																														
United States	U-NII lower band (5.15-5.25)	36	40	5190																																													
		44	48	5230																																													
United States	U-NII middle band (5.25-5.35)	52	56	5270																																													
		60	64	5310																																													
Europe	ETSI (5.5-5.7)	100	104	5510																																													
		108	112	5550																																													
		116	120	5590																																													
		124	128	5630																																													
		132	136	5670																																													
United States	U-NII upper band (5.725-5.825)	149	153	5755																																													
		157	161	5795																																													

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																												
	is given by the following equation: Channel center frequency = 2407 + 5 · n_{ch} (MHz), Where n_{ch} = 1,2,...11. The 40MHz channels in 2.4GHz are specified in the same way as in 5GHz: (N_{control_ch}, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 2 and channel 6 where channel 6 is the control channel shall be specified as (6, -1). The following table lists the valid settings of these two fields in the 2.4 GHz band. Table 19 - 40Mhz channel allocation in the 2.4GHz and <table><tr><th rowspan="2">Regulatory domain</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="7">United States Canada Europe</td><td>1</td><td>5</td><td>2422</td></tr><tr><td>2</td><td>6</td><td>2427</td></tr><tr><td>3</td><td>7</td><td>2432</td></tr><tr><td>4</td><td>8</td><td>2437</td></tr><tr><td>5</td><td>9</td><td>2442</td></tr><tr><td>6</td><td>10</td><td>2447</td></tr><tr><td>7</td><td>11</td><td>2452</td></tr></table>	Regulatory domain	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States Canada Europe	1	5	2422	2	6	2427	3	7	2432	4	8	2437	5	9	2442	6	10	2447	7	11	2452
Regulatory domain	N _{control_ch}		Center Frequency (MHz)																										
	Extension=1	Extension=-1																											
United States Canada Europe	1	5	2422																										
	2	6	2427																										
	3	7	2432																										
	4	8	2437																										
	5	9	2442																										
	6	10	2447																										
	7	11	2452																										

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	6 Transmit Spectrum Mask When transmitting in a 20MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, -20 dBr at 11 MHz frequency offset, -28 dBr at 20 MHz frequency offset and -45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 15. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.  Figure 15 - Transmit spectral mask for 20MHz Transmission

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	When transmitting in a 40MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz offset and -45 dBr at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 16. The transmit spectral mask for 20MHz transmission in upper or lower 20Mhz channels of a 40MHz is the same mask as that used for the 40MHz channel.  Figure 16 - Transmit spectral mask for a 40MHz channel [2006 802.11n Joint PHY Proposal at 56-59]
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to	The 2006 802.11n Joint PHY Proposal disclosed demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference disclosed the following:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
determine the second plurality of header bits,	3.5.2 Legacy Short Training Field The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is $S_{-26,26} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0\} \quad (13)$ The normalization factor $\sqrt{1/2}$ is the QPSK normalization. The legacy short training OFDM symbol in 40MHz mode is based on: $S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, +1 + j, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, +1 + j, 0, 0, 0\} \quad (14)$ The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90°. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	In mixed mode the L-STF on the i_{TX}'th transmit chain is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-STF}^{Tone}}} w_{L-STF}(t) \cdot \left(\sum_{k=-N_{SR}}^0 S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{TX}})) + \Upsilon \sum_{k=1}^{N_{SR}} S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{TX}})) \right) \quad (15)$ In green field the L-STF on the i_{TX}'th transmit chain is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{L-STF}^{Tone}}} w_{L-STF}(t) \cdot \left(\sum_{k=-N_{SR}}^0 \sum_{i_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{i_{TX} i_{STS}} [P_{HILTF}]_{i_{STS},1} S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) + \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{i_{TX} i_{STS}} [P_{HILTF}]_{i_{STS},1} S_k \exp(j 2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) \right) \quad (16)$ In the case of Mixed Mode operation $T_{CS}^{i_{TX}}$ takes values from Table 4. In the case of Green Field operation $T_{CS}^{i_{STS}}$ takes values from Table 6. The value of Υ is 1 for 20MHz and j in 40MHz. $\mathcal{Q}_k$ is defined in section 4.7.1. The L-STF has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	[2006 802.11n Joint PHY Proposal at 22-23] 3.5.3 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1\} \quad (17)$ The legacy long training OFDM signal in the 40MHz mode is based on: $L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,0,0,0,0,0,0,0,0,0,0,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,0,1,-1,-1,1,1,-1,1,-1,1,-1,1,-1,1,1,1\} \quad (18)$ The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90° (see equation (19)). The sub-carriers at ±32 in 40MHz, which are the DC sub-carriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																																																							
	$r_{L-LTF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-LTF}^{Tone}}} w_{T_{L-LTF}}(t) \cdot$$\left(\sum_{k=-N_{SR}}^0 L_k \exp\left(j 2\pi k \Delta_F \left(t - T_{GI2} - T_{CS}^{i_{TX}} \right) \right) + \right. \tag{19}$$\left. \gamma \sum_{k=1}^{N_{SR}} L_k \exp\left(j 2\pi k \Delta_F \left(t - T_{GI2} - T_{CS}^{i_{TX}} \right) \right) \right)$ where $T_{GI2} = 1.6 \mu \text{ sec}$. The value of γ is 1 for 20MHz and j in 40MHz. [2006 802.11n Joint PHY Proposal at 23-24] 3.5.4 The Legacy Signal Field The signal field is used to transfer rate and length information. It has different meaning when used in legacy transmission and when used in a non legacy transmission. When transmitted in a legacy 20MHz mode, it is transmitted using the same method and meaning as specified in section 17.3.4 of the IEEE 802.11a standard [1]. <table><tr><th colspan="4">Rate (4 bits)</th><th rowspan="2">R</th><th colspan="12">Length (12 bits)</th><th rowspan="2">P</th><th colspan="6">Tail 6bits</th></tr><tr><th>R1</th><th>R2</th><th>R3</th><th>R4</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>"0"</th><th>"0"</th><th>"0"</th><th>"0"</th><th>"0"</th><th>"0"</th></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table>	Rate (4 bits)				R	Length (12 bits)												P	Tail 6bits						R1	R2	R3	R4														"0"	"0"	"0"	"0"	"0"	"0"	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Rate (4 bits)				R	Length (12 bits)												P	Tail 6bits																																																						
R1	R2	R3	R4																"0"	"0"	"0"	"0"	"0"	"0"																																																
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																																																	

Figure 4 - The signal field

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	When the transmission is not a legacy transmission the fields in the signal field have different meaning. The bits in the rate field are [1,1,0,1] – corresponding to a rate of 6Mbps in legacy representation. The value in the length field is given through the TX vector. This value is used to spoof legacy devices to defer transmission for a period of corresponding to the length of the rest of the packet. When L-SIG TXOP Protection is not used (see “L-SIG TXOP Protection” section of the MAC spec), the value to be transmitted is $l = 3(\lceil N_{data} \rceil + N_{LTF} + 3) - 3$ where N_{data} is the number of 4usec symbols in the data part of the packet. While using short GI N_{data} is equal to the actual number of symbols in the data part of the packet multiplied by $\frac{9}{10}$. N_{LTF} is the number of HT training symbols. The symbol $\lceil x \rceil$ denotes the lowest integer greater or equal to x. When L-SIG TXOP Protection is used the value of l is defined in the “L-SIG TXOP Protection” section of the MAC spec. If the Length field of the HT-SIG (see Table 7) is set to zero N_{data} shall be set zero in the formula for calculating l. The length field is transmitted LSB first. The reserved bit shall be set to 0. The parity field has the even parity of bits 0-16. The signal field shall be encoded, interleaved and mapped, and have pilots inserted following the steps described in sections 17.3.5.5, 17.3.5.6, 17.3.5.8 of the IEEE802.11a standard [1]. The stream of 48, complex numbers generated by these steps is d_k, $k = 0 \dots 47$. The conversion of these into a time domain signal is described in the following table

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	9 Table 5 - generation of the signal field <table border="1"> <thead> <tr> <th>Modulation Method</th><th>Conversion to Time Domain signal</th></tr> </thead> <tbody> <tr> <td>20MHz transmission on several transmit chains – i_{TX}’th tx chain</td><td> $r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi M(k) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right)$ </td></tr> <tr> <td>40MHz transmission on several transmit chains – i_{TX}’th Tx chain.</td><td> $r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi (M(k) - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $+ j \sum_{k=0}^{47} d_k \exp(j2\pi (M(k) + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) +$ $p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp(j2\pi (k - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. \left. j \exp(j2\pi (k + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right) \right)$ </td></tr> </tbody> </table> $M(k), P_k$ are defined in section 17.3.5.9 of the 802.11a standard [1]. p_0 is the first pilot value in the sequence defined in section 17.3.5.9 of the 802.11a standard [1]. [2006 802.11n Joint PHY Proposal at 24-25]	Modulation Method	Conversion to Time Domain signal	20MHz transmission on several transmit chains – i_{TX}’th tx chain	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi M(k) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right)$	40MHz transmission on several transmit chains – i_{TX}’th Tx chain.	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi (M(k) - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $+ j \sum_{k=0}^{47} d_k \exp(j2\pi (M(k) + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) +$ $p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp(j2\pi (k - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. \left. j \exp(j2\pi (k + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right) \right)$
Modulation Method	Conversion to Time Domain signal						
20MHz transmission on several transmit chains – i_{TX}’th tx chain	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi M(k) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right)$						
40MHz transmission on several transmit chains – i_{TX}’th Tx chain.	$r_{L-SIG}^{(i_{TX})}(t) = w_{TIM}(t) \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tones}}} \cdot$ $\left(\sum_{k=0}^{47} d_k \exp(j2\pi (M(k) - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $+ j \sum_{k=0}^{47} d_k \exp(j2\pi (M(k) + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) +$ $p_0 \sum_{k=-N_{SR}}^{N_{SR}} P_k \left(\exp(j2\pi (k - 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) + \right.$ $\left. \left. j \exp(j2\pi (k + 32) \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \right) \right)$						

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)												
	3.6.2 The High Throughput Signal Field The high throughput signal field is used to carry information required to interpret the HT packet formats. The high throughput signal field (HT_SIG) includes the following fields: Table 7 - Fields of High Throughput Signal Field <table><tr><th>Field Name</th><th>Num of Bits</th><th>Explanation and coding</th></tr><tr><td>Modulation and Coding Scheme</td><td>7</td><td>Index into The MCS table, LSB first</td></tr><tr><td>BW 20/40</td><td>1</td><td>0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz</td></tr><tr><td>Length</td><td>16</td><td>The number of bytes of data in the PSDU – 0*-65535</td></tr></table>	Field Name	Num of Bits	Explanation and coding	Modulation and Coding Scheme	7	Index into The MCS table, LSB first	BW 20/40	1	0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz	Length	16	The number of bytes of data in the PSDU – 0*-65535
Field Name	Num of Bits	Explanation and coding											
Modulation and Coding Scheme	7	Index into The MCS table, LSB first											
BW 20/40	1	0 if 20MHz or 40 MHz upper/lower; 1 if 40MHz											
Length	16	The number of bytes of data in the PSDU – 0*-65535											

Field Name	Num of Bits	Explanation and coding
Smoothing	1	1 – channel estimate smoothing is allowed 0 – Only per-carrier independent (unsmoothed) channel estimate is recommended.
Not Sounding	1	Indicates that the packet is a sounding packet. 0 –Sounding Packet 1 – Not a sounding packet
reserved one	1	set to 1
Aggregation	1	Set to 1 to indicate that the PPDU in the data portion of the packet contains an A-MPDU. Set to 0 otherwise
STBC	2	Indicates the difference between either the number of space time streams N_{STS} and the number of spatial streams N_{SS} indicated by the MCS 00 – No STBC ($N_{STS}=N_{SS}$)
Advanced Coding	1	1 - LDPC 0 - BCC.
Short GI	1	Set to 1 to Indicate that the short GI is used after the HT training. Set to 0 otherwise
Number of extension HT-LTF	2	Number of extension spatial stream(s) N_{ESS} . –b'00 – no extension spatial stream, b'01 – 1 additional spatial stream, b'10 2 additional spatial streams, b'11 3 additional spatial streams.
CRC	8	CRC of bits 0-23 in HT-SIG1 and bits 0-9 in HT-SIG2 – see section 3.6.3. The first bit to be transmitted is bit C7 as explained in aforementioned section .
Tail Bits	6	Used to terminate the trellis of the convolution coder. Set to 0.
Integer fields are transmitted least significant bit first. A value of 0 in the Length Field indicates a PPDU which does not include a data field. The packets <u>ends</u> after the last HT-LTF or the HT-SIG.		

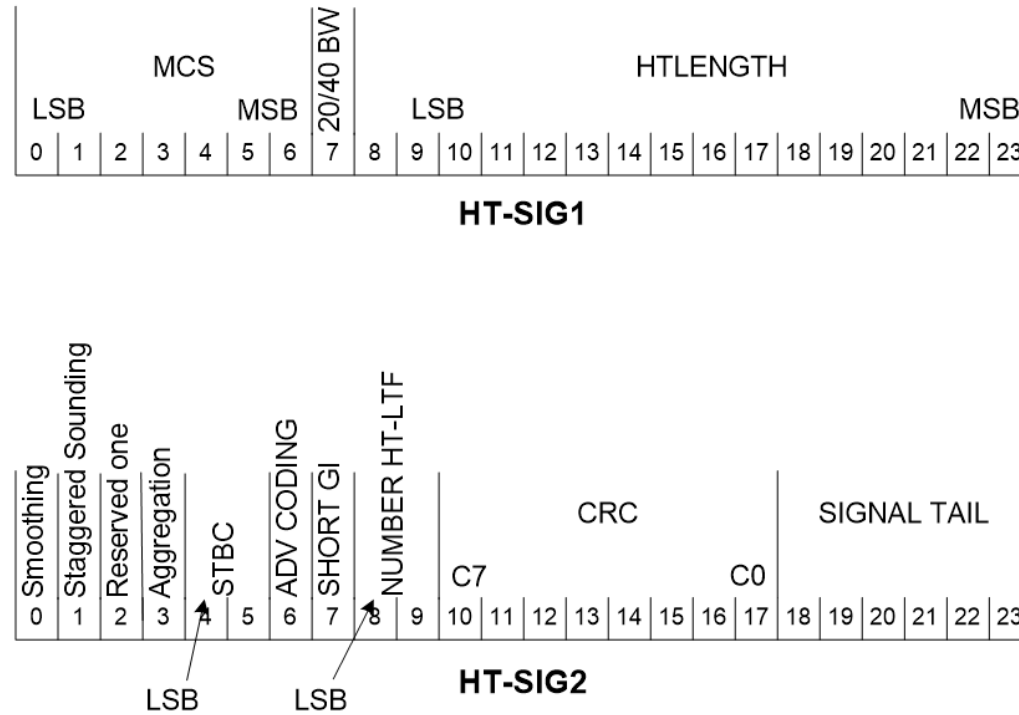


Figure 5 - HT SIG breakdown to HT-SIG1 and HT-SIG2

The HT-SIG is composed of two parts HTSIG₁ and HTSIG₂ each containing 24 bits. All the fields in the HT-SIG are transmitted LSB first.

The HT-SIG parts are encoded, interleaved, mapped, and have pilots inserted following the steps described in sections 17.3.5.5, 17.3.5.6, 17.3.5.8 of the IEEE802.11a standard [1]. The stream of 96, complex numbers generated by these steps are divided into two groups of 48 complex numbers:

$d_{k,n}$, $k = 0 \dots 47, n = 0,1$ see Figure 5. The conversion of these into the time domain signal is according to the next tables:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	1 Table 8 - Modulation for the High Throughput Signal Field in a Mixed Mode Packet <table border="1"> <thead> <tr> <th>Modulation Method</th><th>Conversion to Time Domain signal</th></tr> </thead> <tbody> <tr> <td>20MHz transmission - i_{TX}'th stream</td><td> $r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$ </td></tr> <tr> <td>40MHz Tx on several streams - i_{TX}'th stream</td><td> $r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. - \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$ </td></tr> </tbody> </table>	Modulation Method	Conversion to Time Domain signal	20MHz transmission - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$	40MHz Tx on several streams - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. - \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$
Modulation Method	Conversion to Time Domain signal						
20MHz transmission - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$						
40MHz Tx on several streams - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX}} \cdot N^{Tones}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. - \sum_{k=0}^{47} d_{k,n} \exp(j2\pi (M(k) + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k - 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} P_k \exp(j2\pi (k + 32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \right)$						

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)						
	3 Table 9 - Modulation for the High Throughput Signal Field in a Green Field Packet <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #000080; color: white;"> <th style="width: 25%;">Modulation Method</th><th style="width: 75%;">Conversion to Time Domain signal</th></tr> </thead> <tbody> <tr> <td style="vertical-align: top;"> 20MHz transmission - i_{TX}'th stream </td><td> $r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$ </td></tr> <tr> <td style="vertical-align: top;"> 40MHz Tx on several streams - i_{TX}'th stream </td><td> $r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. - \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$ </td></tr> </tbody> </table>	Modulation Method	Conversion to Time Domain signal	20MHz transmission - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$	40MHz Tx on several streams - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. - \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$
Modulation Method	Conversion to Time Domain signal						
20MHz transmission - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi M(k) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_k]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi k \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$						
40MHz Tx on several streams - i_{TX}'th stream	$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{Tones}}} \sum_{n=0}^1 w_{T_{SYM}}(t - nT_{SYM}) \cdot$ $\left(j \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. - \sum_{k=0}^{47} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{M(k)+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} d_{k,n} \exp(j2\pi (M(k)+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + p_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k-32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k-32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right.$ $\left. + jp_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} \sum_{l_{STS}=1}^{N_{STS}} [\mathcal{Q}_{k+32}]_{l_{TX}, l_{STS}} [P_{HILTF}]_{l_{STS}, 1} P_k \exp(j2\pi (k+32) \Delta_F (t - nT_{SYM} - T_{GI} - T_{CS}^{l_{STS}})) \right)$						

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	$M(k), p_n, P_k$ are defined in section 17.3.5.9 of the 802.11a standard. [1] N^{Tones} is equal to the number of tones in the HT-SIG. The value of z is zero in a GF packet and 1 in a mixed mode packets. Values for $T_{CS}^{I_{TX}}$ are taken from Table 4 in the case of MM. In the case of a GF packet the values of $T_{CS}^{I_{STS}}$ are taken from Table 6. P_{HTLTF} is defined in section 3.6.5. Q_k is defined in section 4.7.1. The value of N_{SR} used in these equations, both for 20MHz and 40MHz, is 26 tones. Note: this definition results in a BPSK modulation in which the constellation of the data tones is rotated by 90° relative to the legacy signal field. Figure 6 - constellation for the legacy signal field and the HT signal field

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	[2006 802.11n Joint PHY Proposal at 26-31] 3.6.4 The HT STF training symbol The purpose of the HT STF training field is to improve AGC training in a multi-transmit and multi-receive system. The duration of the HT-STF is 4μsec; the frequency sequence used to construct the HT-STF in 20MHz transmission is identical to legacy STF; in 40MHz transmission the HT-STF is constructed from the 20MHz version by frequency shifting and duplicating, and rotating the upper sub-carriers by 90°. The frequency sequences are: For 20MHz: $HTS_{-28,28} = \sqrt{1/2} \{0, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0\}$ The HT-STF in 40MHz is based on: $HTS_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, +1 + j, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, +1 + j, 0, 0\}$

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	The time domain representation of the transmission in the i_{TX}’th transmit chain is: $r_{HT-STF}^{i_{TX}}(t) = w_{HT-STF}(t) \frac{1}{\sqrt{N_{STS} N_{HT-STF}^{Tones}}} \cdot$ $\left(\sum_{k=-N_{SR}}^0 \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} HTS(k) \exp(j2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) \right)$ $+ \Upsilon \sum_{k=1}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} HTS(k) \exp(j2\pi k \Delta_F (t - T_{CS}^{i_{STS}})) \Bigg)$ The value of Υ is 1 for 20MHz and j in 40MHz. The values for $T_{CS}^{i_{STS}}$ are given in Table 6. Q_k is defined in section 4.7.1. [2006 802.11n Joint PHY Proposal at 32-33] 3.6.5 The HT-LTF long training Field The HT long training field provides means for the receiver to estimate the channel between each spatial mapper input (or spatial stream transmitter if no STBC is applied) and receive chain; the number of training symbols N_{LTF} is equal or greater than the number of space time streams (with an exception in the case of 3 space time streams). The number of training symbols is greater than the number of space time streams if the transmitter is providing training for more spatial streams (spatial mapper inputs) than the number used for the transmission of the PSDU. This happens in a sounding PPDU.

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	The HT long training field portion has one or two parts. The first part consists of from one to four HT long training fields (HT-LTFs) that are necessary for demodulation of the HT-Data portion of the PPDU. These HT-LTFs are referred to as Data HT-LTFs. The optional second part consists of from zero to four HT-LTFs that may be used to probe extra spatial dimensions of the MIMO channel that are not utilized by the HT-Data portion of the PPDU. These HT-LTFs are referred to as Extension HT-LTFs. If a receiver has not advertised its ability to receive Extension HT-LTFs, it may discard a frame including Extension HT-LTFs as an unknown frame type. The number of Data HT-LTFs is denoted N_{DLTF}. The number of extension HT-LTFs is denoted N_{ELTF}. The total number of HT-LTFs is $N_{LTF} = N_{DLTF} + N_{ELTF}$. N_{LTF} shall not exceed 5. Table 10 shows the determination of the number of space time streams from the MCS and STBC HT-SIG fields. Table 11 shows the number of data and extension LTFs as a function of either number of space time streams N_{STS} or number of extension spatial streams N_{ESS}.

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	<table><tr><th>Number of Spatial Streams (from MCS) N_{SS}</th><th>STBC field</th><th>Number of space time streams N_{STS}</th></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>2</td></tr><tr><td>2</td><td>0</td><td>2</td></tr><tr><td>2</td><td>1</td><td>3</td></tr><tr><td>2</td><td>2</td><td>4</td></tr><tr><td>3</td><td>0</td><td>3</td></tr><tr><td>3</td><td>1</td><td>4</td></tr><tr><td>4</td><td>0</td><td>4</td></tr></table> Table 10 - Determining the number of space time streams <table><tr><th>N_{STS} or N_{ESS}</th><th>N_{DLTF} or N_{ELTFs}</th></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>2</td></tr><tr><td>3</td><td>4</td></tr><tr><td>4</td><td>4</td></tr></table> Table 11 - Number of LTFs required to probe spatial streams	Number of Spatial Streams (from MCS) N_{SS}	STBC field	Number of space time streams N_{STS}	1	0	1	1	1	2	2	0	2	2	1	3	2	2	4	3	0	3	3	1	4	4	0	4	N_{STS} or N_{ESS}	N_{DLTF} or N_{ELTFs}	1	1	2	2	3	4	4	4
Number of Spatial Streams (from MCS) N_{SS}	STBC field	Number of space time streams N_{STS}																																				
1	0	1																																				
1	1	2																																				
2	0	2																																				
2	1	3																																				
2	2	4																																				
3	0	3																																				
3	1	4																																				
4	0	4																																				
N_{STS} or N_{ESS}	N_{DLTF} or N_{ELTFs}																																					
1	1																																					
2	2																																					
3	4																																					
4	4																																					

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The following HT-LTF sequence is transmitted in the case of 20MHz operation:

Note that this sequence is an extension of the legacy LTF where the 4 extra sub-carriers are filled with +1 for negative frequencies and -1 for positive frequencies

$$\begin{aligned}
HTLTF_{-58,58} = & \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, \\
& 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, 0 \\
& 0, 0, -1, 1, 1, -1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, \\
& 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, -1, 1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\}
\end{aligned}$$

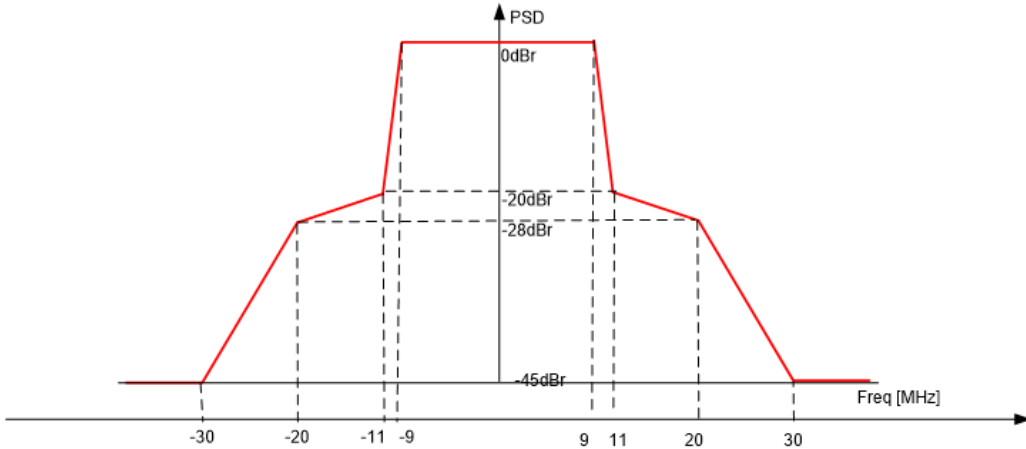
This sequence is used even if the HT-duplicate mode (MCS 32) is used in the data.

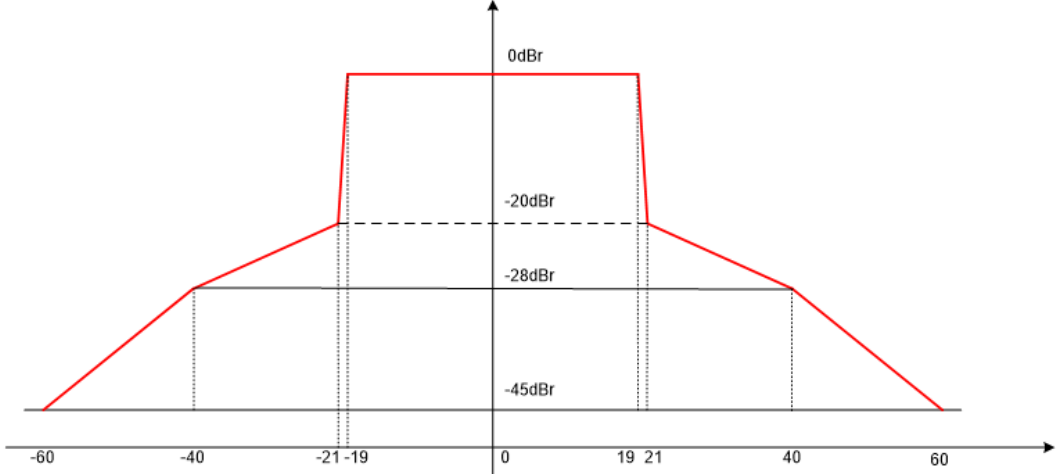
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	The duration of each long training field HT-LTF is 4 μsec and it consists of a single occurrence of the sequence plus a GI insertion. An exception is the first HT-LTF in a GF packet which is 8μsec long consisting of two instances of the sequence plus a double GI insertion. In case of multiple space time streams cyclic shift is invoked as specified in Table 6 [2006 802.11n Joint PHY Proposal at 33-35]
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	The 2006 802.11n Joint PHY Proposal disclosed first narrower and second wider frequency bands with one or more overlapping frequency regions. For example, the reference disclosed the following: 5 Channel Numbering and Channelization The device operates both in the 5GHz band and 2.4GHz band. When using 20MHz channels it uses the same channels as in the 11a/11g. When using the 40MHz channel, it can operate in the channels defined in sections 5.1 and 5.2.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	5.1 Channel Allocation in the 5 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz (for 20 MHz channels). The relationship between center frequency and channel number is given by the following equation: Channel center frequency = $5000 + 5 \cdot n_{ch}$ (MHz), Where $n_{ch} = 0, 1, \dots, 200$. The 40MHz channels in 5GHz are specified by two fields: ($N_{control\ ch}$, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 36 and 40 where channel 36 is the control channel shall be specified as (36,1). The following table lists the valid settings of these two fields in the 5 GHz band.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																																
	Table 18 - 40MHz channel allocation in the 5GHz band <table><tr><th rowspan="2">Regulatory domain</th><th rowspan="2">Band (GHZ)</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII lower band (5.15-5.25)</td><td>36</td><td>40</td><td>5190</td></tr><tr><td>44</td><td>48</td><td>5230</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII middle band (5.25-5.35)</td><td>52</td><td>56</td><td>5270</td></tr><tr><td>60</td><td>64</td><td>5310</td></tr><tr><td rowspan="5">Europe</td><td rowspan="5">ETSI (5.5-5.7)</td><td>100</td><td>104</td><td>5510</td></tr><tr><td>108</td><td>112</td><td>5550</td></tr><tr><td>116</td><td>120</td><td>5590</td></tr><tr><td>124</td><td>128</td><td>5630</td></tr><tr><td>132</td><td>136</td><td>5670</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII upper band (5.725-5.825)</td><td>149</td><td>153</td><td>5755</td></tr><tr><td>157</td><td>161</td><td>5795</td></tr></table> 5.2 Channel Allocation in the 2.4 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz in the 2.4 GHz band. The relationship between center frequency and channel number	Regulatory domain	Band (GHZ)	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States	U-NII lower band (5.15-5.25)	36	40	5190	44	48	5230	United States	U-NII middle band (5.25-5.35)	52	56	5270	60	64	5310	Europe	ETSI (5.5-5.7)	100	104	5510	108	112	5550	116	120	5590	124	128	5630	132	136	5670	United States	U-NII upper band (5.725-5.825)	149	153	5755	157	161	5795
Regulatory domain	Band (GHZ)			N _{control_ch}			Center Frequency (MHz)																																										
		Extension=1	Extension=-1																																														
United States	U-NII lower band (5.15-5.25)	36	40	5190																																													
		44	48	5230																																													
United States	U-NII middle band (5.25-5.35)	52	56	5270																																													
		60	64	5310																																													
Europe	ETSI (5.5-5.7)	100	104	5510																																													
		108	112	5550																																													
		116	120	5590																																													
		124	128	5630																																													
		132	136	5670																																													
United States	U-NII upper band (5.725-5.825)	149	153	5755																																													
		157	161	5795																																													

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	is given by the following equation: Channel center frequency = 2407 + 5 · n_{ch} (MHz), Where n_{ch} = 1,2,...11. The 40MHz channels in 2.4GHz are specified in the same way as in 5GHz: (N_{control_ch}, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 2 and channel 6 where channel 6 is the control channel shall be specified as (6, -1). The following table lists the valid settings of these two fields in the 2.4 GHz band. Table 19 - 40Mhz channel allocation in the 2.4GHz and <table><tr><th rowspan="2">Regulatory domain</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="7">United States Canada Europe</td><td>1</td><td>5</td><td>2422</td></tr><tr><td>2</td><td>6</td><td>2427</td></tr><tr><td>3</td><td>7</td><td>2432</td></tr><tr><td>4</td><td>8</td><td>2437</td></tr><tr><td>5</td><td>9</td><td>2442</td></tr><tr><td>6</td><td>10</td><td>2447</td></tr><tr><td>7</td><td>11</td><td>2452</td></tr></table>	Regulatory domain	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States Canada Europe	1	5	2422	2	6	2427	3	7	2432	4	8	2437	5	9	2442	6	10	2447	7	11	2452
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	6 Transmit Spectrum Mask When transmitting in a 20MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, -20 dBr at 11 MHz frequency offset, -28 dBr at 20 MHz frequency offset and -45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 15. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.  Figure 15 - Transmit spectral mask for 20MHz Transmission

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	When transmitting in a 40MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz offset and -45 dBr at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 16. The transmit spectral mask for 20MHz transmission in upper or lower 20Mhz channels of a 40MHz is the same mask as that used for the 40MHz channel.  Figure 16 - Transmit spectral mask for a 40MHz channel [2006 802.11n Joint PHY Proposal at 56-59]
[2.] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first	The 2006 802.11n Joint PHY Proposal disclosed the wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference disclosed the following:

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packet in the first narrower frequency band.	3.5.1 Cyclic shift definition for the legacy fields. In the rest of the document cyclic shift is used to prevent unintentional beamforming when the same signal or similar signals are transmitted through different spatial streams. A cyclic shift of length τ on a signal $s(t)$ on interval $0 \leq t \leq T$ is defined by replacing $s(t)$ with $s(t-\tau)$ when $\tau < t \leq T$³ and with $s(t-\tau+T)$ when $0 \leq t \leq \tau$. Cylic shift is applied to each OFDM symbol in the packet separately. The following table specifies the values for the cyclic shift that is applied in the legacy short training field (in a MM packet), the legacy long training field, and legacy signal field. It also applies to the HT signal field in a mixed mode packet. <table><tr><th colspan="5">$T_{CS}^{i_{TX}}$ values for the legacy portion of the packet</th></tr><tr><th>Number of Tx</th><th>cyclic shift for</th><th>cyclic shift for</th><th>cyclic shift for</th><th>cyclic shift for</th></tr><tr><td>Chains</td><td>Tx chain 1</td><td>Tx chain 2</td><td>Tx chain 3</td><td>Tx chain 4</td></tr><tr><td>1</td><td>0ns</td><td>-</td><td>-</td><td>-</td></tr><tr><td>2</td><td>0ns</td><td>-200ns</td><td>-</td><td>-</td></tr><tr><td>3</td><td>0ns</td><td>-100ns</td><td>-200ns</td><td>-</td></tr><tr><td>4</td><td>0ns</td><td>-50ns</td><td>-100ns</td><td>-150ns</td></tr></table> Table 4 - Cyclic shift for legacy portion of the packet [2006 802.11n Joint PHY Proposal at 21-22]	$T_{CS}^{i_{TX}}$ values for the legacy portion of the packet					Number of Tx	cyclic shift for	cyclic shift for	cyclic shift for	cyclic shift for	Chains	Tx chain 1	Tx chain 2	Tx chain 3	Tx chain 4	1	0ns	-	-	-	2	0ns	-200ns	-	-	3	0ns	-100ns	-200ns	-	4	0ns	-50ns	-100ns	-150ns
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	3.6.1 Cyclic shift for the High Throughput preamble Throughout the high throughput preamble, cyclic shift is applied to prevent beamforming when similar signals are transmitted in different spatial streams. The same cyclic shift is applied to these streams during the transmission of the data portion of the packet. The values of the cyclic shift to be used during the HT preamble and the data portion of the packet (except the HT-SIG in a MM packet), are specified in Table 6: <table><tr><th colspan="5">T_{CS}^{STS} values for HT portion of the packet</th></tr><tr><th>Number of spatial streams</th><th>Cyclic shift for Spatial stream 1</th><th>Cyclic shift for spatial stream 2</th><th>Cyclic shift for spatial stream 3</th><th>Cyclic shift for spatial stream 4</th></tr><tr><td>1</td><td>0ns</td><td>-</td><td>-</td><td>-</td></tr><tr><td>2</td><td>0ns</td><td>-400ns</td><td>-</td><td>-</td></tr><tr><td>3</td><td>0ns</td><td>-400ns</td><td>-200ns</td><td>-</td></tr><tr><td>4</td><td>0ns</td><td>-400ns</td><td>-200ns</td><td>-600ns</td></tr></table> Table 6 – Cyclic shift values of HT portion of the packet [2006 802.11n Joint PHY Proposal at 26]	T_{CS}^{STS} values for HT portion of the packet					Number of spatial streams	Cyclic shift for Spatial stream 1	Cyclic shift for spatial stream 2	Cyclic shift for spatial stream 3	Cyclic shift for spatial stream 4	1	0ns	-	-	-	2	0ns	-400ns	-	-	3	0ns	-400ns	-200ns	-	4	0ns	-400ns	-200ns	-600ns
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	[2006 802.11n Joint PHY Proposal at Appendix C] 4.7.4 Transmission in HT duplicate mode. HT duplicate mode provides the lowest transmission rate in 40MHz. It may only be used for one spatial stream and only with BPSK coding and rate ½ coding. Under HT duplicate mode, the following equation defines the signal: $r_{HT-DATA}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM})$ $\left(\sum_{k=0}^{47} [Q_{M(k)-32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)-32)\Delta_F(t - nT_{SYM} - T_{GI})) + \right.$ $j \sum_{k=0}^{47} [Q_{M(k)+32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)+32)\Delta_F(t - nT_{SYM} - T_{GI})) +$ $P_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k-32}]_{i_{TX},1} P_k \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI})) +$ $\left. j P_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k+32}]_{i_{TX},1} P_k \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI})) \right)$ z is defined in section 4.7.2. $M(k)$, P_k is defined in section 17.3.5.9 of the 802.11a standard [1]. N_{SR} has the value defined for legacy 20MHz transmission. $[Q_k]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $[Q_k]_{i_{TX}}$ [2006 802.11n Joint PHY Proposal at 55]

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	4.8 Legacy duplicate transmission Legacy duplicate transmission is used to transmit to legacy 802.11a devices that may be present in either the upper and lower channels of the 40MHz channel. The L-STF, L-LTF and L-SIG are transmitted in the same way as in the HT 40MHz transmission. There is no HT-SIG, HT-STF or HT-LTF. Data transmission is defined in the following equation: $r_{LEG-DUP}^{i_{TX}}(t - nT_{SYM}) = \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} w_{TSM}(t - nT_{SYM})$ $\left(\sum_{k=0}^{47} [Q_{M(k)-32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)-32)(\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) + \right.$ $j \sum_{k=0}^{47} [Q_{M(k)+32}]_{i_{TX},1} d_k \exp(j2\pi(M(k)+32)(\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) +$ $P_n \sum_{k=-N_{GB}}^{N_{GB}} [Q_{k-32}]_{i_{TX},1} P_k \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) +$ $j P_n \sum_{k=-N_{GB}}^{N_{GB}} [Q_{k+32}]_{i_{TX},1} P_k \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) \Bigg)$ $P_k, M(k)$ are the ones defined at 11a standard at section 17.3.5.9. $T_{CS}^{i_{TX}}$ are defined in Table 4. $[Q_k]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $[Q_k]_{i_{TX}}$ [2006 802.11n Joint PHY Proposal at 56]
[3.] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to	The 2006 802.11n Joint PHY Proposal disclosed a wireless transceiver, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference disclosed:

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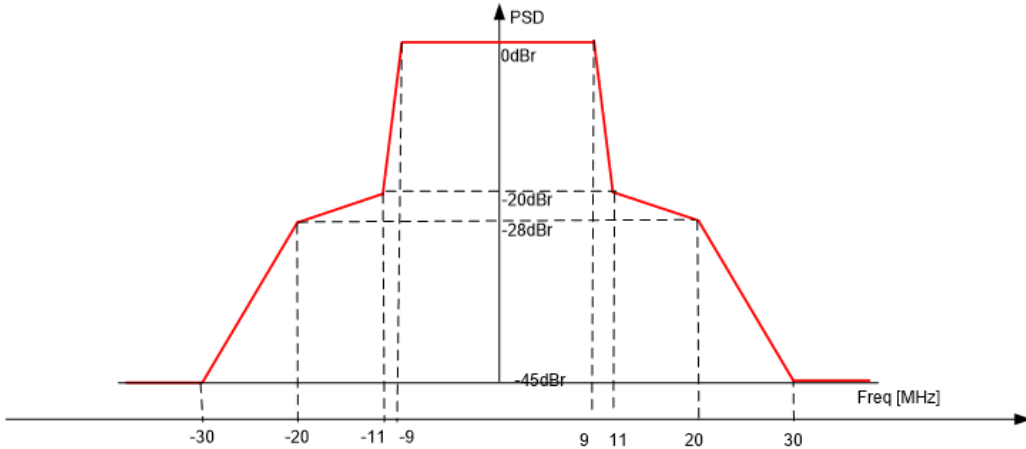
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	[2006 802.11n Joint PHY Proposal at Appendix C] 4.7.4 Transmission in HT duplicate mode. HT duplicate mode provides the lowest transmission rate in 40MHz. It may only be used for one spatial stream and only with BPSK coding and rate ½ coding. Under HT duplicate mode, the following equation defines the signal: $r_{HT-DATA}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM})$ $\left(\sum_{k=0}^{47} [Q_{M(k)-32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)-32)\Delta_F(t - nT_{SYM} - T_{GI})) + \right.$ $j \sum_{k=0}^{47} [Q_{M(k)+32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)+32)\Delta_F(t - nT_{SYM} - T_{GI})) +$ $P_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k-32}]_{i_{TX},1} P_k \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI})) +$ $\left. j P_{n+z} \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k+32}]_{i_{TX},1} P_k \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI})) \right)$ z is defined in section 4.7.2. $M(k)$, P_k is defined in section 17.3.5.9 of the 802.11a standard [1]. N_{SR} has the value defined for legacy 20MHz transmission. $[Q_k]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $[Q_k]_{i_{TX}}$ [2006 802.11n Joint PHY Proposal at 55]

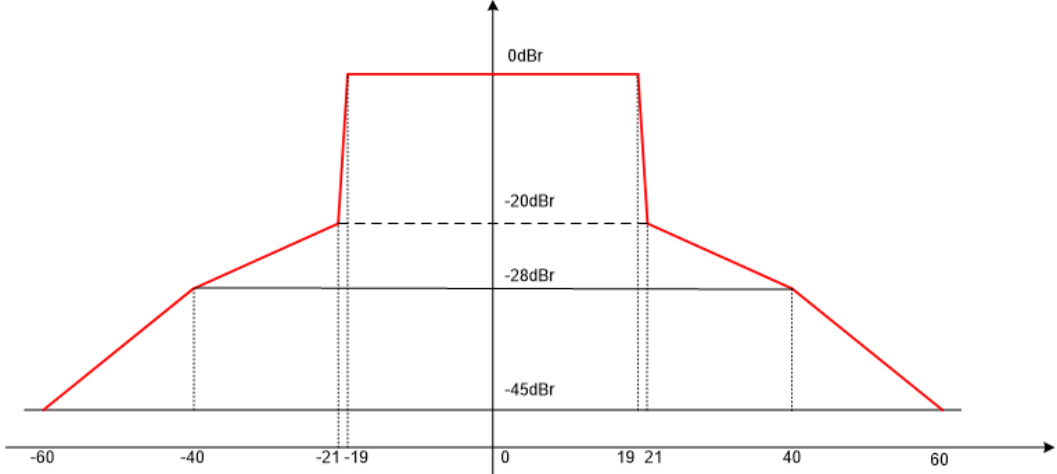
Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	4.8 Legacy duplicate transmission Legacy duplicate transmission is used to transmit to legacy 802.11a devices that may be present in either the upper and lower channels of the 40MHz channel. The L-STF, L-LTF and L-SIG are transmitted in the same way as in the HT 40MHz transmission. There is no HT-SIG, HT-STF or HT-LTF. Data transmission is defined in the following equation: $r_{LEG-DUP}^{i_{TX}}(t - nT_{SYM}) = \frac{1}{\sqrt{N_{Duplicate}^{Tones}}} w_{TSYM}(t - nT_{SYM})$ $\left(\sum_{k=0}^{47} [Q_{M(k)-32}]_{i_{TX},1} d_{k,n} \exp(j2\pi(M(k)-32)(\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) + \right.$ $j \sum_{k=0}^{47} [Q_{M(k)+32}]_{i_{TX},1} d_k \exp(j2\pi(M(k)+32)(\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) +$ $P_n \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k-32}]_{i_{TX},1} P_k \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) +$ $j P_n \sum_{k=-N_{SR}}^{N_{SR}} [Q_{k+32}]_{i_{TX},1} P_k \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}}))) \Bigg)$ $P_k, M(k)$ are the ones defined at 11a standard at section 17.3.5.9. $T_{CS}^{i_{TX}}$ are defined in Table 4. $[Q_k]_{i_{TX}}$ is an element from a vector of length N_{TX}, which may be frequency dependent. The rules of spatial expansion CSD limitation, as specified in section 4.7.1, shall apply to $[Q_k]_{i_{TX}}$ [2006 802.11n Joint PHY Proposal at 56]
[4.] The wireless transceiver of claim 1, wherein the second wider frequency band is two	The 2006 802.11n Joint PHY Proposal disclosed that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference disclosed:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
times wider than the first narrower frequency band.	5 Channel Numbering and Channelization The device operates both in the 5GHz band and 2.4GHz band. When using 20MHz channels it uses the same channels as in the 11a/11g. When using the 40MHz channel, it can operate in the channels defined in sections 5.1 and 5.2. 5.1 Channel Allocation in the 5 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz (for 20 MHz channels). The relationship between center frequency and channel number is given by the following equation: Channel center frequency = $5000 + 5 \cdot n_{ch}$ (MHz), Where $n_{ch} = 0, 1, \dots, 200$. The 40MHz channels in 5GHz are specified by two fields: ($N_{control\ ch}$, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 36 and 40 where channel 36 is the control channel shall be specified as (36,1). The following table lists the valid settings of these two fields in the 5 GHz band.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																																
	Table 18 - 40MHz channel allocation in the 5GHz band <table><tr><th rowspan="2">Regulatory domain</th><th rowspan="2">Band (GHZ)</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII lower band (5.15-5.25)</td><td>36</td><td>40</td><td>5190</td></tr><tr><td>44</td><td>48</td><td>5230</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII middle band (5.25-5.35)</td><td>52</td><td>56</td><td>5270</td></tr><tr><td>60</td><td>64</td><td>5310</td></tr><tr><td rowspan="5">Europe</td><td rowspan="5">ETSI (5.5-5.7)</td><td>100</td><td>104</td><td>5510</td></tr><tr><td>108</td><td>112</td><td>5550</td></tr><tr><td>116</td><td>120</td><td>5590</td></tr><tr><td>124</td><td>128</td><td>5630</td></tr><tr><td>132</td><td>136</td><td>5670</td></tr><tr><td rowspan="2">United States</td><td rowspan="2">U-NII upper band (5.725-5.825)</td><td>149</td><td>153</td><td>5755</td></tr><tr><td>157</td><td>161</td><td>5795</td></tr></table> 5.2 Channel Allocation in the 2.4 GHz Band Channel center frequencies are defined at every integral multiple of 5 MHz in the 2.4 GHz band. The relationship between center frequency and channel number	Regulatory domain	Band (GHZ)	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States	U-NII lower band (5.15-5.25)	36	40	5190	44	48	5230	United States	U-NII middle band (5.25-5.35)	52	56	5270	60	64	5310	Europe	ETSI (5.5-5.7)	100	104	5510	108	112	5550	116	120	5590	124	128	5630	132	136	5670	United States	U-NII upper band (5.725-5.825)	149	153	5755	157	161	5795
Regulatory domain	Band (GHZ)			N _{control_ch}			Center Frequency (MHz)																																										
		Extension=1	Extension=-1																																														
United States	U-NII lower band (5.15-5.25)	36	40	5190																																													
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Europe	ETSI (5.5-5.7)	100	104	5510																																													
		108	112	5550																																													
		116	120	5590																																													
		124	128	5630																																													
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Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																												
	is given by the following equation: Channel center frequency = 2407 + 5 · n_{ch} (MHz), Where n_{ch} = 1,2,...11. The 40MHz channels in 2.4GHz are specified in the same way as in 5GHz: (N_{control_ch}, extension). The first field represents the channel number of the control channel, and the second one indicates whether the extension channel is above or below the control channel (1 -> above, -1 -> below). For example, a 40MHz channel consisting of channel 2 and channel 6 where channel 6 is the control channel shall be specified as (6, -1). The following table lists the valid settings of these two fields in the 2.4 GHz band. Table 19 - 40Mhz channel allocation in the 2.4GHz and <table><tr><th rowspan="2">Regulatory domain</th><th colspan="2">N_{control_ch}</th><th rowspan="2">Center Frequency (MHz)</th></tr><tr><th>Extension=1</th><th>Extension=-1</th></tr><tr><td rowspan="7">United States Canada Europe</td><td>1</td><td>5</td><td>2422</td></tr><tr><td>2</td><td>6</td><td>2427</td></tr><tr><td>3</td><td>7</td><td>2432</td></tr><tr><td>4</td><td>8</td><td>2437</td></tr><tr><td>5</td><td>9</td><td>2442</td></tr><tr><td>6</td><td>10</td><td>2447</td></tr><tr><td>7</td><td>11</td><td>2452</td></tr></table>	Regulatory domain	N _{control_ch}		Center Frequency (MHz)	Extension=1	Extension=-1	United States Canada Europe	1	5	2422	2	6	2427	3	7	2432	4	8	2437	5	9	2442	6	10	2447	7	11	2452
Regulatory domain	N _{control_ch}		Center Frequency (MHz)																										
	Extension=1	Extension=-1																											
United States Canada Europe	1	5	2422																										
	2	6	2427																										
	3	7	2432																										
	4	8	2437																										
	5	9	2442																										
	6	10	2447																										
	7	11	2452																										

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	6 Transmit Spectrum Mask When transmitting in a 20MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, -20 dBr at 11 MHz frequency offset, -28 dBr at 20 MHz frequency offset and -45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 15. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.  Figure 15 - Transmit spectral mask for 20MHz Transmission

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	When transmitting in a 40MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz offset and -45 dBr at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 16. The transmit spectral mask for 20MHz transmission in upper or lower 20Mhz channels of a 40MHz is the same mask as that used for the 40MHz channel.  Figure 16 - Transmit spectral mask for a 40MHz channel [2006 802.11n Joint PHY Proposal at 56-59]
[8.] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	The 2006 802.11n Joint PHY Proposal disclosed a wireless transceiver, wherein the wireless transceiver supports one or more wireless standards. For example, the reference disclosed:

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)																																			
	January 2006 doc.: IEEE 802.11-05/1102r4 1 IEEE P802.11 2 Wireless LANs 3 <table><tr><td colspan="5">Joint Proposal: High throughput extension to the 802.11 Standard: PHY</td></tr><tr><td colspan="5">Date: 2006-01-13</td></tr><tr><td colspan="5">Author(s):</td></tr><tr><td>Name</td><td>Company</td><td>Address</td><td>Phone</td><td>email</td></tr><tr><td>Sean Coffey</td><td>Realtek Semiconductor</td><td>16269 Laguna Canyon Rd, Suite 100 Irvine, CA 92121 USA</td><td>+1 415 572 6221</td><td>coffey@realtek-us.com</td></tr><tr><td>Assaf Kasher</td><td>Intel Corporation</td><td>Matam Industrial Park, POB 1659 Haifa, 31015, Israel</td><td>+972-4-8651547</td><td>assaf.kasher@intel.com</td></tr><tr><td>Adrian Stephens</td><td>Intel Corporation</td><td>15 JJ Thompson Avenue, Cambridge, CB3 0FD, United Kingdom</td><td>+44 1223 763457</td><td>adrian.p.stephens@intel.com</td></tr></table> 4 5 6 Abstract 7 This document contains the PHY layer parts of the 802.11 TGn Joint Proposal Technical 8 Specification. [2006 802.11n Joint PHY Proposal, Cover]	Joint Proposal: High throughput extension to the 802.11 Standard: PHY					Date: 2006-01-13					Author(s):					Name	Company	Address	Phone	email	Sean Coffey	Realtek Semiconductor	16269 Laguna Canyon Rd, Suite 100 Irvine, CA 92121 USA	+1 415 572 6221	coffey@realtek-us.com	Assaf Kasher	Intel Corporation	Matam Industrial Park, POB 1659 Haifa, 31015, Israel	+972-4-8651547	assaf.kasher@intel.com	Adrian Stephens	Intel Corporation	15 JJ Thompson Avenue, Cambridge, CB3 0FD, United Kingdom	+44 1223 763457	adrian.p.stephens@intel.com
Joint Proposal: High throughput extension to the 802.11 Standard: PHY																																				
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Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
	1 Introduction This document specifies those features of a device that are necessary to achieve interoperability. It specifies the signals that may be transmitted by the device and received by the device's receivers. This device is referred to as an HT (High Throughput) device. The HT device is assumed to be compliant with 802.11a/b/g/j standards. This document describes the extensions needed in the physical layer for high throughput transmission. [2006 802.11n Joint PHY Proposal at 10]
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim 1, preamble.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	See, e.g., claim 1, limitation 1.A above.
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of	See, e.g., claim 1, limitation 1.B above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or	<i>See, e.g.</i> , claim 1, limitation 1.E above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
more overlapping frequency regions.	
[10.] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[11.] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[12.] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[16.] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1 preamble.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[17.B] demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim 1, limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second	<i>See, e.g.</i> , claim 1, limitation 1.C above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[21.] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.
[22.] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[23.] The method of claim 17, wherein the at least one repeated header bit increases	<i>See, e.g.</i> , claim 2 above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
reliability of the first packet in the first narrower frequency band.	
[24.] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band	<i>See, e.g.</i> , claim 3 above.
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, preamble.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the	<i>See, e.g.</i> , claim 1, limitation 1.B above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or	<i>See, e.g.</i> , claim 1, limitation 1.E above.

Claim Elements	Disclosure in IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) (“2006 802.11n Joint PHY Proposal”)
more overlapping frequency regions.	
[26.] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27.] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[28.] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[32.] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A3

**Defendant's Invalidity Contentions Comparing the Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent No. 7,349,436 to Maltsev et al. ("Maltsev")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by Maltsev¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of Maltsev standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Maltsev in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ Maltsev was filed on September 30, 2003.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 8,675,754 to Yonge, III et al. (“Yonge”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

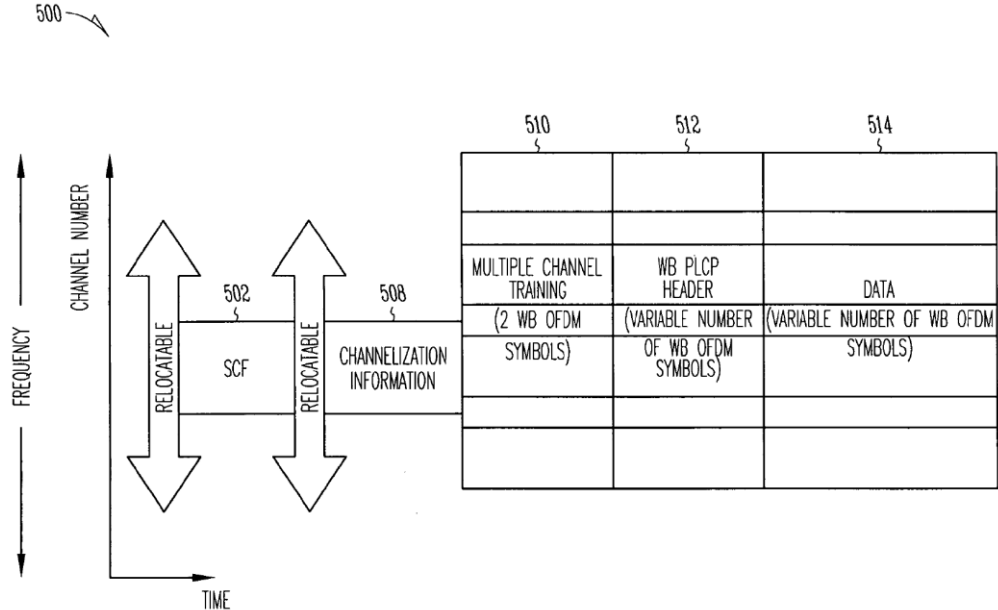
To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in Maltsev
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Maltsev discloses a wireless OFDM transceiver. <i>See, e.g.,</i> Maltsev, Title (“SYSTEMS AND METHODS FOR HIGH-THROUGHPUT WIDEBAND WIRELESS LOCAL AREA NETWORK COMMUNICATIONS”). <i>See, e.g.,</i> Maltsev, 1:16–24: Orthogonal frequency division multiplexing (OFDM) is an example of a

Claim Elements	Disclosure in Maltsev
	multi-carrier transmission technique that uses symbol-modulated orthogonal subcarriers to transmit information within an available spectrum. Many modern digital communication systems ... are using symbol-modulated orthogonal subcarriers as a modulation scheme to help signals survive in environments having multipath reflections and/or strong interference. <i>See, e.g.,</i> Maltsev, 2:23–28 (“CUs 102 may communicate among each other and/or with one or more of APs 104 using a multi-carrier transmission technique, such as an orthogonal frequency division multiplexing (OFDM) technique that uses orthogonal subcarriers to transmit information within an assigned spectrum.”). <i>See, e.g.,</i> Maltsev, 2:60–67 (“CU s 102 and AP 104 may be referred to herein as a transmitting unit, a receiving unit, or both. The terms ‘transmitting’ and ‘receiving’ are applied to communication units 102 and AP 104 for ease in understanding the embodiments of the present invention. It shall be understood that CUs and APs may include both transmitting and receiving capability to establish duplex communications therebetween.”). <i>See, e.g.,</i> Maltsev, 11:18–21 (“The frame formats of embodiments of the present invention may be suitable for WB OFDM data communication systems and may be implemented in IEEE 802.11 standards for HT communication units.”).
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Maltsev discloses a receiver using wireless OFDM communications to receive in a first narrower frequency band a first packet having a first number of OFDM symbols that carry a first plurality of header bits. <i>See, e.g.,</i> Maltsev, 3:29–54: CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN

Claim Elements	Disclosure in Maltsev
	communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications The terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized by the communication units. For example, in some embodiments, narrower-band CUs 110 may communicate on narrower-band channels (e.g., a 20 MHz channel), while wider-band CUs 108 may communicate on wider-band channels (e.g., channels of up to 80 MHz or greater). In these embodiments, the wider-band channels may comprise one or more of the narrower-band channels. AP 104 may include capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. To facility the sharing of channels among narrower-band CUs 110 and wider-band CUs 108, communication packets may have a predetermined frame structure to provide for this flexible channel-width capability. <i>See, e.g.,</i> Maltsev, 4:27–53 (“the channels may be 20 MHz channels and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum ... In some embodiments, frequency spectrum 300 may be utilized by an AP for communicating with CUs including both narrower-band CUs and wider-band CUs.”). <i>See, e.g.,</i> Maltsev, 4:27–31 (“MAC layer 208 may also scan or have other means of detecting the presence of narrower-band CUs 110 (FIG. 1), which it may use to select operating channels as well as the type of physical layer packet format to be used.”). <i>See, e.g.,</i> Maltsev, Fig. 4, 5:28–42:

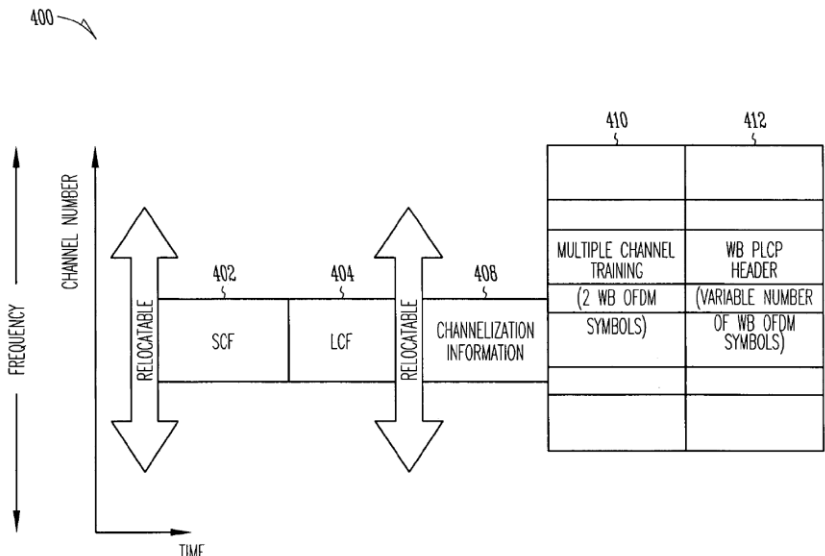
Claim Elements	Disclosure in Maltsev
	Fig. 4 Long-compatibility frame format 400 is an example of an HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) ... Frame format 400 may include short-compatibility field 402, long-compatibility field 404, channelization field 408, multiple-channel training field 410, and wideband-header field 412. ... Multiple-channel training field 410 and wideband-header field 412 may be sent on one or more channels, such as channels 306 (FIG. 3) including compatibility channel 304 (FIG. 3). <i>See, e.g., Maltsev, 5:58–63</i> (“Depending on a frame type and interfering environment, short-compatibility field 402 may be ... multiplied in frequency domain and transmitted over several or all channels 302 (FIG. 3).”).

Claim Elements	Disclosure in Maltsev
	See, e.g., Maltsev, 6:61–64 (“In some embodiments, wideband-training field 410 may comprise a standard 802.11 (a/g) long training sequence multiplied in frequency domain and transmitted over one or more of the channels.”). See, e.g., Maltsev, Fig. 5, 7:66–8:13:  Fig. 5 Short-compatibility frame format 500 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) Frame format 500 may include short-compatibility field 502, channelization field 508, multiple-channel training field 510, wideband-header field 512 and wideband-data field 514. ... Multiple-channel training field 510, wideband header field 512 and wideband-data field 514 may be sent

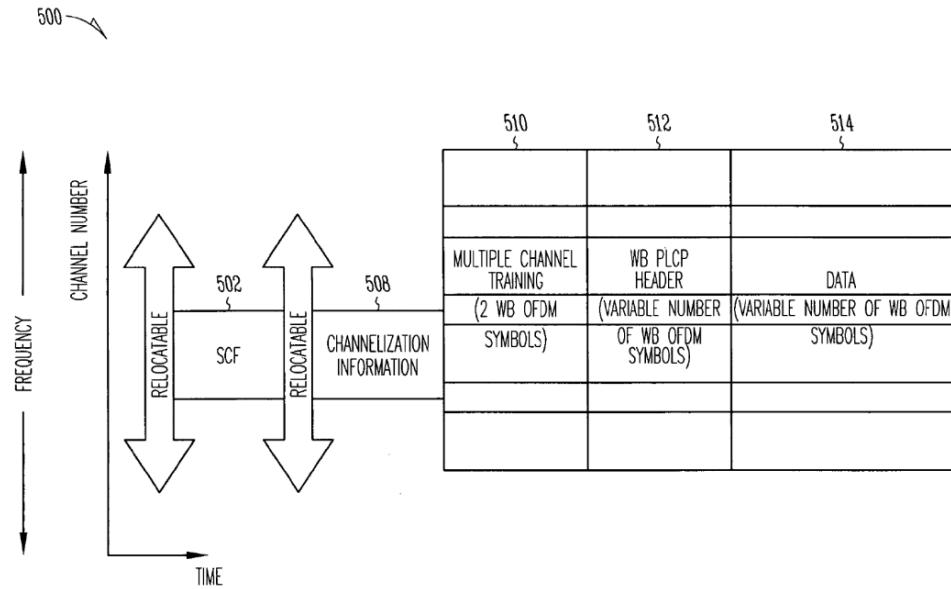
Claim Elements	Disclosure in Maltsev
	on one or more channels, such as channels 306 (FIG. 3) including the compatibility channel. <i>See, e.g.</i>, Maltsev, 8:25–35 (“Frames of format 500 may be used to transmit data-carrying MPDUs in an environment that includes narrower-band CUs and wider-band CUs. ... Frames of format 500 may also provide for the detection and standard signal field decoding range properties of frames by both narrower-band CUs and wider-band CUs.”). <i>See, e.g.</i>, Maltsev, Fig. 6, 8:48–9:2: Multiple-channel frame format 600 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and a HT AP such as AP 104 (FIG. 1), although other frame formats may also be suitable. Multiple-channel frame format 600 may include short-compatibility field 602, multiple-channel training field 610, wideband-header field 612 and wideband-data field 614. In some embodiments, short-compatibility field 602 may be multiplied in frequency and transmitted on one or more channels, such as channels 616, 618, 620 and 622. Multiple-channel training field 610, wideband-header field 612 and wideband-data field 614 may be different for the different channels, such as channels 616, 618, 620 and 622 for communicating with different wider-band CUs. In other words, wideband fields, such as wideband-header field 612 and wideband-data field 614, are spread across the used channels with different content on each channel. In some embodiments, a transmitting wider-band CU may use different channels depending on the receiving wider-band CU or the dynamics of the channel condition.

Claim Elements	Disclosure in Maltsev
	Fig. 6 See, e.g., Maltsev, 6:3–14: Frames of format 600 may be used in an environment that includes a combination of wider-band CUs and narrower-band CUs. Frames of format 600 may also be used when a HT AP overlaps (e.g., shares channels with) an AP that may communicate only with narrower-band CUs. Frames of format 600 allow narrower-band CUs, used in narrowband channels, to be provided with frame duration information at the physical layer through the signal field of short-compatibility field 602. Frames of format 600 may also reduce overhead due to the absence of a long-compatibility field and a channelization field, such as in the case of formats 400 and 500.

Claim Elements	Disclosure in Maltsev
	<i>See, e.g.</i>, Maltsev, 7:56–60 (“In the case of a standard 802.11(a/g) PLCP frame, the preamble field may comprise twelve OFDM symbols, the signal field may comprise one OFDM symbol, and the data field may comprise a variable number of OFDM symbols.”).
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Maltsev discloses a demodulator connected to and in communication with the receiver to demodulate the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. <i>See, e.g.</i>, Maltsev, 7:5–8 (“Wideband-header field 412 may be a PLCP-header field and may contain parameters for demodulation and decoding the packet including parameters for adaptive modulation and coding techniques.”). <i>See, e.g.</i>, Maltsev, 3:29–54: CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications The terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized by the communication units. For example, in some embodiments, narrower-band CUs 110 may communicate on narrower-band channels (e.g., a 20 MHz channel), while wider-band CUs 108 may communicate on wider-band channels (e.g., channels of up to 80 MHz or greater). In these embodiments, the wider-band channels may comprise one or more of the narrower-band channels. AP 104 may include capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. To facility the sharing of channels among narrower-band CUs 110 and wider-band CUs 108, communication packets may have a predetermined frame

Claim Elements	Disclosure in Maltsev
	structure to provide for this flexible channel-width capability. See, e.g., Maltsev, 4:27–53 (“the channels may be 20 MHz channels and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum ... In some embodiments, frequency spectrum 300 may be utilized by an AP for communicating with CUs including both narrower-band CUs and wider-band CUs.”). See, e.g., Maltsev, Fig. 4, 5:28–42:  Fig. 4 Long-compatibility frame format 400 is an example of an HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) ... Frame format 400 may include short-compatibility field 402, long-compatibility field 404, channelization field 408, multiple-channel training field 410, and wideband-header field 412. ... Multiple-channel training

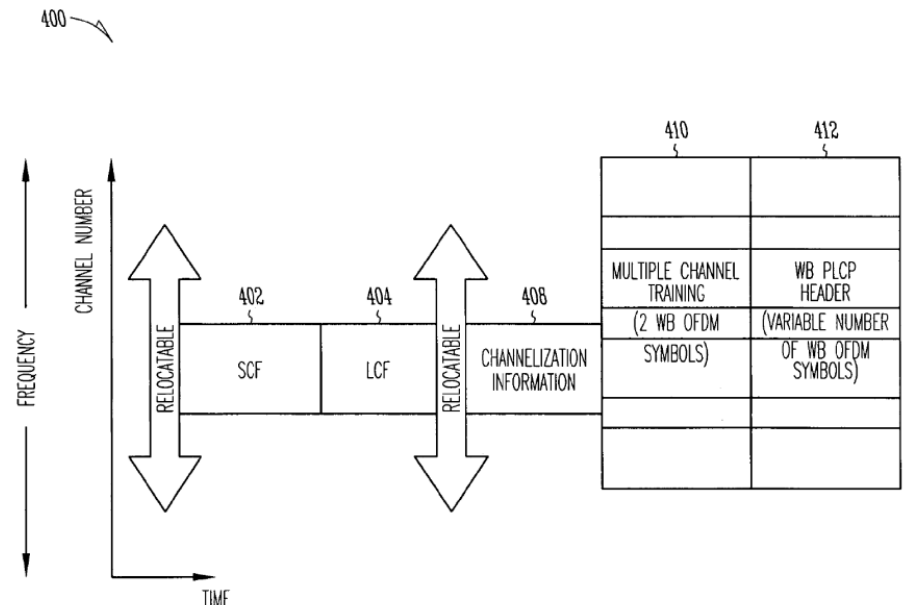
Claim Elements	Disclosure in Maltsev
	field 410 and wideband-header field 412 may be sent on one or more channels, such as channels 306 (FIG. 3) including compatibility channel 304 (FIG. 3). <i>See, e.g.</i>, Maltsev, 4:27–31 (“MAC layer 208 may also scan or have other means of detecting the presence of narrower-band CUs 110 (FIG. 1), which it may use to select operating channels as well as the type of physical layer packet format to be used.”). <i>See, e.g.</i>, Maltsev, 5:58–63 (“Depending on a frame type and interfering environment, short-compatibility field 402 may be ... multiplied in frequency domain and transmitted over several or all channels 302 (FIG. 3).”). <i>See, e.g.</i>, Maltsev, 6:61–64 (“In some embodiments, wideband-training field 410 may comprise a standard 802.11 (a/g) long training sequence multiplied in frequency domain and transmitted over one or more of the channels.”). <i>See, e.g.</i>, Maltsev, Fig. 5, 7:66–8:13: Short-compatibility frame format 500 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) Frame format 500 may include short-compatibility field 502, channelization field 508, multiple-channel training field 510, wideband-header field 512 and wideband-data field 514. ... Multiple-channel training field 510, wideband header field 512 and wideband-data field 514 may be sent on one or more channels, such as channels 306 (FIG. 3) including the compatibility channel.

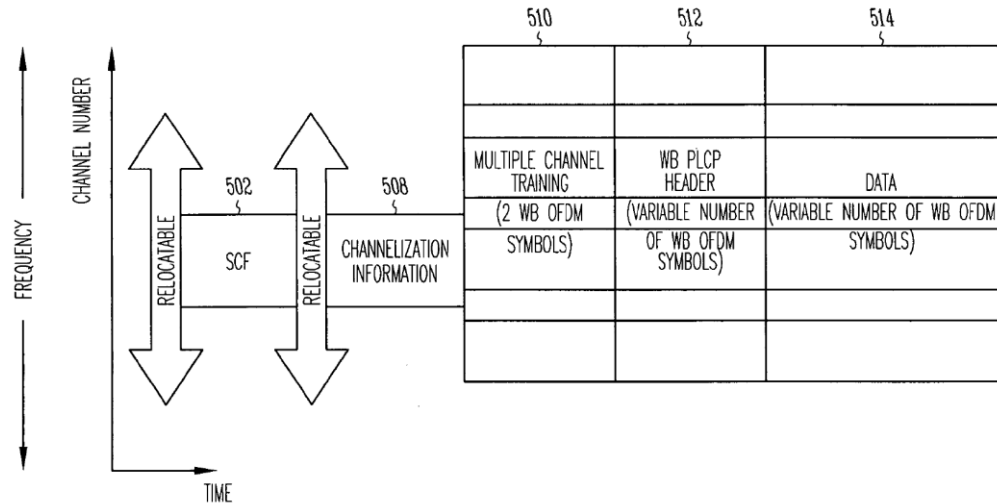
Claim Elements	Disclosure in Maltsev
	 The diagram illustrates a frame format 500 in a frequency-time plane. The vertical axis represents 'FREQUENCY' and 'CHANNEL NUMBER', while the horizontal axis represents 'TIME'. Two vertical double-headed arrows labeled 'RELOCATABLE' indicate frequency flexibility. The frame structure includes: 502 SCF: Short-Compatibility Field. 508 CHANNELIZATION INFORMATION: Field providing channelization details. 510 MULTIPLE CHANNEL TRAINING: Training field consisting of 2 WB OFDM symbols. 512 WB PLCP HEADER: Header field consisting of a variable number of WB OFDM symbols. 514 DATA: Data field consisting of a variable number of WB OFDM symbols. Fig. 5 <i>See, e.g., Maltsev, 8:25–35 (“Frames of format 500 may be used to transmit data-carrying MPDUs in an environment that includes narrower-band CUs and wider-band CUs. ... Frames of format 500 may also provide for the detection and standard signal field decoding range properties of frames by both narrower-band CUs and wider-band CUs.”).</i> <i>See, e.g., Maltsev, Fig. 6, 8:48–9:2:</i> Multiple-channel frame format 600 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and a HT AP such as AP 104 (FIG. 1), although other frame formats may also be suitable. Multiple-channel frame format 600 may include short-compatibility field 602, multiple-channel training field 610, wideband-header field 612 and

Claim Elements	Disclosure in Maltsev
	wideband-data field 614. In some embodiments, short-compatibility field 602 may be multiplied in frequency and transmitted on one or more channels, such as channels 616, 618, 620 and 622. Multiple-channel training field 610, wideband-header field 612 and wideband-data field 614 may be different for the different channels, such as channels 616, 618, 620 and 622 for communicating with different wider-band CUs. In other words, wideband fields, such as wideband-header field 612 and wideband-data field 614, are spread across the used channels with different content on each channel. In some embodiments, a transmitting wider-band CU may use different channels depending on the receiving wider-band CU or the dynamics of the channel condition. 600 ↗ Fig. 6

Claim Elements	Disclosure in Maltsev
	<i>See, e.g., Maltsev, 6:3–14:</i> Frames of format 600 may be used in an environment that includes a combination of wider-band CUs and narrower-band CUs. Frames of format 600 may also be used when a HT AP overlaps (e.g., shares channels with) an AP that may communicate only with narrower-band CUs. Frames of format 600 allow narrower-band CUs, used in narrowband channels, to be provided with frame duration information at the physical layer through the signal field of short-compatibility field 602. Frames of format 600 may also reduce overhead due to the absence of a long-compatibility field and a channelization field, such as in the case of formats 400 and 500. <i>See, e.g., Maltsev, 7:56–60</i> (“In the case of a standard 802.11(a/g) PLCP frame, the preamble field may comprise twelve OFDM symbols, the signal field may comprise one OFDM symbol, and the data field may comprise a variable number of OFDM symbols.”).
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	Maltsev discloses and/or renders obvious a receiver using wireless OFDM communications to receive in a second wider frequency band a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. <i>See, e.g., Maltsev, 3:29–54:</i> CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications The terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized by the communication units. For example, in some

Claim Elements	Disclosure in Maltsev
	embodiments, narrower-band CUs 110 may communicate on narrower-band channels (e.g., a 20 MHz channel), while wider-band CUs 108 may communicate on wider-band channels (e.g., channels of up to 80 MHz or greater). In these embodiments, the wider-band channels may comprise one or more of the narrower-band channels. AP 104 may include capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. To facility the sharing of channels among narrower-band CUs 110 and wider-band CUs 108, communication packets may have a predetermined frame structure to provide for this flexible channel-width capability. <i>See, e.g., Maltsev, 4:27–53</i> (“the channels may be 20 MHz channels and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum ... In some embodiments, frequency spectrum 300 may be utilized by an AP for communicating with CUs including both narrower-band CUs and wider-band CUs.”). <i>See, e.g., Maltsev, 4:27–31</i> (“MAC layer 208 may also scan or have other means of detecting the presence of narrower-band CUs 110 (FIG. 1), which it may use to select operating channels as well as the type of physical layer packet format to be used.”). <i>See, e.g., Maltsev, Fig. 4, 5:28–42:</i> Long-compatibility frame format 400 is an example of an HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) ... Frame format 400 may include short-compatibility field 402, long-compatibility field 404, channelization field 408, multiple-channel training field 410, and wideband-header field 412. ... Multiple-channel training field 410 and wideband-header field 412 may be sent on one or more channels, such as channels 306 (FIG. 3) including compatibility channel 304 (FIG. 3).

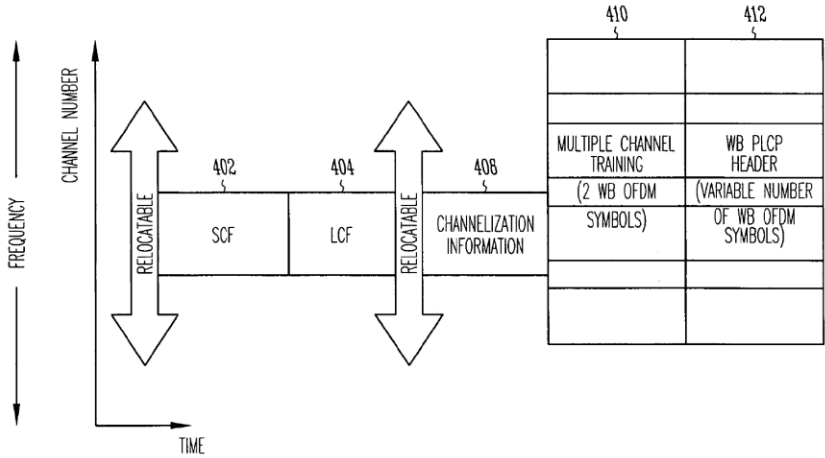
Claim Elements	Disclosure in Maltsev
	 Fig. 4 <i>See, e.g.,</i> Maltsev, 5:58–63 (“Depending on a frame type and interfering environment, short-compatibility field 402 may be ... multiplied in frequency domain and transmitted over several or all channels 302 (FIG. 3).”). <i>See, e.g.,</i> Maltsev, 6:61–64 (“In some embodiments, wideband-training field 410 may comprise a standard 802.11 (a/g) long training sequence multiplied in frequency domain and transmitted over one or more of the channels.”). <i>See, e.g.,</i> Maltsev, Fig. 5, 7:66–8:13: Short-compatibility frame format 500 is an example of a HT OFDM frame and

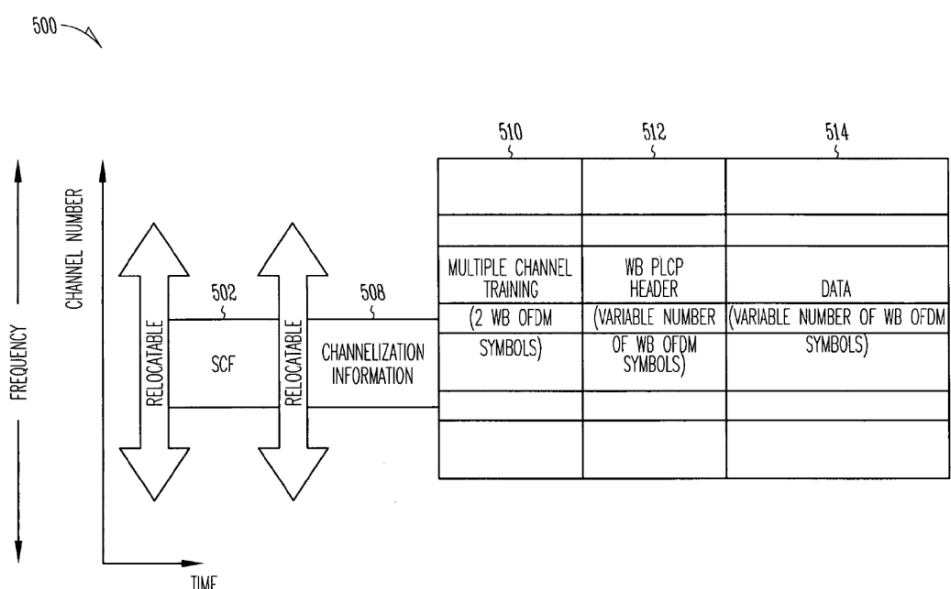
Claim Elements	Disclosure in Maltsev																		
	may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) Frame format 500 may include short-compatibility field 502, channelization field 508, multiple-channel training field 510, wideband-header field 512 and wideband-data field 514. ... Multiple-channel training field 510, wideband header field 512 and wideband-data field 514 may be sent on one or more channels, such as channels 306 (FIG. 3) including the compatibility channel. 500 ↗  The diagram illustrates the frame format 500 in a time-frequency plane. The vertical axis represents 'CHANNEL NUMBER' and the horizontal axis represents 'TIME'. Two vertical double-headed arrows labeled 'RELOCATABLE' indicate that the fields 502 and 508 can be moved across different channels. Field 502 is labeled 'SCF' (Short-Compatibility Field). Field 508 is labeled 'CHANNELIZATION INFORMATION'. To the right, a table shows the structure of fields 510, 512, and 514 across multiple channels (rows). Field 510 is 'MULTIPLE CHANNEL TRAINING' (2 WB OFDM SYMBOLS). Field 512 is 'WB PLCP HEADER' (VARIABLE NUMBER OF WB OFDM SYMBOLS). Field 514 is 'DATA' (VARIABLE NUMBER OF WB OFDM SYMBOLS). <table><tr><th>510</th><th>512</th><th>514</th></tr><tr><td></td><td></td><td></td></tr><tr><td>MULTIPLE CHANNEL TRAINING</td><td>WB PLCP HEADER</td><td>DATA</td></tr><tr><td>(2 WB OFDM SYMBOLS)</td><td>(VARIABLE NUMBER OF WB OFDM SYMBOLS)</td><td>(VARIABLE NUMBER OF WB OFDM SYMBOLS)</td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table> Fig. 5 See, e.g., Maltsev, 8:25–35 (“Frames of format 500 may be used to transmit data-carrying MPDUs in an environment that includes narrower-band CUs and wider-band CUs. ... Frames of format 500 may also provide for the detection and standard signal field decoding range properties of frames by both narrower-band CUs and wider-band CUs.”).	510	512	514				MULTIPLE CHANNEL TRAINING	WB PLCP HEADER	DATA	(2 WB OFDM SYMBOLS)	(VARIABLE NUMBER OF WB OFDM SYMBOLS)	(VARIABLE NUMBER OF WB OFDM SYMBOLS)						
510	512	514																	
MULTIPLE CHANNEL TRAINING	WB PLCP HEADER	DATA																	
(2 WB OFDM SYMBOLS)	(VARIABLE NUMBER OF WB OFDM SYMBOLS)	(VARIABLE NUMBER OF WB OFDM SYMBOLS)																	

Claim Elements	Disclosure in Maltsev
	See, e.g., Maltsev, Fig. 6, 8:48–9:2: Fig. 6 Multiple-channel frame format 600 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and a HT AP such as AP 104 (FIG. 1), although other frame formats may also be suitable. Multiple-channel frame format 600 may include short-compatibility field 602, multiple-channel training field 610, wideband-header field 612 and wideband-data field 614. In some embodiments, short-compatibility field 602 may be multiplied in frequency and transmitted on one or more channels, such as channels 616, 618, 620 and 622. Multiple-channel training field 610, wideband-header field 612 and wideband-data field 614 may be different for the different channels, such as channels 616, 618, 620 and 622 for

Claim Elements	Disclosure in Maltsev
	communicating with different wider-band CUs. In other words, wideband fields, such as wideband-header field 612 and wideband-data field 614, are spread across the used channels with different content on each channel. In some embodiments, a transmitting wider-band CU may use different channels depending on the receiving wider-band CU or the dynamics of the channel condition. <i>See, e.g., Maltsev, 6:3–14:</i> Frames of format 600 may be used in an environment that includes a combination of wider-band CUs and narrower-band CUs. Frames of format 600 may also be used when a HT AP overlaps (e.g., shares channels with) an AP that may communicate only with narrower-band CUs. Frames of format 600 allow narrower-band CUs, used in narrowband channels, to be provided with frame duration information at the physical layer through the signal field of short-compatibility field 602. Frames of format 600 may also reduce overhead due to the absence of a long-compatibility field and a channelization field, such as in the case of formats 400 and 500. <i>See, e.g., Maltsev, 7:56–60</i> (“In the case of a standard 802.11(a/g) PLCP frame, the preamble field may comprise twelve OFDM symbols, the signal field may comprise one OFDM symbol, and the data field may comprise a variable number of OFDM symbols.”).
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Maltsev discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. <i>See, e.g., Maltsev, 7:5–8</i> (“Wideband-header field 412 may be a PLCP-header field and may contain parameters for demodulation and decoding the packet including parameters for adaptive modulation and coding techniques.”). <i>See, e.g., Maltsev, 3:29–54:</i> CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110.

Claim Elements	Disclosure in Maltsev
	Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications The terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized by the communication units. For example, in some embodiments, narrower-band CUs 110 may communicate on narrower-band channels (e.g., a 20 MHz channel), while wider-band CUs 108 may communicate on wider-band channels (e.g., channels of up to 80 MHz or greater). In these embodiments, the wider-band channels may comprise one or more of the narrower-band channels. AP 104 may include capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. To facility the sharing of channels among narrower-band CUs 110 and wider-band CUs 108, communication packets may have a predetermined frame structure to provide for this flexible channel-width capability. <i>See, e.g., Maltsev, 4:27–53 (“the channels may be 20 MHz channels and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum ... In some embodiments, frequency spectrum 300 may be utilized by an AP for communicating with CUs including both narrower-band CUs and wider-band CUs.”).</i> <i>See, e.g., Maltsev, Fig. 4, 5:28–42:</i> Long-compatibility frame format 400 is an example of an HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) ... Frame format 400 may include short-compatibility field 402, long-compatibility field 404, channelization field 408, multiple-channel training field 410, and wideband-header field 412. ... Multiple-channel training field 410 and wideband-header field 412 may be sent on one or more

Claim Elements	Disclosure in Maltsev
	channels, such as channels 306 (FIG. 3) including compatibility channel 304 (FIG. 3). 400  Fig. 4 See, e.g., Maltsev, 4:27–31 (“MAC layer 208 may also scan or have other means of detecting the presence of narrower-band CUs 110 (FIG. 1), which it may use to select operating channels as well as the type of physical layer packet format to be used.”). See, e.g., Maltsev, 5:58–63 (“Depending on a frame type and interfering environment, short-compatibility field 402 may be ... multiplied in frequency domain and transmitted over several or all channels 302 (FIG. 3).”). See, e.g., Maltsev, 6:61–64 (“In some embodiments, wideband-training field 410 may comprise a standard 802.11 (a/g) long training sequence multiplied in frequency domain and transmitted over one or more of the channels.”).

Claim Elements	Disclosure in Maltsev
	See, e.g., Maltsev, Fig. 5, 7:66–8:13:  Fig. 5 Short-compatibility frame format 500 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and AP 104 (FIG. 1) Frame format 500 may include short-compatibility field 502, channelization field 508, multiple-channel training field 510, wideband-header field 512 and wideband-data field 514. ... Multiple-channel training field 510, wideband header field 512 and wideband-data field 514 may be sent on one or more channels, such as channels 306 (FIG. 3) including the compatibility channel. See, e.g., Maltsev, 8:25–35 (“Frames of format 500 may be used to transmit data-

Claim Elements	Disclosure in Maltsev
	carrying MPDUs in an environment that includes narrower-band CUs and wider-band CUs. ... Frames of format 500 may also provide for the detection and standard signal field decoding range properties of frames by both narrower-band CUs and wider-band CUs.”). <i>See, e.g., Maltsev, Fig. 6, 8:48–9:2:</i> Fig. 6 Multiple-channel frame format 600 is an example of a HT OFDM frame and may be used for communications between wider-band CUs 108 (FIG. 1) and a HT AP such as AP 104 (FIG. 1), although other frame formats may also be suitable. Multiple-channel frame format 600 may include short-compatibility field 602, multiple-channel training field 610, wideband-header field 612 and wideband-data field 614. In some embodiments, short-compatibility field 602

Claim Elements	Disclosure in Maltsev
	may be multiplied in frequency and transmitted on one or more channels, such as channels 616, 618, 620 and 622. Multiple-channel training field 610, wideband-header field 612 and wideband-data field 614 may be different for the different channels, such as channels 616, 618, 620 and 622 for communicating with different wider-band CUs. In other words, wideband fields, such as wideband-header field 612 and wideband-data field 614, are spread across the used channels with different content on each channel. In some embodiments, a transmitting wider-band CU may use different channels depending on the receiving wider-band CU or the dynamics of the channel condition. <i>See, e.g., Maltsev, 6:3–14:</i> Frames of format 600 may be used in an environment that includes a combination of wider-band CUs and narrower-band CUs. Frames of format 600 may also be used when a HT AP overlaps (e.g., shares channels with) an AP that may communicate only with narrower-band CUs. Frames of format 600 allow narrower-band CUs, used in narrowband channels, to be provided with frame duration information at the physical layer through the signal field of short-compatibility field 602. Frames of format 600 may also reduce overhead due to the absence of a long-compatibility field and a channelization field, such as in the case of formats 400 and 500. <i>See, e.g., Maltsev, 7:56–60</i> (“In the case of a standard 802.11(a/g) PLCP frame, the preamble field may comprise twelve OFDM symbols, the signal field may comprise one OFDM symbol, and the data field may comprise a variable number of OFDM symbols.”).
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Maltsev discloses first narrower and second wider frequency bands that have one or more overlapping frequency regions. <i>See, e.g., Maltsev, 3:29–54:</i> CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110.

Claim Elements	Disclosure in Maltsev
	Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications, although the scope of the invention is not limited in this respect. The terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized by the communication units. For example, in some embodiments, narrower-band CUs 110 may communicate on narrower-band channels (e.g., a 20 MHz channel), while wider-band CUs 108 may communicate on wider-band channels (e.g., channels of up to 80 MHz or greater). In these embodiments, the wider-band channels may comprise one or more of the narrower-band channels. AP 104 may include capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. To facility the sharing of channels among narrower-band CUs 110 and wider-band CUs 108, communication packets may have a predetermined frame structure to provide for this flexible channel-width capability. <i>See, e.g., Maltsev, 6:3–14:</i> Frames of format 600 may be used in an environment that includes a combination of wider-band CUs and narrower-band CUs. Frames of format 600 may also be used when a HT AP overlaps (e.g., shares channels with) an AP that may communicate only with narrower-band CUs. Frames of format 600 allow narrower-band CUs, used in narrowband channels, to be provided with frame duration information at the physical layer through the signal field of short-compatibility field 602. Frames of format 600 may also reduce overhead due to the absence of a long-compatibility field and a channelization field, such as in the case of formats 400 and 500.

Claim Elements	Disclosure in Maltsev
[2.] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Maltsev discloses and/or renders obvious at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. <i>See, e.g.,</i> Maltsev, 1:16–24 (“Orthogonal frequency division multiplexing (OFDM) is an example of a multi-carrier transmission technique that uses symbol-modulated orthogonal subcarriers to transmit information within an available spectrum. Many modern digital communication systems, including wireless local area networks (WLANS), are using symbol-modulated orthogonal subcarriers as a modulation scheme to help signals survive in environments having multipath reflections and/or strong interference.”). <i>See, e.g.,</i> Maltsev, 5:58–63 (“Depending on a frame type and interfering environment, short-compatibility field 402 may be transmitted over compatibility channel 304 (FIG. 3), or alternatively, short-compatibility field 402 may be multiplied in frequency domain and transmitted over several or all channels 302 (FIG. 3).”). <i>See, e.g.,</i> Maltsev, 6:56–64 (“Wideband-training field 410 may comprise multiple-channel training fields, and may be used for timing and fine-frequency-offset estimation, and channel estimation. These multiple-channel training fields may also be used for dynamic equalization and channel transfer-function variation rate-measurement purposes. In some embodiments, wideband-training field 410 may comprise a standard 802.11 (a/g) long training sequence multiplied in frequency domain and transmitted over one or more of the channels.”).
[3.] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Maltsev discloses and/or renders obvious wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. <i>See, e.g.,</i> Maltsev, 7:5–8 (“Wideband-header field 412 may be a PLCP-header field and may contain parameters for demodulation and decoding the packet including parameters for adaptive modulation and coding techniques.”). <i>See, e.g.,</i> Maltsev, 1:16–24 (“Orthogonal frequency division multiplexing (OFDM) is an example of a multi-carrier transmission technique that uses symbol-modulated orthogonal subcarriers to transmit information within an available spectrum. Many modern digital

Claim Elements	Disclosure in Maltsev
	communication systems, including wireless local area networks (WLANS), are using symbol-modulated orthogonal subcarriers as a modulation scheme to help signals survive in environments having multipath reflections and/or strong interference.”). <i>See, e.g.</i>, Maltsev, 5:58–63 (“Depending on a frame type and interfering environment, short-compatibility field 402 may be transmitted over compatibility channel 304 (FIG. 3), or alternatively, short-compatibility field 402 may be multiplied in frequency domain and transmitted over several or all channels 302 (FIG. 3).”). <i>See, e.g.</i>, Maltsev, 6:56–64 (“Wideband-training field 410 may comprise multiple-channel training fields, and may be used for timing and fine-frequency-offset estimation, and channel estimation. These multiple-channel training fields may also be used for dynamic equalization and channel transfer-function variation rate-measurement purposes. In some embodiments, wideband-training field 410 may comprise a standard 802.11 (a/g) long training sequence multiplied in frequency domain and transmitted over one or more of the channels.”).
[4.] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	Maltsev discloses and/or renders obvious a second wider frequency band that is two times wider than the first narrower frequency band <i>See, e.g.</i>, Maltsev, 3:29–54: CUs 102 may comprise both wider-band CUs 108 and narrower-band CUs 110. Narrower-band CUs 110 may communicate on a single channel while wider-band CUs 108 may communicate on one or more of the channels to provide wider-bandwidth communications. Wider-band CUs 108 may be referred to as high-throughput (HT) CUs, and in some embodiments, wider-band CUs 108 may communicate in accordance with an IEEE 802.11 standard for HT WLAN communications. Narrower-band CUs 110 may communicate in accordance with the IEEE 802.11(a/g) standard for WLAN communications The terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized by the communication units. For example, in some embodiments, narrower-band CUs 110 may communicate on narrower-band channels (e.g., a 20 MHz channel), while wider-band CUs 108 may

Claim Elements	Disclosure in Maltsev
	communicate on wider-band channels (e.g., channels of up to 80 MHz or greater). In these embodiments, the wider-band channels may comprise one or more of the narrower-band channels. AP 104 may include capability for communicating with both wider-band CUs 108 and narrower-band CUs 110. To facility the sharing of channels among narrower-band CUs 110 and wider-band CUs 108, communication packets may have a predetermined frame structure to provide for this flexible channel-width capability. <i>See, e.g.,</i> Maltsev, 4:27–53 (“the channels may be 20 MHz channels and frequency spectrum 300 may comprise at least a contiguous 80 MHz portion of the spectrum ... In some embodiments, frequency spectrum 300 may be utilized by an AP for communicating with CUs including both narrower-band CUs and wider-band CUs.”). <i>See, e.g.,</i> Maltsev, 5:10–14 (“In some embodiments, a nearest neighboring AP may be decoupled by compatibility channels in different ... 80 MHz bands or by more detailed spectrum division. For example, the spectrum may be divided into sets of six 40 MHz channels.”).
[8.] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Maltsev discloses a wireless transceiver that supports one or more wireless standards. <i>See, e.g.,</i> Maltsev, 2:18–21 (“CUs 102 and AP 104 may communicate in accordance with one or more communication standards, such as one of the Institute of Electrical and Electronics Engineers (I.E.E.E.) 802.11 standards”). <i>See, e.g.,</i> Maltsev, 11:18–21 (“The frame formats of embodiments of the present invention may be suitable for WB OFDM data communication systems and may be implemented in IEEE 802.11 standards for HT communication units.”).
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.,</i> claim preamble 1.PRE above.
[9.A] a wireless OFDM	<i>See, e.g.,</i> claim limitation 1.A above.

Claim Elements	Disclosure in Maltsev
communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Maltsev
header portion;	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[10.] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[11.] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[12.] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[16.] The wireless transceiver of	<i>See, e.g.</i> , claim 8 above.

Claim Elements	Disclosure in Maltsev
claim 9, wherein the wireless transceiver supports one or more wireless standards.	
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	Maltsev discloses a method of operating a wireless OFDM transceiver. <i>See, e.g.,</i> claim preamble 1.PRE above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Maltsev discloses receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits. <i>See, e.g.,</i> claim limitation 1.A above.
[17.B] demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Maltsev discloses demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers. <i>See, e.g.,</i> claim limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the	Maltsev discloses receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits. <i>See, e.g.,</i> claim limitation 1.C above.

Claim Elements	Disclosure in Maltsev
first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Maltsev discloses demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits. <i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Maltsev discloses first narrower and second wider frequency bands that have one or more overlapping frequency regions. <i>See, e.g.</i> , claim limitation 1.E above.
[21.] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.
[22.] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[23.] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[24.] The method of claim 17, wherein the at least one repeated	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosure in Maltsev
header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim limitation 1.A above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Maltsev
the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26.] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27.] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[28.] The method of claim 25, wherein the second wider frequency band is two times wider	<i>See, e.g.</i> , claim 4 above.

Claim Elements	Disclosure in Maltsev
than the first narrower frequency band.	
[32.] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A4

**Defendant's Invalidity Contentions Comparing the Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent No. 7,903,755 to Mujtaba ("Mujtaba")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by Mujtaba¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of Mujtaba standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Mujtaba in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ Mujtaba was filed on February 8, 2006.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

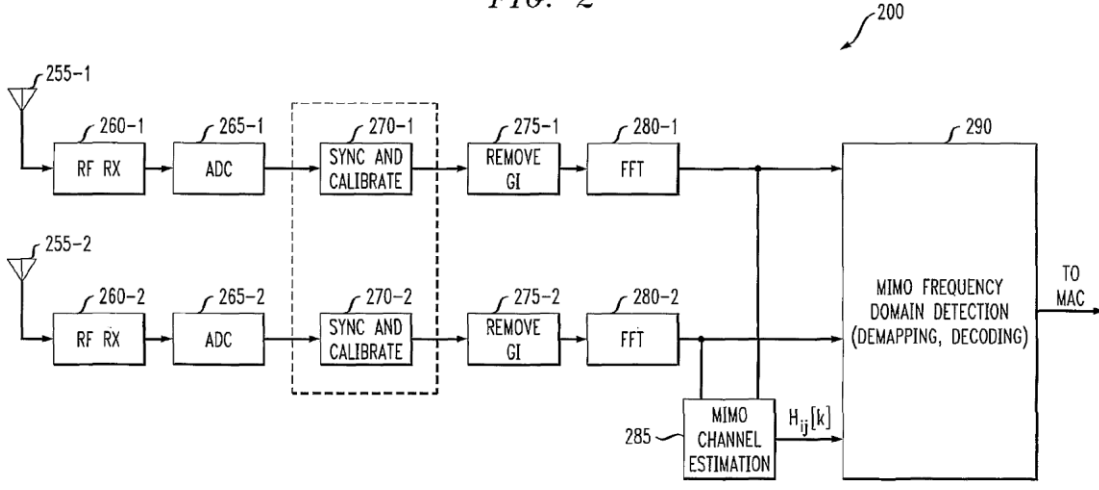
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 8,675,754 to Yonge, III et al. (“Yonge”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

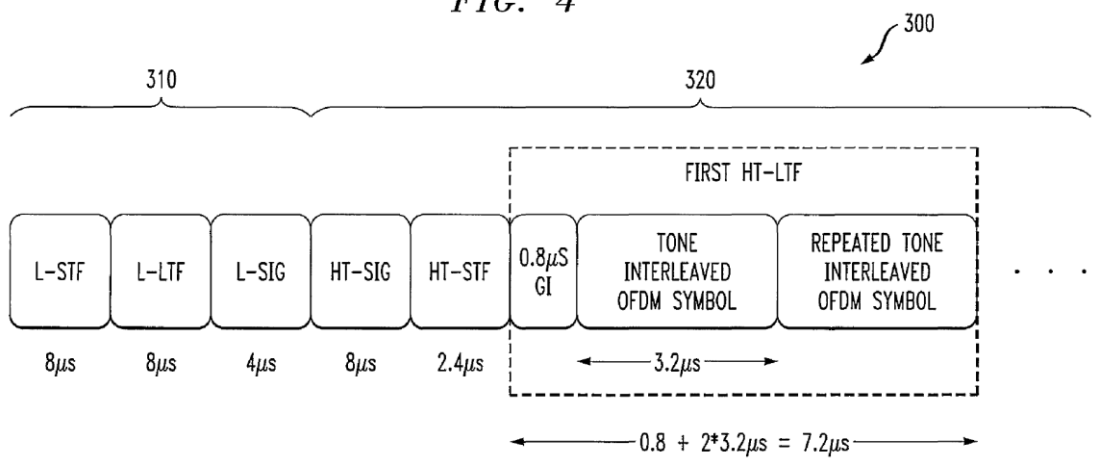
Claim Elements	Disclosure in Mujtaba
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Mujtaba discloses a wireless OFDM transceiver. <i>See, e.g.,</i> Mujtaba, Abstract: Methods and apparatus are provided for communicating data in a multiple antenna communication system having N transmit antennas. According to one aspect of the invention, a header format includes a legacy preamble having at least one legacy long training field and an extended portion having at least N

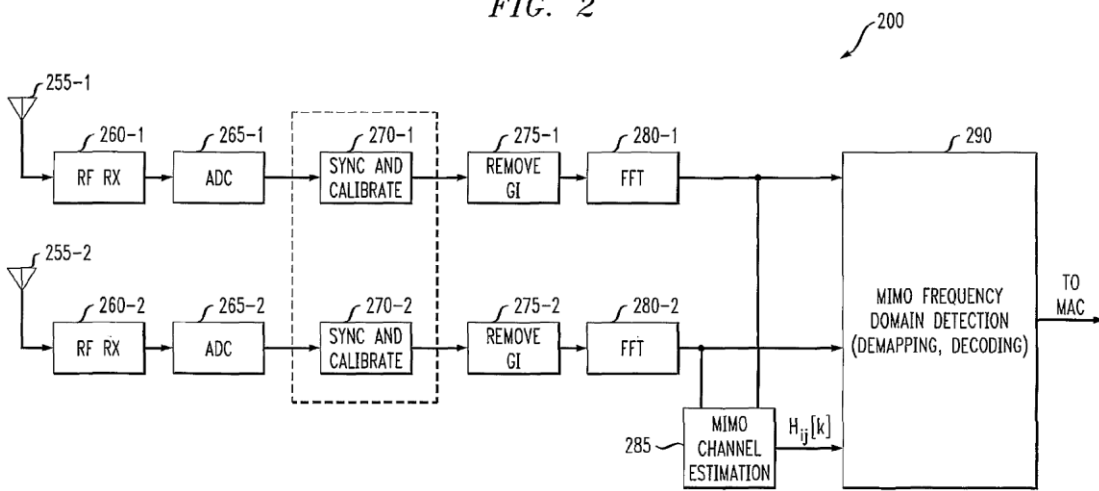
Claim Elements	Disclosure in Mujtaba
	additional long training fields on each of the N transmit antennas, wherein one or more of the at least N additional long training fields are comprised of only one Orthogonal Frequency Division Multiplexing (OFDM) symbol. The extended portion optionally comprises one or more repeated OFDM symbols for frequency offset estimation. In one implementation, the extended portion comprises a first high throughput long training field comprised of two repeated OFDM symbols and N-1 high throughput long training fields comprised of only one OFDM symbol. In another variation, the extended portion comprises N high throughput long training fields comprised of only one OFDM symbol. <i>See, e.g.,</i> Mutjaba, 2:22–26 (“A need therefore exists for a method and system for performing channel estimation and training in a MIMO-OFDM system that is compatible with current IEEE 802.11a/g standard (SISO) systems, allowing MIMO-OFDM based WLAN systems to efficiently co-exist with SISO systems.”).
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Mujtaba discloses and/or renders obvious a receiver using wireless OFDM communications to receive in a first narrower frequency band a first packet having a first number of OFDM symbols that carry a first plurality of header bits. <i>See, e.g.,</i> Mutjaba, Fig. 1 & 3:33–47: FIG. 2 is a schematic block diagram of a MIMO receiver 200. As shown in FIG. 2, the exemplary two antenna receiver 200 processes the signal received on two receive antennas 255-1 and 255-2 at corresponding RF stages 260-1, 260-2. The analog signals are then converted to digital signals by corresponding converters 265-1 and 265-2. The receiver 200 processes the preamble to detect the packet, and then extracts the frequency and timing synchronization information at synchronization stage 270-1 and 270-2 for both branches. The guard interval is removed at stage 275-1 and 275-2. The signal is then transformed back to the frequency domain by an FFT at stage 280-1 and 280-2. The channel estimates are obtained at stage 285 using the long training symbol. The channel estimates are applied to the demapper/decoder 290, and the information bits are recovered.

Claim Elements	Disclosure in Mujtaba
	<i>FIG. 2</i>  See, e.g., Mutjaba, 2:22–26 (“A need therefore exists for a method and system for performing channel estimation and training in a MIMO-OFDM system that is compatible with current IEEE 802.11a/g standard (SISO) systems, allowing MIMO-OFDM based WLAN systems to efficiently co-exist with SISO systems.”). See, e.g., Mutjaba, 3:3–17: The present invention provides preamble formats and techniques for preamble training for MIMO system. The training phase of a MIMO transmission will contain two phases. The first training phase is a legacy training phase particularly suited, for example, to WLAN OFDM legacy systems and the second phase is particularly suited to a multiple antenna system, such as a MIMO system. To overcome the problems in the prior systems, the Automatic Gain Control (AGC) of a receiver will perform one training sequence during the first training phase and the AGC of the receiver will retrain during the second training phase. This will allow the receiver to retrain its power

Claim Elements	Disclosure in Mujtaba
	measurements during the MIMO phase in order to ensure accuracy, while also allowing the receiver to be backwards compatible to WLAN systems that are not MIMO based. <i>See, e.g., Mujtaba, Abstract:</i> Methods and apparatus are provided for communicating data in a multiple antenna communication system having N transmit antennas. According to one aspect of the invention, a header format includes a legacy preamble having at least one legacy long training field and an extended portion having at least N additional long training fields on each of the N transmit antennas, wherein one or more of the at least N additional long training fields are comprised of only one Orthogonal Frequency Division Multiplexing (OFDM) symbol. The extended portion optionally comprises one or more repeated OFDM symbols for frequency offset estimation. In one implementation, the extended portion comprises a first high throughput long training field comprised of two repeated OFDM symbols and N-1 high throughput long training fields comprised of only one OFDM symbol. In another variation, the extended portion comprises N high throughput long training fields comprised of only one OFDM symbol. <i>See, e.g., Mutjaba, Fig. 3, 3:48–53 (“FIG. 3 illustrates a preamble design 300 that is backwards compatible with 802.11a/g legacy devices. The preamble design 300 provides a dedicated legacy portion 310 with a signal field for backward compatibility and a dedicated MIMO training portion 320 for performance of the MIMO system.”).</i>

Claim Elements	Disclosure in Mujtaba
	<i>FIG. 3</i> See, e.g., Mutjaba, 4:4–6 (“As shown in FIG. 3, following the legacy and HT signal fields is a MIMO short training field 330 and then the MIMO long training fields.”). See, e.g., Mutjaba, Fig. 4, 4:39– 58: FIG. 4 illustrates the preamble format 300 of FIG. 3 in further detail. The preamble design 300 provides the dedicated legacy portion 310 with a signal field for backward compatibility and a dedicated MIMO training portion 320 for performance of the MIMO system. As shown in FIG. 4, the dedicated MIMO training portion 320 includes two OFDM symbols for each MIMO long training field (HT-LTF). Thus, a single MIMO long training field in the exemplary embodiment shown in FIGS. 3 and 4 comprises a guard interval and two tone interleaved OFDM symbols for a total duration of 7.2 μs (0.8+2*3.2μs). It is noted that the preamble format 300 generally comprises N additional long training fields on each of N transmit antennas. ... The channel estimation performance that has been observed for the preamble format 300 having two OFDM symbols for each MIMO long training field is 1.76 dB less than that with an ideal channel estimation (i.e., this demonstrates the

Claim Elements	Disclosure in Mujtaba
	nominal channel estimation error). <i>FIG. 4</i> 
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Mujtaba discloses and/or renders obvious a demodulator connected to and in communication with the receiver to demodulate the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. See, e.g., Mutjaba, Fig. 2 & 3:33–47: FIG. 2 is a schematic block diagram of a MIMO receiver 200. As shown in FIG. 2, the exemplary two antenna receiver 200 processes the signal received on two receive antennas 255-1 and 255-2 at corresponding RF stages 260-1, 260-2. The analog signals are then converted to digital signals by corresponding converters 265-1 and 265-2. The receiver 200 processes the preamble to detect the packet, and then extracts the frequency and timing synchronization information at synchronization stage 270-1 and 270-2 for both branches. The guard interval is removed at stage 275-1 and 275-2. The signal is then transformed back to the frequency domain by an FFT at stage 280-1 and 280-2. The channel estimates are obtained at stage 285 using the long training symbol.

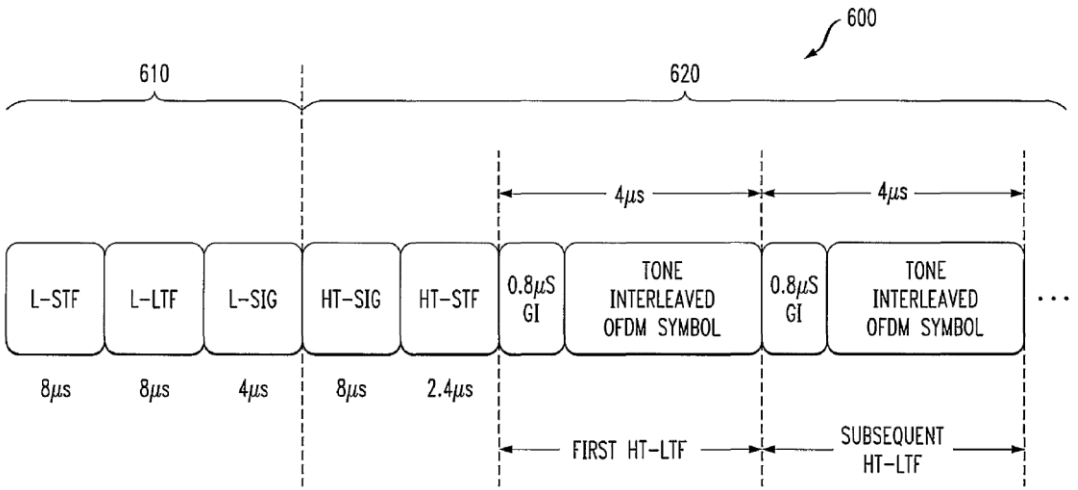
Claim Elements	Disclosure in Mujtaba
	The channel estimates are applied to the demapper/decoder 290, and the information bits are recovered. <i>FIG. 2</i>  <i>See, e.g., Mutjaba, 2:22–26</i> (“A need therefore exists for a method and system for performing channel estimation and training in a MIMO-OFDM system that is compatible with current IEEE 802.11a/g standard (SISO) systems, allowing MIMO-OFDM based WLAN systems to efficiently co-exist with SISO systems.”). <i>See, e.g., Mutjaba, 3:3–17:</i> The present invention provides preamble formats and techniques for preamble training for MIMO system. The training phase of a MIMO transmission will contain two phases. The first training phase is a legacy training phase particularly suited, for example, to WLAN OFDM legacy systems and the second phase is particularly suited to a multiple antenna system, such as a MIMO system. To overcome the problems in the prior systems, the Automatic Gain Control (AGC) of a receiver will perform one training sequence during

Claim Elements	Disclosure in Mujtaba
	the first training phase and the AGC of the receiver will retrain during the second training phase. This will allow the receiver to retrain its power measurements during the MIMO phase in order to ensure accuracy, while also allowing the receiver to be backwards compatible to WLAN systems that are not MIMO based. <i>See, e.g., Mujtaba, Abstract:</i> Methods and apparatus are provided for communicating data in a multiple antenna communication system having N transmit antennas. According to one aspect of the invention, a header format includes a legacy preamble having at least one legacy long training field and an extended portion having at least N additional long training fields on each of the N transmit antennas, wherein one or more of the at least N additional long training fields are comprised of only one Orthogonal Frequency Division Multiplexing (OFDM) symbol. The extended portion optionally comprises one or more repeated OFDM symbols for frequency offset estimation. In one implementation, the extended portion comprises a first high throughput long training field comprised of two repeated OFDM symbols and N-1 high throughput long training fields comprised of only one OFDM symbol. In another variation, the extended portion comprises N high throughput long training fields comprised of only one OFDM symbol. <i>See, e.g., Mutjaba, Fig. 3, 3:48–53 (“FIG. 3 illustrates a preamble design 300 that is backwards compatible with 802.11a/g legacy devices. The preamble design 300 provides a dedicated legacy portion 310 with a signal field for backward compatibility and a dedicated MIMO training portion 320 for performance of the MIMO system.”).</i>

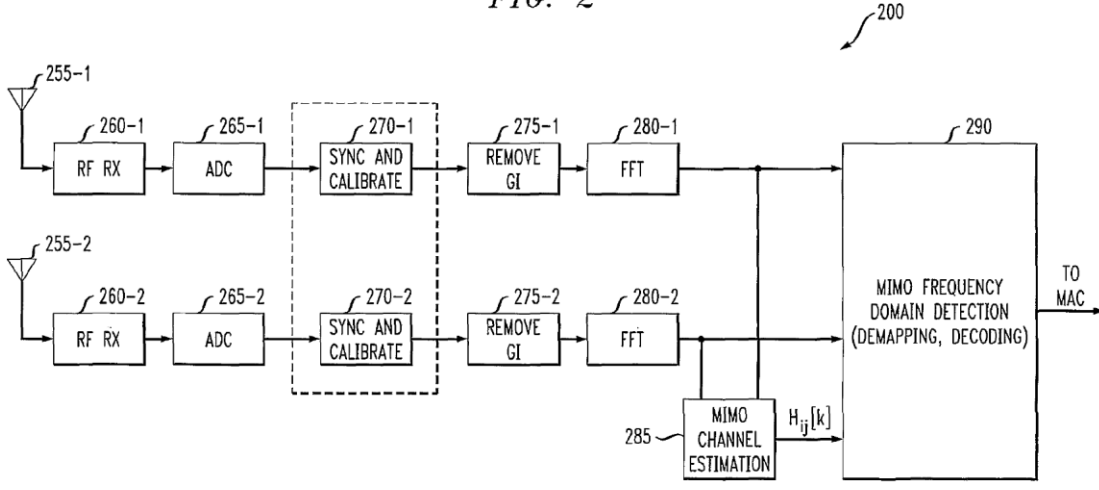
Claim Elements	Disclosure in Mujtaba
	FIG. 3 See, e.g., Mutjaba, 4:4–6 (“As shown in FIG. 3, following the legacy and HT signal fields is a MIMO short training field 330 and then the MIMO long training fields.”). See, e.g., Mutjaba, Fig. 4, 4:39–58: FIG. 4 illustrates the preamble format 300 of FIG. 3 in further detail. The preamble design 300 provides the dedicated legacy portion 310 with a signal field for backward compatibility and a dedicated MIMO training portion 320 for performance of the MIMO system. As shown in FIG. 4, the dedicated MIMO training portion 320 includes two OFDM symbols for each MIMO long training field (HT-LTF). Thus, a single MIMO long training field in the exemplary embodiment shown in FIGS. 3 and 4 comprises a guard interval and two tone interleaved OFDM symbols for a total duration of 7.2 μs (0.8+2*3.2μs). It is noted that the preamble format 300 generally comprises N additional long training fields on each of N transmit antennas. ... The channel estimation performance that has been observed for the preamble format 300 having two OFDM symbols for each MIMO long training field is 1.76 dB less than that with an ideal channel estimation (i.e., this demonstrates the

Claim Elements	Disclosure in Mujtaba
	nominal channel estimation error). FIG. 4 $0.8 + 2 \times 3.2\mu s = 7.2\mu s$

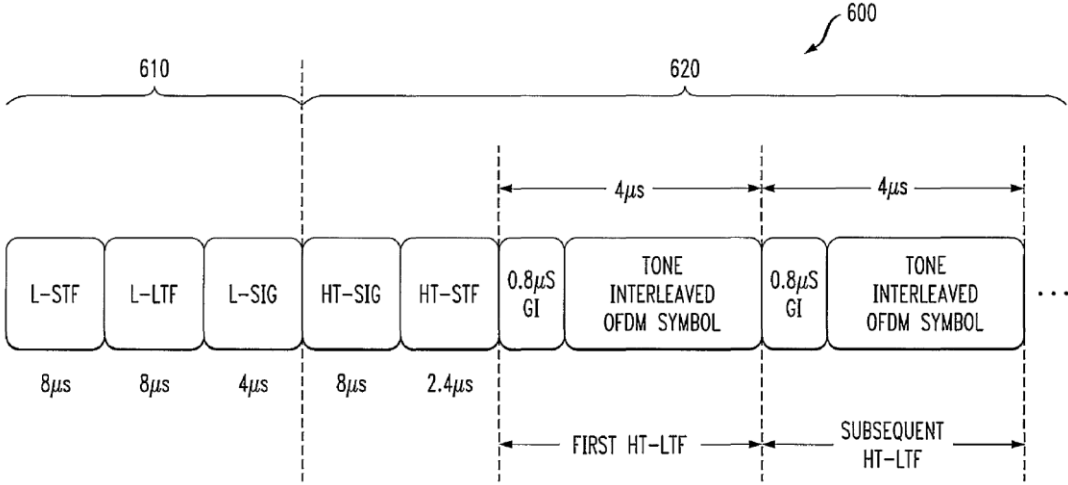
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	Mujtaba discloses and/or renders obvious a receiver using wireless OFDM communications to receive in a second wider frequency band a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. <i>See, e.g.,</i> Mutjaba, 2:22–26 (“A need therefore exists for a method and system for performing channel estimation and training in a MIMO-OFDM system that is compatible with current IEEE 802.11a/g standard (SISO) systems, allowing MIMO-OFDM based WLAN systems to efficiently co-exist with SISO systems.”). <i>See, e.g.,</i> Mutjaba, 3:3–17: The present invention provides preamble formats and techniques for preamble training for MIMO system. The training phase of a MIMO transmission will contain two phases. The first training phase is a legacy training phase particularly suited, for example, to WLAN OFDM legacy systems and the second phase is particularly suited to a multiple antenna system, such as a MIMO system. To overcome the problems in the prior systems, the Automatic Gain Control (AGC) of a receiver will perform one training sequence during the first training phase and the AGC of the receiver will retrain during the second training phase. This will allow the receiver to retrain its power measurements during the MIMO phase in order to ensure accuracy, while also allowing the receiver to be backwards compatible to WLAN systems that are not MIMO based. <i>See, e.g.,</i> Mujtaba, Abstract: Methods and apparatus are provided for communicating data in a multiple antenna communication system having N transmit antennas. According to one aspect of the invention, a header format includes a legacy preamble having at least one legacy long training field and an extended portion having at least N additional long training fields on each of the N transmit antennas, wherein one or more of the at least N additional long training fields are comprised of only

Claim Elements	Disclosure in Mujtaba
	one Orthogonal Frequency Division Multiplexing (OFDM) symbol. The extended portion optionally comprises one or more repeated OFDM symbols for frequency offset estimation. In one implementation, the extended portion comprises a first high throughput long training field comprised of two repeated OFDM symbols and N-1 high throughput long training fields comprised of only one OFDM symbol. In another variation, the extended portion comprises N high throughput long training fields comprised of only one OFDM symbol. See, e.g., Mujtaba, Fig. 6, 5:13–35: <i>FIG. 6</i>  The diagram illustrates a preamble format 600. It is divided into two main sections: a legacy portion 610 and a MIMO long training portion 620. The legacy portion 610 includes L-STF (8μs), L-LTF (8μs), and L-SIG (4μs). The MIMO long training portion 620 includes HT-SIG (8μs), HT-STF (2.4μs), and a series of HT-LTFs. Each HT-LTF consists of a 0.8μs GI (Guard Interval) followed by a TONE INTERLEAVED OFDM SYMBOL. The first HT-LTF is shown with a 4μs duration, and subsequent HT-LTFs are also shown with a 4μs duration. The diagram indicates that the HT-LTFs are repeated, with the first HT-LTF and subsequent HT-LTFs being shown. The total length of the preamble is given by (30.4+N*4) us, where N is the number of HT-LTFs. FIG. 6 illustrates a preamble format 600 incorporating features of the current invention. The preamble design 600 provides the dedicated legacy portion 610 with a legacy signal field for backwards compatibility and a dedicated MIMO long training portion 620 to achieve performance of the MIMO system. As shown in FIG. 6, neither the first nor the subsequent MIMO Long Training Fields (HT-LTF) are repeated. This leads to the shortest possible preamble design, whose length is given by $(30.4+N*4)$ us, where N is the number of

Claim Elements	Disclosure in Mujtaba
	spatial streams. ... The present invention recognizes that shortening each MIMO long training field (HT-LTF) from two OFDM symbols to one OFDM symbol increases the channel estimation error while reducing the preamble overhead. It has been observed that the preamble formats 500, 600 having one OFDM symbol per MIMO long training field outperforms the preamble format 300 having two OFDM symbols per MIMO long training field (in the sense of throughput versus SNR (dB)) at high SNR and larger number of spatial streams (N).
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Mujtaba discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. <i>See, e.g., Mutjaba, Fig. 2 & 3:33–47:</i> FIG. 2 is a schematic block diagram of a MIMO receiver 200. As shown in FIG. 2, the exemplary two antenna receiver 200 processes the signal received on two receive antennas 255-1 and 255-2 at corresponding RF stages 260-1, 260-2. The analog signals are then converted to digital signals by corresponding converters 265-1 and 265-2. The receiver 200 processes the preamble to detect the packet, and then extracts the frequency and timing synchronization information at synchronization stage 270-1 and 270-2 for both branches. The guard interval is removed at stage 275-1 and 275-2. The signal is then transformed back to the frequency domain by an FFT at stage 280-1 and 280-2. The channel estimates are obtained at stage 285 using the long training symbol. The channel estimates are applied to the demapper/decoder 290, and the information bits are recovered.

Claim Elements	Disclosure in Mujtaba
	<i>FIG. 2</i>  See, e.g., Mutjaba, 2:22–26 (“A need therefore exists for a method and system for performing channel estimation and training in a MIMO-OFDM system that is compatible with current IEEE 802.11a/g standard (SISO) systems, allowing MIMO-OFDM based WLAN systems to efficiently co-exist with SISO systems.”). See, e.g., Mutjaba, 3:3–17: The present invention provides preamble formats and techniques for preamble training for MIMO system. The training phase of a MIMO transmission will contain two phases. The first training phase is a legacy training phase particularly suited, for example, to WLAN OFDM legacy systems and the second phase is particularly suited to a multiple antenna system, such as a MIMO system. To overcome the problems in the prior systems, the Automatic Gain Control (AGC) of a receiver will perform one training sequence during the first training phase and the AGC of the receiver will retrain during the second training phase. This will allow the receiver to retrain its power

Claim Elements	Disclosure in Mujtaba
	measurements during the MIMO phase in order to ensure accuracy, while also allowing the receiver to be backwards compatible to WLAN systems that are not MIMO based. <i>See, e.g., Mujtaba, Abstract:</i> Methods and apparatus are provided for communicating data in a multiple antenna communication system having N transmit antennas. According to one aspect of the invention, a header format includes a legacy preamble having at least one legacy long training field and an extended portion having at least N additional long training fields on each of the N transmit antennas, wherein one or more of the at least N additional long training fields are comprised of only one Orthogonal Frequency Division Multiplexing (OFDM) symbol. The extended portion optionally comprises one or more repeated OFDM symbols for frequency offset estimation. In one implementation, the extended portion comprises a first high throughput long training field comprised of two repeated OFDM symbols and N-1 high throughput long training fields comprised of only one OFDM symbol. In another variation, the extended portion comprises N high throughput long training fields comprised of only one OFDM symbol. <i>See, e.g., Mujtaba, Fig. 6, 5:13–35:</i> FIG. 6 illustrates a preamble format 600 incorporating features of the current invention. The preamble design 600 provides the dedicated legacy portion 610 with a legacy signal field for backwards compatibility and a dedicated MIMO long training portion 620 to achieve performance of the MIMO system. As shown in FIG. 6, neither the first nor the subsequent MIMO Long Training Fields (HT-LTF) are repeated. This leads to the shortest possible preamble design, whose length is given by $(30.4+N*4)$ us, where N is the number of spatial streams. ... The present invention recognizes that shortening each MIMO long training field (HT-LTF) from two OFDM symbols to one OFDM symbol increases the channel estimation error while reducing the

Claim Elements	Disclosure in Mujtaba
	preamble overhead. It has been observed that the preamble formats 500, 600 having one OFDM symbol per MIMO long training field outperforms the preamble format 300 having two OFDM symbols per MIMO long training field (in the sense of throughput versus SNR (dB)) at high SNR and larger number of spatial streams (N). <i>FIG. 6</i> 
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Mujtaba discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. <i>See, e.g.</i>, claim limitation 1.A and 1.C above. To the extent that it is determined that Mujtaba does not expressly or inherently disclose this limitation or render the limitation obvious, this reference in combination with one or more of the following secondary prior art references renders this limitation obvious: • TGN Sync Proposal 2005 and TGN Sync Proposal 2004 (<i>See Ex. A1</i>) • 2006 802.11n Joint PHY Proposal (<i>See Ex. A2</i>) • Maltsev (<i>See Ex. A3</i>); • The G.9960 Draft, Schrum, Kol, and Brown (<i>See Ex. A5</i>);

Claim Elements	Disclosure in Mujtaba
	• Takahashi (<i>See</i> Ex. A6); • Van Nee (<i>See</i> Ex. A8); • Williams, Ma, and Soliman (<i>See</i> Ex. A9) • Wwise 2005 (<i>See</i> Ex. A10); • Yonge (<i>See</i> Ex. A11) • Zelst (<i>See</i> Ex. A12); • Zhang '159 (<i>See</i> Ex. A13); Citations on a limitation-by-limitation basis can be found in the claim chart for these secondary references in the Exhibits identified above. One of ordinary skill in the art would have been motivated to combine each of these references, either individually or in combination, with the primary reference cited in this claim chart because, among other things, each of these references relates to systems and methods for wireless communication, most relate to OFDM wireless communications, and relate to Wi-Fi networking. Moreover, It would have been a routine adaption for a person of ordinary skill in the art to merely specify the relative width of the first and second frequency bands of the wireless transceiver disclosed in Mujtaba to meet this claim limitation.
[2.] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Mujtaba discloses and/or renders obvious at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. <i>See, e.g.,</i> Mutjaba, 3:3–17: The present invention provides preamble formats and techniques for preamble training for MIMO system. The training phase of a MIMO transmission will contain two phases. The first training phase is a legacy training phase particularly suited, for example, to WLAN OFDM legacy systems and the second phase is particularly suited to a multiple antenna system, such as a MIMO system. To overcome the problems in the prior systems, the Automatic Gain Control (AGC) of a receiver will perform one training sequence during the first training phase and the AGC of the receiver will retrain during the second training phase. This will allow the receiver to retrain its power measurements during the MIMO phase in order to ensure accuracy, while

Claim Elements	Disclosure in Mujtaba
	also allowing the receiver to be backwards compatible to WLAN systems that are not MIMO based. <i>See, e.g.,</i> Mujtaba, 3:61–4:3: In the exemplary preamble design 300, the transmitter 100 first transmits the legacy 802.11a/g preamble 310, for example, using CDD. The legacy preamble 310 permits the performance of packet detection and coarse frequency offset estimation. The results of these two functions are also going to be used in the MIMO transmission. In addition to these two functions, the legacy preamble 310 is used to perform legacy AGC, timing and frequency synchronization and channel estimation, in a known manner. The receiver 200 then decodes the subsequent legacy and HT signal fields. <i>See, e.g.,</i> Mujtaba, 4:63–67 (“As shown in FIG. 5, the first MIMO long training field (HT-LTF) contains a repeated OFDM symbol 530-1, 530-2. The motivation for repeating the OFDM symbol is to allow for a re-estimation of the fine frequency offset.”).
[3.] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Mujtaba discloses and/or renders obvious wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. <i>See, e.g.,</i> Mutjaba, 3:3–17: The present invention provides preamble formats and techniques for preamble training for MIMO system. The training phase of a MIMO transmission will contain two phases. The first training phase is a legacy training phase particularly suited, for example, to WLAN OFDM legacy systems and the second phase is particularly suited to a multiple antenna system, such as a MIMO system. To overcome the problems in the prior systems, the Automatic Gain Control (AGC) of a receiver will perform one training sequence during the first training phase and the AGC of the receiver will retrain during the second training phase. This will allow the receiver to retrain its power

Claim Elements	Disclosure in Mujtaba
	measurements during the MIMO phase in order to ensure accuracy, while also allowing the receiver to be backwards compatible to WLAN systems that are not MIMO based. <i>See, e.g.</i>, Mujtaba, 3:61–4:3: In the exemplary preamble design 300, the transmitter 100 first transmits the legacy 802.11a/g preamble 310, for example, using CDD. The legacy preamble 310 permits the performance of packet detection and coarse frequency offset estimation. The results of these two functions are also going to be used in the MIMO transmission. In addition to these two functions, the legacy preamble 310 is used to perform legacy AGC, timing and frequency synchronization and channel estimation, in a known manner. The receiver 200 then decodes the subsequent legacy and HT signal fields. <i>See, e.g.</i>, Mujtaba, 4:63–67 (“As shown in FIG. 5, the first MIMO long training field (HT-LTF) contains a repeated OFDM symbol 530-1, 530-2. The motivation for repeating the OFDM symbol is to allow for a re-estimation of the fine frequency offset.”).
[4.] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	To the extent that it is determined that Mujtaba does not expressly or inherently disclose this limitation or render the limitation obvious, this reference in combination with one or more of the following secondary prior art references renders this limitation obvious: • TGN Sync Proposal 2005 and TGN Sync Proposal 2004 (<i>See Ex. A1</i>) • 2006 802.11n Joint PHY Proposal (<i>See Ex. A2</i>) • Maltsev (<i>See Ex. A3</i>); • The G.9960 Draft, Schrum, Kol, and Brown (<i>See Ex. A5</i>); • Takahashi (<i>See Ex. A6</i>); • Van Nee (<i>See Ex. A8</i>); • Williams, Ma, and Soliman (<i>See Ex. A9</i>) • WWise 2005 (<i>See Exhibit A10</i>); • Yonge (<i>See Ex. A11</i>) • Zelst (<i>See Ex. A12</i>);

Claim Elements	Disclosure in Mujtaba
	• Zhang '159 (See Ex. A13); Citations on a limitation-by-limitation basis can be found in the claim chart for these secondary references in the Exhibits identified above. One of ordinary skill in the art would have been motivated to combine each of these references, either individually or in combination, with the primary reference cited in this claim chart because, among other things, each of these references relates to systems and methods for wireless communication, most relate to OFDM wireless communications, and relate to Wi-Fi networking. Moreover, It would have been a routine adaption for a person of ordinary skill in the art to merely specify the relative width of the first and second frequency bands of the wireless transceiver disclosed in Mujtaba to meet this claim limitation.
[8.] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Mujtaba discloses a wireless transceiver that supports one or more wireless standards. <i>See, e.g.,</i> Mujtaba, 1:39–53: It is desirable for multiple antenna communication systems to co-exist with legacy single antenna communications systems (typically referred to as Single Input Single Output (SISO) systems). Thus, a legacy (single antenna) communications system must be able to interpret the preambles that are transmitted by multiple antenna communication systems. Most legacy Wireless Local Area Network (WLAN) systems based upon OFDM modulation comply with either the IEEE 802.11a or IEEE 802.11g standards (hereinafter ‘IEEE 802.11a/g’). Generally, the preamble signal seen by the legacy device should allow for accurate synchronization and channel estimation for the part of the packet that the legacy device needs to understand.
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.,</i> claim preamble 1.PRE above.
[9.A] a wireless OFDM communications receiver	<i>See, e.g.,</i> claim limitation 1.A above.

Claim Elements	Disclosure in Mujtaba
operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Mujtaba
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[10.] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[11.] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[12.] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[16.] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more	<i>See, e.g.</i> , claim 8 above.

Claim Elements	Disclosure in Mujtaba
wireless standards.	
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	Mujtaba discloses a method of operating a wireless OFDM transceiver. <i>See, e.g.,</i> claim preamble 1.PRE above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Mujtaba discloses and/or renders obvious receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits. <i>See, e.g.,</i> claim limitation 1.A above.
[17.B] demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Mujtaba discloses and/or renders obvious demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers. <i>See, e.g.,</i> claim limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of	Mujtaba discloses and/or renders obvious receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits. <i>See, e.g.,</i> claim limitation 1.C above.

Claim Elements	Disclosure in Mujtaba
header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Mujtaba discloses demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits. <i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21.] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.
[22.] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[23.] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[24.] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosure in Mujtaba
of correctly decoding header information of the first packet in the first narrower frequency band	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim limitation 1.A above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Mujtaba
a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26.] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27.] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[28.] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency	<i>See, e.g.</i> , claim 4 above.

Claim Elements	Disclosure in Mujtaba
band.	
[32.] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	See, e.g., claim 8 above.

Exhibit A5

Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262 to "ITU-T Recommendation G.9960 - Draft generation home Networking transceivers" ("the G.9960 Draft") Alone or in Combination with "G.hn: Extended PHY frame header," ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), "G.hn: Using Two Symbols for the Header of a PHY frame on Coax" ITU-T SGJ 5/Q4 09XC-119 by Boaz Kol at CoperGate ("Kol"), and/or "G.hn: 09CC-R12 HomePlug AV interoperability updates" ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA ("Brown")

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under pre-AIA 35 U.S.C. § 102 as anticipated by the G.9960 Draft; (2) under pre-AIA 35 U.S.C. § 103 as obvious in view of the G.9960 Draft standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of the G.9960 Draft in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.¹

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published

¹ Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

and made publicly available at least as early as July 27, 2009;

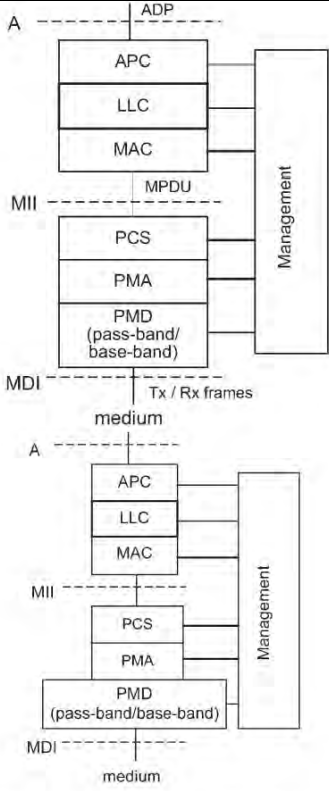
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-l 19 by Boaz Kol at CoperGate (“Kol”), published and made publicly available at least as early as July 27, 2009;
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

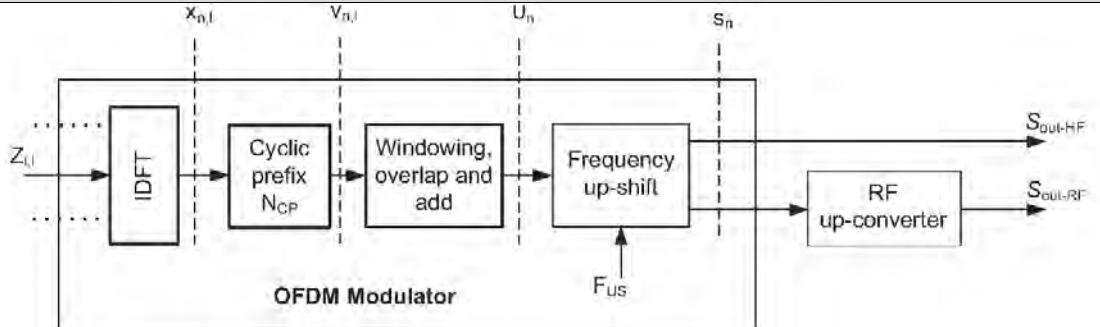
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses a wireless OFDM transceiver. For example, the reference discloses the following: <i>See, e.g.,</i> G.9960 Draft at 4:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	Introduction This Foundation Recommendation specifies basic characteristics of home networking transceivers capable of operating over premises wiring including inside telephone wiring, coaxial cable, and power line wiring, and combinations of these. The transceivers defined by this specification provide the data rate and quality of service necessary for triple-play residential services as well as business-type services delivered over xDSL, PON, or other access technology. The transceivers use OFDM type of modulation and are designed to provide EMC and spectral compatibility of home networking transmission with VDSL2 and other types of DSL used to access the home. <i>Id.</i> at 28: 5.2.3 Functional model of an HN transceiver The functional model of an HN transceiver is presented in Figure 5-12. It addresses a regular node, a master node, and a relay node (including DAP), which differ by their MAC, LLC and upper layer functionalities. <i>Id.</i> at Fig. 5-12:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	 Figure 5-12/G.9960 – Functional model of HN transceiver
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Kol at 1:</i>

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
symbols that carry a first plurality of header bits;	1. Introduction The PHY-header of a PHY-frame is defined in G.9960 [1] to contain important information necessary in order to process the payload. The information of the header is encoded in a single FEC block of 168 bits with code rate 1/2. This information is modulated onto either one or two OFDM symbols using QPSK modulation. The effective number of repetitions depends on the number of active subcarriers and on the number of header symbols (1 or 2). It is not specified what the conditions for choosing one or two symbols are. The intention is that there will be a sufficient number of repetitions of the FEC block so that some minimum level of robustness is guaranteed. A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate 1/2 a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness. <i>Id.</i> at 2-3: The FEC codeword enters the HRE. The HRE shall operate as follows: - The FEC codeword shall be first copied M times, where $M = \text{ceiling}(D \times k_H / N_{FEC})$, k_H is the number of bits to be loaded onto the OFDM symbol carrying the header, and D is the number of symbols to be used for header transmission - The encoded header block shall be formed by concatenation of M copies of the header FEC encoder output. As each codeword is cascaded to one another, the bits (b_i) within a codeword shall be cyclically shifted by 2 bits as follows: ○ The 1st FEC codeword copy shall be formed as $\{b_0, b_1, \dots, b_{N_{FEC}-2}, b_{N_{FEC}-1}\}$. ○ The 2nd FEC codeword copy shall be formed as $\{b_2, b_3, \dots, b_{N_{FEC}-1}, b_0, b_1\}$. ○ The 3rd FEC codeword copy shall be formed as $\{b_4, b_5, \dots, b_{N_{FEC}-1}, b_0, b_1, b_2, b_3\}$. ○ ...

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	○ The M^{th} FEC codeword copy, where $M > 3$, shall be formed as $\{b_{(2 \times M - 2)}, b_{(2 \times M - 1)}, \dots, b_{N_{\text{FEC}} - 1}, b_0, b_1, \dots, b_{(2 \times M - 4)}, b_{(2 \times M - 3)}\}$. Valid values of D are either 1 or 2. Details <u>for powerline and phoneline</u> are for further study. <u>For coax (baseband and RF) the number of PHY-frame header shall be two, i.e., $D = 2$.</u> NOTE: Since the coding rate used for header encoding is $\frac{1}{2}$, the number of bits in the FEC codeword is always even, and the number of bits in the encoded header block is even. G.9960 Draft at 64: 7.1.4.4 OFDM modulator The OFDM modulator consists of the following major parts: IDFT, cyclic extension, windowing, overlap and add, and frequency up-shift. The incoming signal to the modulator at the i-th OFDM symbol in the present frame for a single sub-carrier, with index i, is the real and imaginary parts of the value $Z_{i,l}$ generated by the Constellation encoder as described in §7.1.4.3.2 (for symbols of the header and the payload) or by Preamble Generator as described in §7.1.4.5.2.1 (for symbols of the preamble). Time-domain samples generated by the IDFT, after adding the cyclic prefix and windowing, are frequency up-shifted to the center frequency F_{US}. The functional diagram of OFDM modulator is presented in Figure 7-19. RF up-converter facilitates G.9960 operation in RF frequency range. <i>Id.</i> at Fig. 7-19:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	 Figure 7-19/G.9960 – Functional model of the OFDM modulator <i>Id.</i> at 65: 7.1.4.4.2 Cyclic extension and OFDM symbol The cyclic extension provides guard interval between data-carrying samples of adjacent OFDM symbols. This guard interval is necessary to protect the data-carrying samples from the inter-symbol interference (ISI) caused by the previous symbol. In OFDM guard interval of the l-th OFDM symbol in the frame shall be implemented by pre-pending the last $N_{CP}(l)$ samples of the IDFT (called cyclic prefix) to its output N samples, as presented in Figure 7-20. The order of samples in the symbol shall be as follows: Schrum at 1: This contribution proposes to add an option for supporting extended PHY frame headers that contain $2 \times \text{PHY}_H$ information bits in order to allow for expansion of the ACKI field and to allow additional header bits for future enhancements to G.9960.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	The G.9960 draft in §7.1.2.1 alludes to PHY frame headers that contain more than one symbol (although the reference does not make it clear if this is for PHY frame header symbol repetition or to support additional PHY frame header information bits), and support for extended PHY frame headers with additional information bits that are encoded with double the symbols used for the non-extended PHY frame header has been discussed in the G.hn group. However, currently, the current text (G.9960 draft, G.9960 Amendment I, or G.hn draft) does not describe support for more than PHY_H information bits in the PHY frame header. This contribution proposes to add an option for supporting an extended PHY frame header with 2 x PHY_H information bits in order to allow for expansion of the ACKI field and to allow additional header bits for future enhancements to G.9960. A larger ACKI field allows more frames to be acknowledged, and is especially useful for bi-directional transmissions, which is proposed in separate contribution. Proposed is to define two one-bit fields which are assigned to bits in the PHY frame header that are currently reserved. The extended header indication (EHI) is set to indicate that the PHY header contains 2 x PHY_H information bits, allowing receivers to determine how to decode the PHY header. The immediate response frame extended header indication (IREHI) tells receivers if they should respond with a header than contains PHY_H or 2 x PHY_H information bits when transmitting immediate response frames. This allows receivers to know if sufficient time has been allocated for a immediate response frame and for nodes tracking durations to know the duration of a frame transmission sequence. If at some point the definition of the duration field is modified so that it includes immediate response frames (ACK frame), then it may be possible to eliminate the IREHI bit. This contribution proposes two HCS fields to independently protect the content of each set of PHY_H information bits in the PHY header. Two independent HCS fields results more robust protection of the header contents. It also eliminates ambiguity for receivers when determining how to decode the PHY frame header. If a single HCS field were to be defined that protected 2 x PHY_H information bits then the IREHI bit would need to be interpreted and acted on before the bit is verified with the HCS. <i>Id.</i> at 2-3:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	2. Proposed Text Updates <<Start Text – G.9960 Amendment I>> 7.1.2.3 PHY-frame header The PHY-frame header contains ~~is~~ PHY_H information bits if the extended header information (EHI) bit is set to zero, and 2 x PHY_H information bits if the EHI bit is set to one, ~~less~~ and is composed of a common part and a variable part. The common part contains fields that are common for all PHY-frame types. The variable part contains fields according to the PHY-frame type. PHY-frame type is indicated by the FT field. The PAD fields fit the length of the header of different PHY frame-types to the standard values of PHY_H bits. The content of the header is protected by the 16-bit header check sequences (HCS, and E_HCS in the case of the extended PHY header). The fields of the PHY-frame header are defined in Table 7-1

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown			
	Table 7-1/G.9960 – PHY-frame header fields			
	Field	Octet	Field Size [Bits]	Description
	FT	0	4	Frame type
	DOD	0	4	Domain ID
	SID	1	8	The device ID of the source node
	DID	2	8	The device ID of the destination node
	MI	3	1	Multicast indication identifies whether the DID is a multicast destination
	PHI	3	1	Post header indication identifies whether the first payload symbol after the header is a PRBS symbol or a data symbol
	<u>EHI</u>	<u>3</u>	<u>1</u>	<u>Extended PHY frame header indication.</u>
	<u>IREHI</u>	<u>3</u>	<u>1</u>	<u>Immediate response frame extended PHY frame header indication.</u>
	Reserved	3	46	Reserved by ITU-T
	Duration	4-5	16	The PHY frame transmission duration
	...	6-18		
	HCS	19-20	16	Header check sequence
		<u>21-32 [1]</u>		<u>Variable part 2 (present for extended PHY frame header only)</u>
	<u>E HCS</u>	<u>40- 41 [1]</u>	<u>16</u>	<u>Extended PHY header - header check sequence</u>
				<u>Common part (present for extended PHY frame header only)</u>
	<u>Notes</u> <u>[1] These fields are present only if the PHI bit is set.</u>			

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	<u>7.1.2.3.1.8 Extended header indication (EHI)</u> The EHI field when set indicates that the PHY frame header contains 2 x PHY_H information bits. If the EHI field is zero then the header of the PHY frame contains PHY_H information bits. The EHI field shall be set to zero for all frames types except the ACK frame. In ACK frames this bit may be set to zero or one. <u>7.1.2.3.1.9 Immediate response frame extended header indication (IREHI)</u> The IREHI field when set indicates that receivers shall use for immediate response frames (ACK for example) extended PHY-frame headers. If the IREHI field is zero then immediate response frames shall use standard (non-extended) PHY-frame headers. <u>7.1.2.3.1.8/10 Header check sequence and Extended header check sequence (HCS and E_HCS)</u> The HCS and E_HCS fields are intended for PHY-frame header verification. The HCS is a 16-bit cyclic redundancy check (CRC) and shall be computed over all the fields of the first PHY_H information bits of the PHY-frame header in the order they are transmitted, starting with the MSB of the frame type (FT) field and ending with the LSB of the last field in the first PHY_H information bits of the PHY Frame. The E_HCS is present only for extended PHY header frames and shall be computed over all the fields of the second set of PHY_H PHY-frame header information bits in the order they are transmitted, starting with the MSB of the first field in the second set of PHY_H information bits of the PHY-frame header and ending with the LSB of the last field in the second set of PHY_H information bits. The HCS and E_HCS shall be computed using the following generator polynomial of degree 16: $G(x) = x^{16} + x^{12} + x^5 + 1.$ The value of the HCS and E_HCS shall be the remainder after the contents (treated as a polynomial where the first input bit is associated with the highest degree, X^{PHY_H-1}, where PHY_H is the number of header information length in bits over which the HCS or E_HCS is computed, and the last input bit is associated with X^0) of the calculation fields is multiplied by x^{16} and then divided by $G(x)$. The HCS and E_HCS fields shall be transmitted starting with the coefficient of the highest order term (MSB).

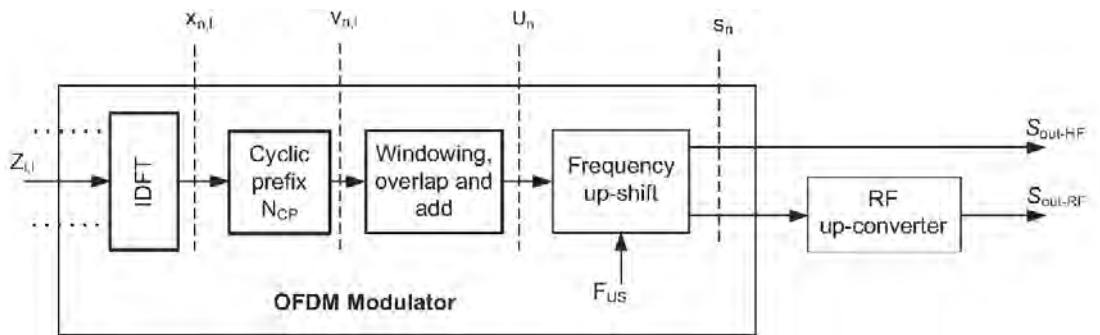
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																														
	7.1.2.3.2.2 ACK PHY-frame type specific fields (working text) Table 7-11.1 lists the ACK PHY frame type specific fields. Table 7-11.1/G.hn – ACK PHY Frame Type Specific Fields <table> <tr> <th>Field</th><th>Size in bits</th></tr> <tr> <td>FAACK</td><td>3</td></tr> <tr> <td>FLCTRLT</td><td>1</td></tr> <tr> <td>FLCTRL</td><td>3</td></tr> <tr> <td>LSSNP</td><td>1</td></tr> <tr> <td>RXRST DATA</td><td>1</td></tr> <tr> <td>RXRST MNGMT</td><td>1</td></tr> <tr> <td>ACKI/LSSN</td><td>16</td></tr> <tr> <td>ACKI</td><td>64</td></tr> <tr> <td>RXRST DATA</td><td>1</td></tr> <tr> <td>RXRST MNGMT</td><td>1</td></tr> <tr> <td>Pad</td><td>padding until PHY_H</td></tr> <tr> <td>ACKI[1]</td><td>136</td></tr> <tr> <td>Pad [1]</td><td>padding until 2 x PHY_H</td></tr> <tr> <td colspan="2"> Notes [1] These fields are present for the extended PHY-frame header only. </td></tr> </table> Brown at 80:	Field	Size in bits	FAACK	3	FLCTRLT	1	FLCTRL	3	LSSNP	1	RXRST DATA	1	RXRST MNGMT	1	ACKI/LSSN	16	ACKI	64	RXRST DATA	1	RXRST MNGMT	1	Pad	padding until PHY _H	ACKI[1]	136	Pad [1]	padding until 2 x PHY _H	Notes [1] These fields are present for the extended PHY-frame header only.	
Field	Size in bits																														
FAACK	3																														
FLCTRLT	1																														
FLCTRL	3																														
LSSNP	1																														
RXRST DATA	1																														
RXRST MNGMT	1																														
ACKI/LSSN	16																														
ACKI	64																														
RXRST DATA	1																														
RXRST MNGMT	1																														
Pad	padding until PHY _H																														
ACKI[1]	136																														
Pad [1]	padding until 2 x PHY _H																														
Notes [1] These fields are present for the extended PHY-frame header only.																															

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown					
	8.8.1 TXOP MAP message (working text) Each MAC cycle is identified by a Sequence Number (see §8.8.1) contained in the TXOP MAP message. By default, the medium access plan described by a TXOP MAP message frame is for a single MAC cycle, but it may carry persistency information related to one or more subsequent MAC cycles. The structure of the TXOP MAP message shall be as described in Figure 8-30. <table border="1"><tr><td>TXOP MAP Header</td><td>TXOP Desc [0]</td><td>...</td><td>TXOP Desc [N]</td><td>Auxiliary Information</td></tr></table> Figure 8-30/G.hn – TXOP MAP message structure The TXOP MAP message contains a TXOP MAP header (§8.8.1) followed by a number of TXOP descriptors (§8.8.2), followed by an Auxiliary Information field (§8.8.3). The number of TXOP descriptors in the TXOP MAP message as well as control and sequence information is encoded in the TXOP MAP header. The TXOP MAP message, as presented in Figure 8-30 shall be transmitted in a single B-LCDU and shall be communicated as a MAC frame with MACFT = 3. The MAP message shall be the payload of the B-LCDU. The B-LCDU containing the MAP message shall be the only data unit contained within the MAP PHY frame. The MAP frame shall not be a subject for ARQ (no ACKs shall be sent). The SSN field in the first PB in a MAP PHY frame shall be initialized to 0 and shall be incremented by 1 for each subsequent PB in the same MAP PHY frame. The SSN numbers used in PBs within a MAP PHY frame represent their own address space and shall be separate from the address space associated with other management streams. The MQF flag in the PBH shall be set to 1. The MAP frame shall be sent unencrypted and shall not carry the timestamp: the TSMPI and the CCMPI bits of the MFH of the MAP LCDU shall be set to 0. <i>Id.</i> at 81:	TXOP MAP Header	TXOP Desc [0]	...	TXOP Desc [N]	Auxiliary Information
TXOP MAP Header	TXOP Desc [0]	...	TXOP Desc [N]	Auxiliary Information		

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																												
	Table 8-39/G.hn - MAP Header format <table><tr><th>Field</th><th>Octet</th><th>Bits</th><th>Description</th></tr><tr><td>Sequence Number</td><td>0</td><td>7:0</td><td>A MAP sequence number. The sequence number shall be incremented by one for each MAP transmission (modulo 256). An RMAP shall keep the sequence number of the original MAP (shall not increment the sequence number).</td></tr><tr><td>MAP Header Length</td><td>1</td><td>7:0</td><td>The length of the MAP header expressed in a number of 32 bit words.</td></tr><tr><td>Number of entries</td><td>2-3</td><td>15:0</td><td>Number of TXOP descriptors, including TXOP extensions, in the MAP.</td></tr><tr><td>MAP Modified</td><td>4</td><td>7</td><td>The domain master shall set this bit when the MAP is modified compared with the previous MAP and reset otherwise.</td></tr><tr><td>Handover In Progress (HOIP)</td><td>4</td><td>6</td><td>When set to 1, indicates that the present Domain Master is handing over its role to a newly registered node. At other times, is set to 0.</td></tr><tr><td>Reserved</td><td>4</td><td>5:3</td><td>Reserved by ITU-T</td></tr><tr><td>TICK_Factor</td><td>4</td><td>2:0</td><td>A time shift factor that shall be used to determine the resolution of a TXOP TIME_UNIT (see §8.2.3). The resolution of a TIME_UNIT is determined as follows: $\text{TIME\_UNIT} = \text{TICK} * 2^{\text{TICK\_Factor}}$ The values of TICK are defined in §8.4</td></tr><tr><td>Current Schedule Life Time (CSLT)</td><td>5</td><td>7:4</td><td>The number of consequent MAC cycles in which the TXOP schedule described in the MAP shall remain valid. The value of CSLT shall be reduced by 1 after each MAP frame with CSLT > 0</td></tr><tr><td>Future Schedule Life Time (FSLT)</td><td>5</td><td>3:0</td><td>If FSLT is non-zero, the MAP frame carries the future TXOP schedule which shall take effect when CSLT reaches zero and shall remain valid for FSLT consecutive MAC cycles after it takes effect.</td></tr><tr><td>Reserved</td><td>8-15</td><td></td><td>Reserved by ITU-T</td></tr></table>	Field	Octet	Bits	Description	Sequence Number	0	7:0	A MAP sequence number. The sequence number shall be incremented by one for each MAP transmission (modulo 256). An RMAP shall keep the sequence number of the original MAP (shall not increment the sequence number).	MAP Header Length	1	7:0	The length of the MAP header expressed in a number of 32 bit words.	Number of entries	2-3	15:0	Number of TXOP descriptors, including TXOP extensions, in the MAP.	MAP Modified	4	7	The domain master shall set this bit when the MAP is modified compared with the previous MAP and reset otherwise.	Handover In Progress (HOIP)	4	6	When set to 1, indicates that the present Domain Master is handing over its role to a newly registered node. At other times, is set to 0.	Reserved	4	5:3	Reserved by ITU-T	TICK_Factor	4	2:0	A time shift factor that shall be used to determine the resolution of a TXOP TIME_UNIT (see §8.2.3). The resolution of a TIME_UNIT is determined as follows: $\text{TIME\_UNIT} = \text{TICK} * 2^{\text{TICK\_Factor}}$ The values of TICK are defined in §8.4	Current Schedule Life Time (CSLT)	5	7:4	The number of consequent MAC cycles in which the TXOP schedule described in the MAP shall remain valid. The value of CSLT shall be reduced by 1 after each MAP frame with CSLT > 0	Future Schedule Life Time (FSLT)	5	3:0	If FSLT is non-zero, the MAP frame carries the future TXOP schedule which shall take effect when CSLT reaches zero and shall remain valid for FSLT consecutive MAC cycles after it takes effect.	Reserved	8-15		Reserved by ITU-T
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	<i>Id.</i> at 83:																																												

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	8.8.3 TXOP Descriptor (baseline text) Each TXOP is described by at least one TXOP descriptor. A TXOP descriptor is composed of basic TXOP descriptor that may be extended by one or more additional TXOP descriptor extensions (see §8.8.2.1.1 - §8.8.2.1.3). TXOP descriptor extensions supply additional information like scheduling information, timing information and TXOP attributes. Basic TXOP descriptors and TXOP descriptor extensions are each 4 octets in length. A TXOP descriptor represents the right of a certain node or a set of nodes to transmit within a certain TXOP. A CFTXOP shall be described using a single TXOP descriptor. A STXOP shall be described using several TXOP descriptors representing the TSs within the STXOP. The differentiation between different TXOPs shall be done via the TXOP Attributes extension, which shall be appended to the last TXOP descriptor of a TXOP. The TXOP Attributes extension supplies the timing information for the TXOP (see §8.8.2.1.1). A node associated with a TXOP or a /TS is uniquely identified in a TXOP descriptor by the SID field, which shall be set to the device ID of the node as was assigned by the domain master.
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. For example, the reference discloses the following: <i>See, e.g., G.9960 Draft at 24:</i> The PCS provides bit rate adaptation (data flow control) between the MAC and PHY and encapsulates transmit packets into the PHY frame and adds PHY-related control and management overhead. The PMA provides encoding of PHY frame content for transmission over the medium. The PMD modulates and demodulates PHY frames for transmission over the medium using orthogonal frequency division modulation (OFDM). By implementation, the PMD may include media-dependent adaptors for different media, including frequency shifting for pass-band transmission. <i>Id.</i> at 31: In the receive direction, frames entering from the medium via the MDI are demodulated and decoded. The recovered MPDUs are forwarded to MAC via the MII. The recovered PHY-frame headers are processed in the PHY to extract the relevant frame parameters specified in §7.1.2.3. <i>Id.</i> at Fig. 7-11:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	The diagram illustrates the functional model of the PMD (Physical Medium Dependent) layer, showing the flow of data between the δ-interface and the MDI (Medium Dependent Interface). TX Path (Transmit): TX symbol frames enter from the δ-interface. - These frames pass through a Tone Mapper and a Constellation encoder. - The output goes to the OFDM Modulator. - The OFDM Modulator is connected to the Medium-specific AFE (Analog Front End) via a signal labeled F_{uc}. - The Medium-specific AFE is connected to the Medium (represented by a thick horizontal line). RX Path (Receive): - The Medium sends signals to the Medium-specific AFE. - The Medium-specific AFE outputs to the OFDM Modulator. - The OFDM Modulator outputs to a block containing Symbol frames recovery, Constellation Decoder, Demodulator, and Preamble decoder. - This block outputs RX symbol frames to the δ-interface. - The Preamble decoder outputs Preamble data to the PHY Management entity (represented by a vertical line on the right). - The PHY Management entity also provides Preamble data to a Preamble generator, which in turn feeds back into the OFDM Modulator. Interfaces: - The top dashed line represents the δ-interface. - The bottom dashed line represents the MDI. Figure 7-11/G.9960 – Functional model of the PMD <i>Id.</i> at 53: In the receive direction, the frames incoming from the medium are demodulated and decoded. The recovered symbol frames are transferred to the PMA via δ-interface. The preamble is processed and preamble data are passed to the PHY management entity. <i>Id.</i> at 64:

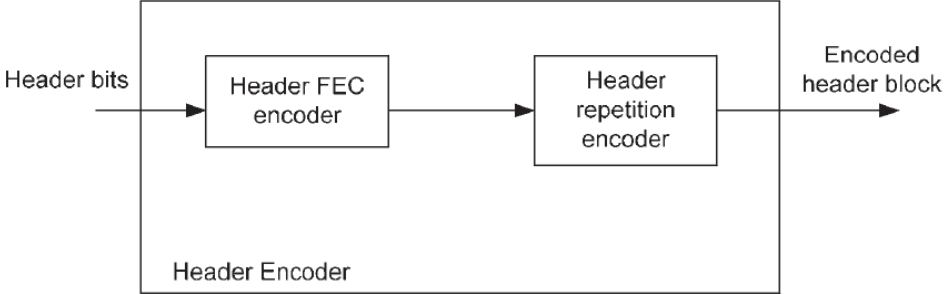
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	7.1.4.4 OFDM modulator The OFDM modulator consists of the following major parts: IDFT, cyclic extension, windowing, overlap and add, and frequency up-shift. The incoming signal to the modulator at the l-th OFDM symbol in the present frame for a single sub-carrier, with index i, is the real and imaginary parts of the value $Z_{i,l}$ generated by the Constellation encoder as described in §7.1.4.3.2 (for symbols of the header and the payload) or by Preamble Generator as described in §7.1.4.5.2.1 (for symbols of the preamble). Time-domain samples generated by the IDFT, after adding the cyclic prefix and windowing, are frequency up-shifted to the center frequency F_{US}. The functional diagram of OFDM modulator is presented in Figure 7-19. RF up-converter facilitates G.9960 operation in RF frequency range. <i>Id.</i> at Fig. 7-19:  The diagram illustrates the functional model of the OFDM modulator. It shows a sequence of processing blocks: IDFT, Cyclic prefix (N_{CP}), Windowing, overlap and add, Frequency up-shift, and RF up-converter. The input signal $Z_{i,l}$ enters the IDFT block. The output of the IDFT block is $x_{n,l}$, which then enters the Cyclic prefix block. The output of the Cyclic prefix block is $v_{n,l}$, which then enters the Windowing, overlap and add block. The output of the Windowing, overlap and add block is u_n, which then enters the Frequency up-shift block. The output of the Frequency up-shift block is s_n, which then enters the RF up-converter block. The RF up-converter block has two outputs: S_{out-HF} and S_{out-RF}. The center frequency F_{US} is indicated as an input to the Frequency up-shift block. The entire process is labeled as the OFDM Modulator. Figure 7-19/G.9960 – Functional model of the OFDM modulator Schrum at 1:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	Proposed is to define two one-bit fields which are assigned to bits in the PHY frame header that are currently reserved. The extended header indication (EHI) is set to indicate that the PHY header contains 2 x PHY_H information bits, allowing receivers to determine how to decode the PHY header. The immediate response frame extended header indication (IREHI) tells receivers if they should respond with a header than contains PHY_H or 2 x PHY_H information bits when transmitting immediate response frames. This allows receivers to know if sufficient time has been allocated for a immediate response frame and for nodes tracking durations to know the duration of a frame transmission sequence. If at some point the definition of the duration field is modified so that it includes immediate response frames (ACK frame), then it may be possible to eliminate the IREHI bit. This contribution proposes two HCS fields to independently protect the content of each set of PHY_H information bits in the PHY header. Two independent HCS fields results more robust protection of the header contents. It also eliminates ambiguity for receivers when determining how to decode the PHY frame header. If a single HCS field were to be defined that protected 2 x PHY_H information bits then the IREHI bit would need to be interpreted and acted on before the bit is verified with the HCS. <i>Id.</i> at 2-3: 2. Proposed Text Updates <<Start Text – G.9960 Amendment I>> 7.1.2.3 PHY-frame header The PHY-frame header <del>contains 1 x PHY_H information bits if the extended header information (EHI) bit is set to zero, and 2 x PHY_H information bits if the EHI bit is set to one, ~~long~~</del> and is composed of a common part and a variable part. The common part contains fields that are common for all PHY-frame types. The variable part contains fields according to the PHY-frame type. PHY-frame type is indicated by the FT field. The PAD fields fit the length of the header of different PHY frame-types to the standard values of PHY_H bits. The content of the header is protected by the 16-bit header check sequences (HCS, and E_HCS in the case of the extended PHY header). The fields of the PHY-frame header are defined in Table 7-1

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown			
	Table 7-1/G.9960 – PHY-frame header fields			
	Field	Octet	Field Size [Bits]	Description
	FT	0	4	Frame type
	DOD	0	4	Domain ID
	SID	1	8	The device ID of the source node
	DID	2	8	The device ID of the destination node
	MI	3	1	Multicast indication identifies whether the DID is a multicast destination
	PHI	3	1	Post header indication identifies whether the first payload symbol after the header is a PRBS symbol or a data symbol
	<u>EHI</u>	<u>3</u>	<u>1</u>	<u>Extended PHY frame header indication.</u>
	<u>IREHI</u>	<u>3</u>	<u>1</u>	<u>Immediate response frame extended PHY frame header indication.</u>
	Reserved	3	<u>46</u>	Reserved by ITU-T
	Duration	4-5	16	The PHY frame transmission duration
	...	6-18		
	HCS	19-20	16	Header check sequence
		<u>21-32 [1]</u>		<u>Variable part 2 (present for extended PHY frame header only)</u>
	<u>E_HCS</u>	<u>40-41 [1]</u>	<u>16</u>	<u>Extended PHY header - header check sequence</u>
				<u>Common part (present for extended PHY frame header only)</u>
	<u>Notes</u> <u>[1] These fields are present only if the PHI bit is set.</u>			

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	<u>7.1.2.3.1.8 Extended header indication (EHI)</u> The EHI field when set indicates that the PHY frame header contains 2 x PHY_H information bits. If the EHI field is zero then the header of the PHY frame contains PHY_H information bits. The EHI field shall be set to zero for all frames types except the ACK frame. In ACK frames this bit may be set to zero or one. <u>7.1.2.3.1.9 Immediate response frame extended header indication (IREHI)</u> The IREHI field when set indicates that receivers shall use for immediate response frames (ACK for example) extended PHY-frame headers. If the IREHI field is zero then immediate response frames shall use standard (non-extended) PHY-frame headers. <u>7.1.2.3.1.810 Header check sequence and Extended header check sequence (HCS and E HCS)</u> The HCS and E HCS fields are intended for PHY-frame header verification. The HCS is a 16-bit cyclic redundancy check (CRC) and shall be computed over all the fields of the first PHY_H information bits of the PHY-frame header in the order they are transmitted, starting with the MSB of the frame type (FT) field and ending with the LSB of the last field in the first PHY_H information bits of the PHY Frame. The E HCS is present only for extended PHY header frames and shall be computed over all the fields of the second set of PHY_H PHY-frame header information bits in the order they are transmitted, starting with the MSB of the first field in the second set of PHY_H information bits of the PHY-frame header and ending with the LSB of the last field in the second set of PHY_H information bits. The HCS and E HCS shall be computed using the following generator polynomial of degree 16: $G(x) = x^{16} + x^{12} + x^5 + 1.$ The value of the HCS and E HCS shall be the remainder after the contents (treated as a polynomial where the first input bit is associated with the highest degree, X^{PHY_H-17}, where PHY_H is the number of header information length in bits over which the HCS or E HCS is computed, and the last input bit is associated with X^0) of the calculation fields is multiplied by x^{16} and then divided by $G(x)$. The HCS and E HCS fields shall be transmitted starting with the coefficient of the highest order term (MSB). Kol at 1:

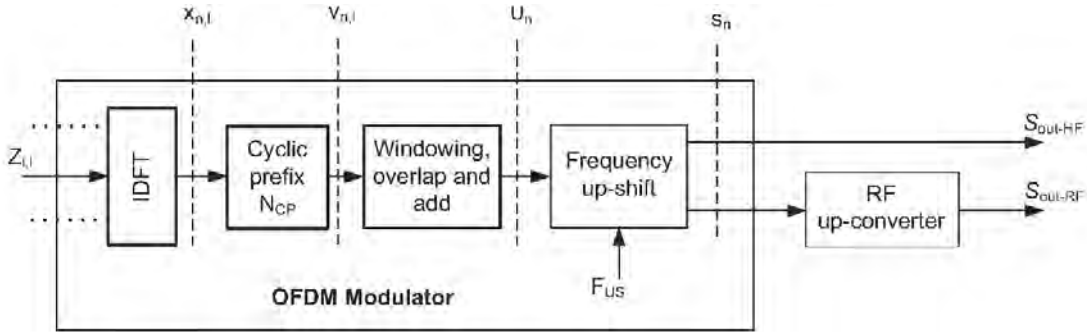
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	The PHY-header of a PHY-frame is defined in G.9960 [1] to contain important information necessary in order to process the payload. The information of the header is encoded in a single FEC block of 168 bits with code rate 1/2. This information is modulated unto either one or two OFDM symbols using QPSK modulation. The effective number of repetitions depends on the number of active subcarriers and on the number of header symbols (1 or 2). It is not specified what the conditions for choosing one or two symbols are. The intention is that there will be a sufficient number of repetitions of the FEC block so that some minimum level of robustness is guaranteed. A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate 1/2 a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness. Decoding a 136-bit FEC block with a BLER level of 10^{-6} requires an SNR of 5 dB or so. On the other hand, decoding a 520-byte FEC block with a BLER level of 10^{-6} requires an SNR of about 3.5 dB – some 1.5 dB less. <i>Id.</i> at 2:

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	7.1.3.4 Header encoder The functional model of the header encoder is presented in Figure 7-10. It contains an FEC encoder and a Header Repetition Encoder (HRE).  Figure 7-10/G.9960 – Functional diagram of the Header Encoder <i>Id.</i> at 2-3: The FEC codeword enters the HRE. The HRE shall operate as follows: - The FEC codeword shall be first copied M times, where $M = \text{ceiling}(D \times k_H / N_{FEC})$, k_H is the number of bits to be loaded onto the OFDM symbol carrying the header, and D is the number of symbols to be used for header transmission - The encoded header block shall be formed by concatenation of M copies of the header FEC encoder output. As each codeword is cascaded to one another, the bits (b_i) within a codeword shall be cyclically shifted by 2 bits as follows: ○ The 1st FEC codeword copy shall be formed as $\{b_0, b_1, \dots, b_{N_{FEC}-2}, b_{N_{FEC}-1}\}$. ○ The 2nd FEC codeword copy shall be formed as $\{b_2, b_3, \dots, b_{N_{FEC}-1}, b_0, b_1\}$. ○ The 3rd FEC codeword copy shall be formed as $\{b_4, b_5, \dots, b_{N_{FEC}-1}, b_0, b_1, b_2, b_3\}$. ○ ...

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	○ The M^{th} FEC codeword copy, where $M > 3$, shall be formed as $\{b_{(2 \times M - 2)}, b_{(2 \times M - 1)}, \dots, b_{N_{\text{FEC}} - 1}, b_0, b_1, \dots, b_{(2 \times M - 4)}, b_{(2 \times M - 3)}\}$. Valid values of D are either 1 or 2. Details <u>for powerline and phoneline</u> are for further study. <u>For coax (baseband and RF) the number of PHY-frame header shall be two, i.e., $D = 2$.</u> NOTE: Since the coding rate used for header encoding is $\frac{1}{2}$, the number of bits in the FEC codeword is always even, and the number of bits in the encoded header block is even.
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Kol at 1:</i> 1. Introduction The PHY-header of a PHY-frame is defined in G.9960 [1] to contain important information necessary in order to process the payload. The information of the header is encoded in a single FEC block of 168 bits with code rate $1/2$. This information is modulated onto either one or two OFDM symbols using QPSK modulation. The effective number of repetitions depends on the number of active subcarriers and on the number of header symbols (1 or 2). It is not specified what the conditions for choosing one or two symbols are. The intention is that there will be a sufficient number of repetitions of the FEC block so that some minimum level of robustness is guaranteed. A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate $1/2$ a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness. <i>Id.</i> at 2-3:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	The FEC codeword enters the HRE. The HRE shall operate as follows: - The FEC codeword shall be first copied M times, where $M = \text{ceiling}(D \times k_H / N_{FEC})$, k_H is the number of bits to be loaded onto the OFDM symbol carrying the header, and D is the number of symbols to be used for header transmission - The encoded header block shall be formed by concatenation of M copies of the header FEC encoder output. As each codeword is cascaded to one another, the bits (b_i) within a codeword shall be cyclically shifted by 2 bits as follows: ○ The 1st FEC codeword copy shall be formed as $\{b_0, b_1, \dots, b_{N_{FEC}-2}, b_{N_{FEC}-1}\}$. ○ The 2nd FEC codeword copy shall be formed as $\{b_2, b_3, \dots, b_{N_{FEC}-1}, b_0, b_1\}$. ○ The 3rd FEC codeword copy shall be formed as $\{b_4, b_5, \dots, b_{N_{FEC}-1}, b_0, b_1, b_2, b_3\}$. ○ ... ○ The M^{th} FEC codeword copy, where $M > 3$, shall be formed as $\{b_{(2 \times M - 2)}, b_{(2 \times M - 1)}, \dots, b_{N_{FEC}-1}, b_0, b_1, \dots, b_{(2 \times M - 4)}, b_{(2 \times M - 3)}\}$. Valid values of D are either 1 or 2. Details <u>for powerline and phoneline</u> are for further study. <u>For coax (baseband and RF) the number of PHY-frame header shall be two, i.e., $D = 2$.</u> NOTE: Since the coding rate used for header encoding is $1/2$, the number of bits in the FEC codeword is always even, and the number of bits in the encoded header block is even. G.9960 Draft at 33:

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	Table 7-1/G.9960 – PHY-frame header fields <table><tr><th>Field</th><th>Octet</th><th>Field Size [Bits]</th><th>Description</th><th></th></tr><tr><td>FT</td><td>0</td><td>4</td><td>Frame type</td><td rowspan="8">Common part</td></tr><tr><td>DOD</td><td>0</td><td>4</td><td>Domain ID</td></tr><tr><td>SID</td><td>1</td><td>8</td><td>The device ID of the source node</td></tr><tr><td>DID</td><td>2</td><td>8</td><td>The device ID of the destination node</td></tr><tr><td>MI</td><td>3</td><td>1</td><td>Multicast indication identifies whether the DID is a multicast destination</td></tr><tr><td>PHI</td><td>3</td><td>1</td><td>Post header indication identifies whether the first payload symbol after the header is a PRBS symbol or a data symbol</td></tr><tr><td>Reserved</td><td>3</td><td>6</td><td>Reserved by ITU-T</td></tr><tr><td>Duration</td><td>4-5</td><td>16</td><td>The PHY frame transmission duration</td></tr><tr><td>...</td><td>6-18</td><td></td><td></td><td>Variable part</td></tr><tr><td>HCS</td><td>19-20</td><td>16</td><td>Header check sequence</td><td>Common part</td></tr></table> <i>Id.</i> at 64: 7.1.4.4 OFDM modulator The OFDM modulator consists of the following major parts: IDFT, cyclic extension, windowing, overlap and add, and frequency up-shift. The incoming signal to the modulator at the <i>l</i>-th OFDM symbol in the present frame for a single sub-carrier, with index <i>i</i>, is the real and imaginary parts of the value <i>Z_{i,l}</i> generated by the Constellation encoder as described in §7.1.4.3.2 (for symbols of the header and the payload) or by Preamble Generator as described in §7.1.4.5.2.1 (for symbols of the preamble). Time-domain samples generated by the IDFT, after adding the cyclic prefix and windowing, are frequency up-shifted to the center frequency <i>F_{US}</i>. The functional diagram of	Field	Octet	Field Size [Bits]	Description		FT	0	4	Frame type	Common part	DOD	0	4	Domain ID	SID	1	8	The device ID of the source node	DID	2	8	The device ID of the destination node	MI	3	1	Multicast indication identifies whether the DID is a multicast destination	PHI	3	1	Post header indication identifies whether the first payload symbol after the header is a PRBS symbol or a data symbol	Reserved	3	6	Reserved by ITU-T	Duration	4-5	16	The PHY frame transmission duration	...	6-18			Variable part	HCS	19-20	16	Header check sequence	Common part
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HCS	19-20	16	Header check sequence	Common part																																													

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	OFDM modulator is presented in Figure 7-19. RF up-converter facilitates G.9960 operation in RF frequency range. <i>Id.</i> at Fig. 7-19:  Figure 7-19/G.9960 – Functional model of the OFDM modulator <i>Id.</i> at 65: 7.1.4.4.2 Cyclic extension and OFDM symbol The cyclic extension provides guard interval between data-carrying samples of adjacent OFDM symbols. This guard interval is necessary to protect the data-carrying samples from the inter-symbol interference (ISI) caused by the previous symbol. In OFDM guard interval of the l-th OFDM symbol in the frame shall be implemented by prepending the last $N_{CP}(l)$ samples of the IDFT (called cyclic prefix) to its output N samples, as presented in Figure 7-20. The order of samples in the symbol shall be as follows: Schrum at 1-3:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	Proposed is to define two one-bit fields which are assigned to bits in the PHY frame header that are currently reserved. The extended header indication (EHI) is set to indicate that the PHY header contains 2 x PHY_H information bits, allowing receivers to determine how to decode the PHY header. The immediate response frame extended header indication (IREHI) tells receivers if they should respond with a header than contains PHY_H or 2 x PHY_H information bits when transmitting immediate response frames. This allows receivers to know if sufficient time has been allocated for a immediate response frame and for nodes tracking durations to know the duration of a frame transmission sequence. If at some point the definition of the duration field is modified so that it includes immediate response frames (ACK frame), then it may be possible to eliminate the IREHI bit. This contribution proposes two HCS fields to independently protect the content of each set of PHY_H information bits in the PHY header. Two independent HCS fields results more robust protection of the header contents. It also eliminates ambiguity for receivers when determining how to decode the PHY frame header. If a single HCS field were to be defined that protected 2 x PHY_H information bits then the IREHI bit would need to be interpreted and acted on before the bit is verified with the HCS. 2. Proposed Text Updates <<Start Text – G.9960 Amendment I>> 7.1.2.3 PHY-frame header The PHY-frame header ~~contains 1 x PHY_H information bits if the extended header information (EHI) bit is set to zero, and 2 x PHY_H information bits if the EHI bit is set to one, long~~ and is composed of a common part and a variable part. The common part contains fields that are common for all PHY-frame types. The variable part contains fields according to the PHY-frame type. PHY-frame type is indicated by the FT field. The PAD fields fit the length of the header of different PHY frame-types to the standard values of PHY_H bits. The content of the header is protected by the 16-bit header check sequences (HCS₁ and E₁ HCS in the case of the extended PHY header). The fields of the PHY-frame header are defined in Table 7-1

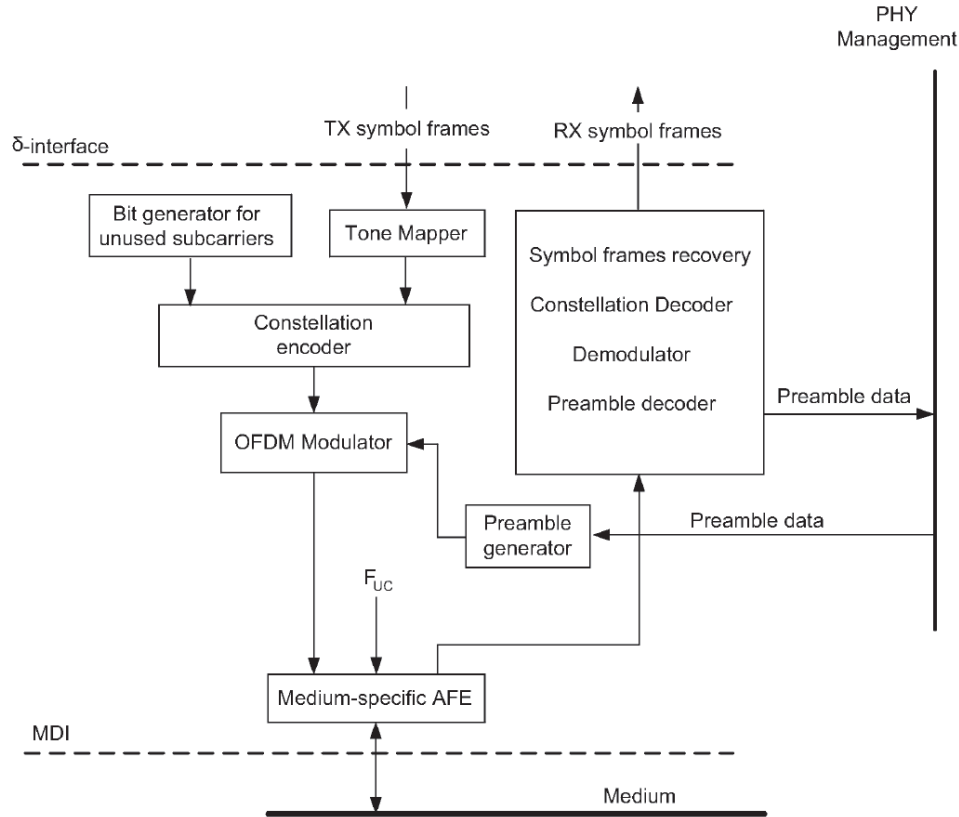
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown			
	Table 7-1/G.9960 – PHY-frame header fields			
	Field	Octet	Field Size [Bits]	Description
	FT	0	4	Frame type
	DOD	0	4	Domain ID
	SID	1	8	The device ID of the source node
	DID	2	8	The device ID of the destination node
	MI	3	1	Multicast indication identifies whether the DID is a multicast destination
	PHI	3	1	Post header indication identifies whether the first payload symbol after the header is a PRBS symbol or a data symbol
	<u>EHI</u>	<u>3</u>	<u>1</u>	<u>Extended PHY frame header indication.</u>
	<u>IREHI</u>	<u>3</u>	<u>1</u>	<u>Immediate response frame extended PHY frame header indication.</u>
	Reserved	3	<u>46</u>	Reserved by ITU-T
	Duration	4-5	16	The PHY frame transmission duration
	...	6-18		
	HCS	19-20	16	Header check sequence
		<u>21-32 [1]</u>		<u>Variable part 2 (present for extended PHY frame header only)</u>
	<u>E HCS</u>	<u>40- 41 [1]</u>	<u>16</u>	<u>Extended PHY header - header check sequence</u>
				<u>Common part (present for extended PHY frame header only)</u>
	<u>Notes</u> <u>[1] These fields are present only if the PHI bit is set.</u>			

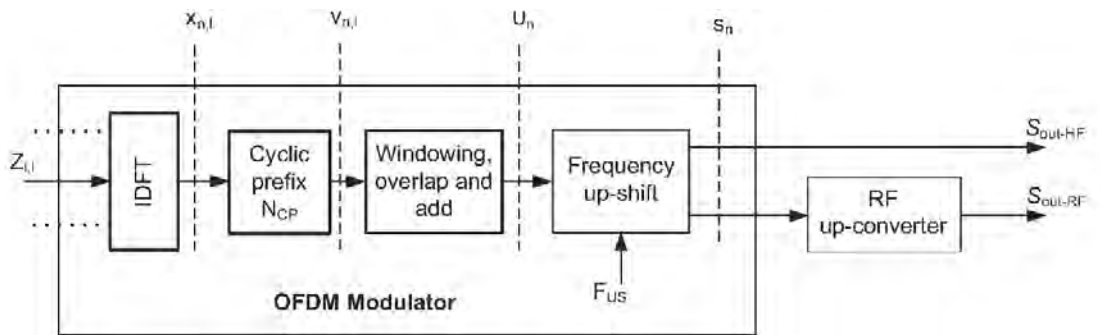
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	<u>7.1.2.3.1.8 Extended header indication (EHI)</u> The EHI field when set indicates that the PHY frame header contains 2 x PHY_H information bits. If the EHI field is zero then the header of the PHY frame contains PHY_H information bits. The EHI field shall be set to zero for all frames types except the ACK frame. In ACK frames this bit may be set to zero or one. <u>7.1.2.3.1.9 Immediate response frame extended header indication (IREHI)</u> The IREHI field when set indicates that receivers shall use for immediate response frames (ACK for example) extended PHY-frame headers. If the IREHI field is zero then immediate response frames shall use standard (non-extended) PHY-frame headers. <u>7.1.2.3.1.810 Header check sequence and Extended header check sequence (HCS and E HCS)</u> The HCS and E HCS fields are intended for PHY-frame header verification. The HCS is a 16-bit cyclic redundancy check (CRC) and shall be computed over all the fields of the first PHY_H information bits of the PHY-frame header in the order they are transmitted, starting with the MSB of the frame type (FT) field and ending with the LSB of the last field in the first PHY_H information bits of the PHY Frame. The E HCS is present only for extended PHY header frames and shall be computed over all the fields of the second set of PHY_H PHY-frame header information bits in the order they are transmitted, starting with the MSB of the first field in the second set of PHY_H information bits of the PHY-frame header and ending with the LSB of the last field in the second set of PHY_H information bits. The HCS and E HCS shall be computed using the following generator polynomial of degree 16: $G(x) = x^{16} + x^{12} + x^5 + 1.$ The value of the HCS and E HCS shall be the remainder after the contents (treated as a polynomial where the first input bit is associated with the highest degree, X^{PHY_H-1}, where PHY_H is the number of header information length in bits over which the HCS or E HCS is computed, and the last input bit is associated with X^0) of the calculation fields is multiplied by x^{16} and then divided by $G(x)$. The HCS and E HCS fields shall be transmitted starting with the coefficient of the highest order term (MSB). Brown at 80:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown					
	8.8.1 TXOP MAP message (working text) Each MAC cycle is identified by a Sequence Number (see §8.8.1) contained in the TXOP MAP message. By default, the medium access plan described by a TXOP MAP message frame is for a single MAC cycle, but it may carry persistency information related to one or more subsequent MAC cycles. The structure of the TXOP MAP message shall be as described in Figure 8-30. <table border="1"><tr><td>TXOP MAP Header</td><td>TXOP Desc [0]</td><td>...</td><td>TXOP Desc [N]</td><td>Auxiliary Information</td></tr></table> Figure 8-30/G.hn – TXOP MAP message structure The TXOP MAP message contains a TXOP MAP header (§8.8.1) followed by a number of TXOP descriptors (§8.8.2), followed by an Auxiliary Information field (§8.8.3). The number of TXOP descriptors in the TXOP MAP message as well as control and sequence information is encoded in the TXOP MAP header. The TXOP MAP message, as presented in Figure 8-30 shall be transmitted in a single B-LCDU and shall be communicated as a MAC frame with MACFT = 3. The MAP message shall be the payload of the B-LCDU. The B-LCDU containing the MAP message shall be the only data unit contained within the MAP PHY frame. The MAP frame shall not be a subject for ARQ (no ACKs shall be sent). The SSN field in the first PB in a MAP PHY frame shall be initialized to 0 and shall be incremented by 1 for each subsequent PB in the same MAP PHY frame. The SSN numbers used in PBs within a MAP PHY frame represent their own address space and shall be separate from the address space associated with other management streams. The MQF flag in the PBH shall be set to 1. The MAP frame shall be sent unencrypted and shall not carry the timestamp: the TSMPI and the CCMPI bits of the MFH of the MAP LCDU shall be set to 0. <i>Id.</i> at 81:	TXOP MAP Header	TXOP Desc [0]	...	TXOP Desc [N]	Auxiliary Information
TXOP MAP Header	TXOP Desc [0]	...	TXOP Desc [N]	Auxiliary Information		

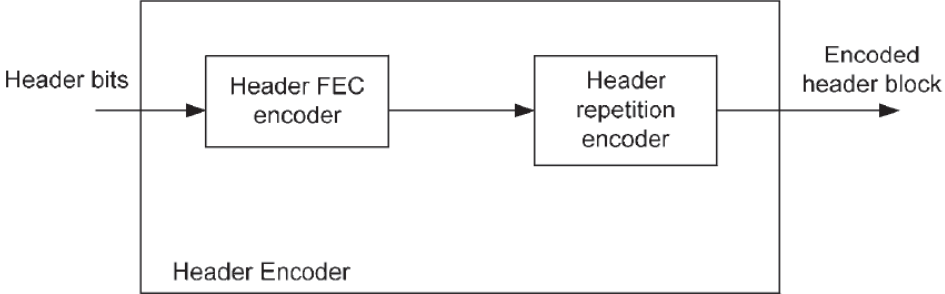
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																												
	Table 8-39/G.hn - MAP Header format <table><tr><th>Field</th><th>Octet</th><th>Bits</th><th>Description</th></tr><tr><td>Sequence Number</td><td>0</td><td>7:0</td><td>A MAP sequence number. The sequence number shall be incremented by one for each MAP transmission (modulo 256). An RMAP shall keep the sequence number of the original MAP (shall not increment the sequence number).</td></tr><tr><td>MAP Header Length</td><td>1</td><td>7:0</td><td>The length of the MAP header expressed in a number of 32 bit words.</td></tr><tr><td>Number of entries</td><td>2-3</td><td>15:0</td><td>Number of TXOP descriptors, including TXOP extensions, in the MAP.</td></tr><tr><td>MAP Modified</td><td>4</td><td>7</td><td>The domain master shall set this bit when the MAP is modified compared with the previous MAP and reset otherwise.</td></tr><tr><td>Handover In Progress (HOIP)</td><td>4</td><td>6</td><td>When set to 1, indicates that the present Domain Master is handing over its role to a newly registered node. At other times, is set to 0.</td></tr><tr><td>Reserved</td><td>4</td><td>5:3</td><td>Reserved by ITU-T</td></tr><tr><td>TICK_Factor</td><td>4</td><td>2:0</td><td>A time shift factor that shall be used to determine the resolution of a TXOP TIME_UNIT (see §8.2.3). The resolution of a TIME_UNIT is determined as follows: $\text{TIME\_UNIT} = \text{TICK} * 2^{\text{TICK\_Factor}}$ The values of TICK are defined in §8.4</td></tr><tr><td>Current Schedule Life Time (CSLT)</td><td>5</td><td>7:4</td><td>The number of consequent MAC cycles in which the TXOP schedule described in the MAP shall remain valid. The value of CSLT shall be reduced by 1 after each MAP frame with CSLT > 0</td></tr><tr><td>Future Schedule Life Time (FSLT)</td><td>5</td><td>3:0</td><td>If FSLT is non-zero, the MAP frame carries the future TXOP schedule which shall take effect when CSLT reaches zero and shall remain valid for FSLT consecutive MAC cycles after it takes effect.</td></tr><tr><td>Reserved</td><td>8-15</td><td></td><td>Reserved by ITU-T</td></tr></table>	Field	Octet	Bits	Description	Sequence Number	0	7:0	A MAP sequence number. The sequence number shall be incremented by one for each MAP transmission (modulo 256). An RMAP shall keep the sequence number of the original MAP (shall not increment the sequence number).	MAP Header Length	1	7:0	The length of the MAP header expressed in a number of 32 bit words.	Number of entries	2-3	15:0	Number of TXOP descriptors, including TXOP extensions, in the MAP.	MAP Modified	4	7	The domain master shall set this bit when the MAP is modified compared with the previous MAP and reset otherwise.	Handover In Progress (HOIP)	4	6	When set to 1, indicates that the present Domain Master is handing over its role to a newly registered node. At other times, is set to 0.	Reserved	4	5:3	Reserved by ITU-T	TICK_Factor	4	2:0	A time shift factor that shall be used to determine the resolution of a TXOP TIME_UNIT (see §8.2.3). The resolution of a TIME_UNIT is determined as follows: $\text{TIME\_UNIT} = \text{TICK} * 2^{\text{TICK\_Factor}}$ The values of TICK are defined in §8.4	Current Schedule Life Time (CSLT)	5	7:4	The number of consequent MAC cycles in which the TXOP schedule described in the MAP shall remain valid. The value of CSLT shall be reduced by 1 after each MAP frame with CSLT > 0	Future Schedule Life Time (FSLT)	5	3:0	If FSLT is non-zero, the MAP frame carries the future TXOP schedule which shall take effect when CSLT reaches zero and shall remain valid for FSLT consecutive MAC cycles after it takes effect.	Reserved	8-15		Reserved by ITU-T
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	<i>Id.</i> at 83:																																												

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	8.8.3 TXOP Descriptor (baseline text) Each TXOP is described by at least one TXOP descriptor. A TXOP descriptor is composed of basic TXOP descriptor that may be extended by one or more additional TXOP descriptor extensions (see §8.8.2.1.1 – §8.8.2.1.3). TXOP descriptor extensions supply additional information like scheduling information, timing information and TXOP attributes. Basic TXOP descriptors and TXOP descriptor extensions are each 4 octets in length. A TXOP descriptor represents the right of a certain node or a set of nodes to transmit within a certain TXOP. A CFTXOP shall be described using a single TXOP descriptor. A STXOP shall be described using several TXOP descriptors representing the TSs within the STXOP. The differentiation between different TXOPs shall be done via the TXOP Attributes extension, which shall be appended to the last TXOP descriptor of a TXOP. The TXOP Attributes extension supplies the timing information for the TXOP (see §8.8.2.1.1). A node associated with a TXOP or a /TS is uniquely identified in a TXOP descriptor by the SID field, which shall be set to the device ID of the node as was assigned by the domain master.
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference discloses the following: <i>See, e.g.,</i> G.9960 Draft at 24: The PCS provides bit rate adaptation (data flow control) between the MAC and PHY and encapsulates transmit packets into the PHY frame and adds PHY-related control and management overhead. The PMA provides encoding of PHY frame content for transmission over the medium. The PMD modulates and demodulates PHY frames for transmission over the medium using orthogonal frequency division modulation (OFDM). By implementation, the PMD may include media-dependent adaptors for different media, including frequency shifting for pass-band transmission. <i>Id.</i> at 31: In the receive direction, frames entering from the medium via the MDI are demodulated and decoded. The recovered MPDUs are forwarded to MAC via the MII. The recovered PHY-frame headers are processed in the PHY to extract the relevant frame parameters specified in §7.1.2.3. <i>Id.</i> at Fig. 7-11:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	 The diagram illustrates the functional model of the PMD (Physical Medium Dependent) layer, showing the flow of data between the δ-interface and the MDI (Medium Dependent Interface). TX Path (Transmit): TX symbol frames are received from the δ-interface. - These frames are processed by a Tone Mapper and a Constellation encoder. - The output of the Constellation encoder is sent to the OFDM Modulator. - The OFDM Modulator is also connected to a Bit generator for unused subcarriers. - The output of the OFDM Modulator is sent to the Medium-specific AFE (Analog Front End). - The Medium-specific AFE is connected to the Medium via the MDI. RX Path (Receive): - The Medium sends data to the Medium-specific AFE via the MDI. - The output of the Medium-specific AFE is sent to the Preamble generator and the Symbol frames recovery block. - The Preamble generator outputs Preamble data to the PHY Management entity. - The Symbol frames recovery block contains a Constellation Decoder and a Demodulator. - The output of the Symbol frames recovery block is sent to the δ-interface as RX symbol frames. PHY Management: - Receives Preamble data from the Preamble generator. - Sends Preamble data to the Preamble generator. Figure 7-11/G.9960 – Functional model of the PMD <i>Id.</i> at 53: In the receive direction, the frames incoming from the medium are demodulated and decoded. The recovered symbol frames are transferred to the PMA via δ-interface. The preamble is processed and preamble data are passed to the PHY management entity. <i>Id.</i> at 64:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	7.1.4.4 OFDM modulator The OFDM modulator consists of the following major parts: IDFT, cyclic extension, windowing, overlap and add, and frequency up-shift. The incoming signal to the modulator at the l-th OFDM symbol in the present frame for a single sub-carrier, with index i, is the real and imaginary parts of the value $Z_{i,l}$ generated by the Constellation encoder as described in §7.1.4.3.2 (for symbols of the header and the payload) or by Preamble Generator as described in §7.1.4.5.2.1 (for symbols of the preamble). Time-domain samples generated by the IDFT, after adding the cyclic prefix and windowing, are frequency up-shifted to the center frequency F_{US}. The functional diagram of OFDM modulator is presented in Figure 7-19. RF up-converter facilitates G.9960 operation in RF frequency range. <i>Id.</i> at Fig. 7-19:  The diagram illustrates the functional model of the OFDM modulator. It shows a sequence of processing blocks: IDFT, Cyclic prefix (N_{CP}), Windowing, overlap and add, Frequency up-shift, and RF up-converter. The input signal $Z_{i,l}$ enters the IDFT block. The output of the IDFT block is labeled $x_{n,l}$. This signal then enters the Cyclic prefix block, which outputs $v_{n,l}$. The signal then enters the Windowing, overlap and add block, which outputs u_n. The signal then enters the Frequency up-shift block, which outputs s_n. The Frequency up-shift block also receives an input F_{US}. The signal s_n then enters the RF up-converter block, which outputs S_{out-HF} and S_{out-RF}. The entire process is labeled OFDM Modulator. Figure 7-19/G.9960 – Functional model of the OFDM modulator Schrum at 1:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	Proposed is to define two one-bit fields which are assigned to bits in the PHY frame header that are currently reserved. The extended header indication (EHI) is set to indicate that the PHY header contains 2 x PHY_H information bits, allowing receivers to determine how to decode the PHY header. The immediate response frame extended header indication (IREHI) tells receivers if they should respond with a header than contains PHY_H or 2 x PHY_H information bits when transmitting immediate response frames. This allows receivers to know if sufficient time has been allocated for a immediate response frame and for nodes tracking durations to know the duration of a frame transmission sequence. If at some point the definition of the duration field is modified so that it includes immediate response frames (ACK frame), then it may be possible to eliminate the IREHI bit. This contribution proposes two HCS fields to independently protect the content of each set of PHY_H information bits in the PHY header. Two independent HCS fields results more robust protection of the header contents. It also eliminates ambiguity for receivers when determining how to decode the PHY frame header. If a single HCS field were to be defined that protected 2 x PHY_H information bits then the IREHI bit would need to be interpreted and acted on before the bit is verified with the HCS. Kol at 1: The PHY-header of a PHY-frame is defined in G.9960 [1] to contain important information necessary in order to process the payload. The information of the header is encoded in a single FEC block of 168 bits with code rate 1/2. This information is modulated unto either one or two OFDM symbols using QPSK modulation. The effective number of repetitions depends on the number of active subcarriers and on the number of header symbols (1 or 2). It is not specified what the conditions for choosing one or two symbols are. The intention is that there will be a sufficient number of repetitions of the FEC block so that some minimum level of robustness is guaranteed. A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate 1/2 a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness. Decoding a 136-bit FEC block with a BLER level of 10^{-6} requires an SNR of 5 dB or so. On the other hand, decoding a 520-byte FEC block with a BLER level of 10^{-6} requires an SNR of about 3.5 dB – some 1.5 dB less. Id. at 2:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	7.1.3.4 Header encoder The functional model of the header encoder is presented in Figure 7-10. It contains an FEC encoder and a Header Repetition Encoder (HRE).  <pre> graph LR subgraph Header_Encoder [Header Encoder] direction LR HFE[Header FEC encoder] --> HRE[Header repetition encoder] end HB[Header bits] --> HFE HRE --> EHB[Encoded header block] </pre> Figure 7-10/G.9960 – Functional diagram of the Header Encoder
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following: <i>See, e.g., G.9960 Draft at 76:</i>

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																				
	Table 7-30/G.9960 – OFDM control parameters for phone line <table><tr><th>Domain Type</th><th colspan="2">Phone Line Baseband</th></tr><tr><th>Bandplan Name</th><th>50MHz – TB (NOTE 2)</th><th>100MHz – TB (NOTE 3)</th></tr><tr><td>N</td><td>1024</td><td>2048</td></tr><tr><td>F_{SC}</td><td>48.828125 kHz</td><td>48.828125kHz</td></tr><tr><td>N_{GI}</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-HD}</td><td>$N/4 = 256$ samples @ 50 Msamples/s</td><td>$N/4 = 512$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-DF}</td><td>$N/4=256$ samples @ 50 Msamples/s</td><td>$N/4=512$ samples @ 100 Msamples/s</td></tr><tr><td>β</td><td>$N/32 = 32$ samples @ 50 Msamples/s</td><td>$N/32 = 64$ samples @ 100 Msamples/s</td></tr><tr><td>F_{US}</td><td>25 MHz</td><td>50 MHz</td></tr><tr><td>$F_C = F_{UC} + F_{US}$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td></tr><tr><td>Sub-carrier frequency f for sub-carrier index i (NOTE 1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td></tr><tr><td colspan="3">NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The range of sub-carrier frequencies is between 0 and 50 MHz 3. The range of sub-carrier frequencies is between 0 and 100 MHz</td></tr></table>	Domain Type	Phone Line Baseband		Bandplan Name	50MHz – TB (NOTE 2)	100MHz – TB (NOTE 3)	N	1024	2048	F_{SC}	48.828125 kHz	48.828125kHz	N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	N_{GI-HD}	$N/4 = 256$ samples @ 50 Msamples/s	$N/4 = 512$ samples @ 100 Msamples/s	N_{GI-DF}	$N/4=256$ samples @ 50 Msamples/s	$N/4=512$ samples @ 100 Msamples/s	β	$N/32 = 32$ samples @ 50 Msamples/s	$N/32 = 64$ samples @ 100 Msamples/s	F_{US}	25 MHz	50 MHz	$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The range of sub-carrier frequencies is between 0 and 50 MHz 3. The range of sub-carrier frequencies is between 0 and 100 MHz		
Domain Type	Phone Line Baseband																																				
Bandplan Name	50MHz – TB (NOTE 2)	100MHz – TB (NOTE 3)																																			
N	1024	2048																																			
F_{SC}	48.828125 kHz	48.828125kHz																																			
N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s																																			
N_{GI-HD}	$N/4 = 256$ samples @ 50 Msamples/s	$N/4 = 512$ samples @ 100 Msamples/s																																			
N_{GI-DF}	$N/4=256$ samples @ 50 Msamples/s	$N/4=512$ samples @ 100 Msamples/s																																			
β	$N/32 = 32$ samples @ 50 Msamples/s	$N/32 = 64$ samples @ 100 Msamples/s																																			
F_{US}	25 MHz	50 MHz																																			
$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$																																			
Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)																																			
NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The range of sub-carrier frequencies is between 0 and 50 MHz 3. The range of sub-carrier frequencies is between 0 and 100 MHz																																					
	<i>Id.</i> at 80:																																				

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																
	Table 7-33/G.9960 – OFDM control parameters for power lines <table><tr><th>Domain Type</th><th colspan="2">Power Line Baseband</th><th>Power Line Passband</th></tr><tr><th>Bandplan Name</th><th>50MHz – PB (NOTE 3)</th><th>100MHz – PB (NOTE 4)</th><th>100MHz – PP (NOTE 5)</th></tr><tr><td>N</td><td>2048</td><td>4096</td><td>1024</td></tr><tr><td>F_{SC}</td><td>24.4140625 kHz</td><td>24.4140625 kHz</td><td>97.65625 kHz</td></tr><tr><td>N_{GI}</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s</td></tr><tr><td>N_{GI-HD}</td><td>$N/4=512$ samples @ 50 Msamples/s</td><td>$N/4=1024$ samples @ 100 Msamples/s</td><td>$N/4=256$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-DF}</td><td>$N/4=512$ samples @ 50 Msamples/s</td><td>$N/4=1024$ samples @ 100 Msamples/s</td><td>$N/4=256$ samples @ 100 Msamples/s</td></tr><tr><td>β</td><td>$N/8 = 256$ samples @ 50 Msamples/s</td><td>$N/8 = 512$ samples @ 100 Msamples/s</td><td>$N/32 = 32$ samples @ 100 Msamples/s</td></tr><tr><td>F_{US}</td><td>25 MHz</td><td>50 MHz</td><td>150 MHz</td></tr><tr><td>$F_C = F_{UC} + F_{US}$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td></tr><tr><td>Sub-carrier frequency f for sub-carrier index i (NOTE 1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = F_{US} - (N/2 - i) \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td></tr><tr><td colspan="4">NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50 MHz and 100 MHz bandplans may be used by nodes operating in the same Power Line Baseband domain. 3. The range of sub-carrier frequencies is between 0 and 50 MHz 4. The range of sub-carrier frequencies is between 0 and 100 MHz 5. The range of sub-carrier frequencies is between 100 MHz and 200 MHz</td></tr></table>	Domain Type	Power Line Baseband		Power Line Passband	Bandplan Name	50MHz – PB (NOTE 3)	100MHz – PB (NOTE 4)	100MHz – PP (NOTE 5)	N	2048	4096	1024	F_{SC}	24.4140625 kHz	24.4140625 kHz	97.65625 kHz	N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s	N_{GI-HD}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s	N_{GI-DF}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s	β	$N/8 = 256$ samples @ 50 Msamples/s	$N/8 = 512$ samples @ 100 Msamples/s	$N/32 = 32$ samples @ 100 Msamples/s	F_{US}	25 MHz	50 MHz	150 MHz	$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_{UC} = 0$	Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = F_{US} - (N/2 - i) \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50 MHz and 100 MHz bandplans may be used by nodes operating in the same Power Line Baseband domain. 3. The range of sub-carrier frequencies is between 0 and 50 MHz 4. The range of sub-carrier frequencies is between 0 and 100 MHz 5. The range of sub-carrier frequencies is between 100 MHz and 200 MHz			
Domain Type	Power Line Baseband		Power Line Passband																																														
Bandplan Name	50MHz – PB (NOTE 3)	100MHz – PB (NOTE 4)	100MHz – PP (NOTE 5)																																														
N	2048	4096	1024																																														
F_{SC}	24.4140625 kHz	24.4140625 kHz	97.65625 kHz																																														
N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s																																														
N_{GI-HD}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s																																														
N_{GI-DF}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s																																														
β	$N/8 = 256$ samples @ 50 Msamples/s	$N/8 = 512$ samples @ 100 Msamples/s	$N/32 = 32$ samples @ 100 Msamples/s																																														
F_{US}	25 MHz	50 MHz	150 MHz																																														
$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_{UC} = 0$																																														
Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = F_{US} - (N/2 - i) \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)																																														
NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50 MHz and 100 MHz bandplans may be used by nodes operating in the same Power Line Baseband domain. 3. The range of sub-carrier frequencies is between 0 and 50 MHz 4. The range of sub-carrier frequencies is between 0 and 100 MHz 5. The range of sub-carrier frequencies is between 100 MHz and 200 MHz																																																	
	<i>Id.</i> at 82:																																																

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																				
	Table 7-35/G.9960 – Parameters of Limit PSD mask for bandplans 50MHz-PB and 100MHz-PB <table><tr><th>Parameters</th><th>Frequency, MHz</th><th>PSD, dBm/Hz</th><th>Note/Description</th></tr><tr><td>f_{L1}</td><td>1.1</td><td>−90</td><td>Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL</td></tr><tr><td>f_{L2}</td><td>1.8</td><td rowspan="2">−80</td><td rowspan="2">Coincides with the Amateur radio band</td></tr><tr><td>f_{L3}</td><td>2.0</td></tr><tr><td>$f_{L3} + \Delta F$</td><td>$2.0 + \Delta F$</td><td>−50</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td>f_{HAM}</td><td>As defined in Table D-1</td><td>−80</td><td>Additional notches could be added based on regional regulations</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td>$f_{H1} - \Delta F$</td><td>$30 - \Delta F$</td><td>−50</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>f_{H1}</td><td>30</td><td rowspan="2">−80</td><td rowspan="2">ΔF is an arbitrary small positive value</td></tr><tr><td>f_{H2}</td><td>$100 - \Delta F$</td></tr><tr><td>f_{H2}</td><td>100</td><td>−100</td><td></td></tr><tr><td>f_{H3}</td><td>110</td><td>−130</td><td></td></tr><tr><td>f_{H4}</td><td>120</td><td>−140</td><td></td></tr></table> NOTE – All sub-carriers below $f_{L3} + \Delta F$, and above $f_{H2} - \Delta F$, and inside the notched Amateur radio bands shall not be used for transmission (neither data nor any auxiliary information). <i>Id.</i> at 84:	Parameters	Frequency, MHz	PSD, dBm/Hz	Note/Description	f_{L1}	1.1	−90	Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL	f_{L2}	1.8	−80	Coincides with the Amateur radio band	f_{L3}	2.0	$f_{L3} + \Delta F$	$2.0 + \Delta F$	−50	ΔF is an arbitrary small positive value					f_{HAM}	As defined in Table D-1	−80	Additional notches could be added based on regional regulations					$f_{H1} - \Delta F$	$30 - \Delta F$	−50	ΔF is an arbitrary small positive value	f_{H1}	30	−80	ΔF is an arbitrary small positive value	f_{H2}	$100 - \Delta F$	f_{H2}	100	−100		f_{H3}	110	−130		f_{H4}	120	−140	
Parameters	Frequency, MHz	PSD, dBm/Hz	Note/Description																																																		
f_{L1}	1.1	−90	Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL																																																		
f_{L2}	1.8	−80	Coincides with the Amateur radio band																																																		
f_{L3}	2.0																																																				
$f_{L3} + \Delta F$	$2.0 + \Delta F$	−50	ΔF is an arbitrary small positive value																																																		
f_{HAM}	As defined in Table D-1	−80	Additional notches could be added based on regional regulations																																																		
$f_{H1} - \Delta F$	$30 - \Delta F$	−50	ΔF is an arbitrary small positive value																																																		
f_{H1}	30	−80	ΔF is an arbitrary small positive value																																																		
f_{H2}	$100 - \Delta F$																																																				
f_{H2}	100	−100																																																			
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f_{H4}	120	−140																																																			

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																							
	Table 7-37/G.9960 – OFDM control parameters for coax cables <table><tr><th>Domain Type</th><th colspan="2">Coax Baseband</th><th colspan="2">Coax RF</th></tr><tr><th>Bandplan Name</th><th>50MHz – CB (NOTE 4)</th><th>100MHz – CB (NOTE 5)</th><th>50MHz – RF (NOTE 6)</th><th>100MHz – RF (NOTE 7)</th></tr><tr><td>N</td><td>256</td><td>512</td><td>256</td><td>512</td></tr><tr><td>F_{SC}</td><td>195.3125 kHz</td><td>195.3125 kHz</td><td>195.3125 kHz</td><td>195.3125 kHz</td></tr><tr><td>N_{GI}</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-HD}</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-DF}</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td></tr><tr><td>β</td><td>$N/32=8$ samples @ 50 Msamples/s</td><td>$N/32=16$ samples @ 100 Msamples/s</td><td>$N/32=8$ samples @ 50 Msamples/s</td><td>$N/32=16$ samples @ 100 Msamples/s</td></tr><tr><td>F_{US}</td><td>25 MHz</td><td>50 MHz</td><td>25 MHz</td><td>50 MHz</td></tr><tr><td>$F_C = F_{UC} + F_{US}$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td><td>$F_C = X$ (NOTE 3)</td><td>$F_C = Y$ (NOTE 3)</td></tr><tr><td>Sub-carrier frequency f for sub-carrier index i (NOTE 1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)</td><td>indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)</td></tr></table> NOTES: - See §7.1.4.1 for more details on sub-carrier indexing rules. - The 50MHz and 100MHz bandplans may be used by nodes operating in the same Coax Baseband domain. The same principle applies to 50MHz and 100MHz bandplans defined for Coax RF domain. - The values of center frequency F_C shall be selected from the valid set defined in Table 7-28 and may be subject to regional spectrum management rules (see regional Annexes). - The range of sub-carrier frequencies is between 0 and 50 MHz - The range of sub-carrier frequencies is between 0 and 100MHz - The range of sub-carrier frequencies is between $(X - 25)$ MHz and $(X + 25)$ MHz - The range of sub-carrier frequencies is between $(Y - 50)$ MHz and $(Y + 50)$ MHz - The specific indexing rule is specified in each regional Annex.	Domain Type	Coax Baseband		Coax RF		Bandplan Name	50MHz – CB (NOTE 4)	100MHz – CB (NOTE 5)	50MHz – RF (NOTE 6)	100MHz – RF (NOTE 7)	N	256	512	256	512	F_{SC}	195.3125 kHz	195.3125 kHz	195.3125 kHz	195.3125 kHz	N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	N_{GI-HD}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	N_{GI-DF}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	β	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s	F_{US}	25 MHz	50 MHz	25 MHz	50 MHz	$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_C = X$ (NOTE 3)	$F_C = Y$ (NOTE 3)	Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)
Domain Type	Coax Baseband		Coax RF																																																					
Bandplan Name	50MHz – CB (NOTE 4)	100MHz – CB (NOTE 5)	50MHz – RF (NOTE 6)	100MHz – RF (NOTE 7)																																																				
N	256	512	256	512																																																				
F_{SC}	195.3125 kHz	195.3125 kHz	195.3125 kHz	195.3125 kHz																																																				
N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s																																																				
N_{GI-HD}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s																																																				
N_{GI-DF}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s																																																				
β	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s																																																				
F_{US}	25 MHz	50 MHz	25 MHz	50 MHz																																																				
$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_C = X$ (NOTE 3)	$F_C = Y$ (NOTE 3)																																																				
Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)																																																				
	<i>Id.</i> at 87:																																																							

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																																																																								
	Table 7-40/G.9960 – Parameters of Limit PSD mask over RF coax for bandplan 50MHz-RF <table><tr><th>Parameters</th><th>Frequency, MHz</th><th>PSD, dBm/Hz (NOTE)</th><th>Note/Description</th></tr><tr><td>$F_{UC} - f_{L1}$</td><td>75</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td>$F_{UC} - f_{L2}$</td><td>50</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$F_{UC} - f_{L3}$</td><td>35</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$F_{UC} - f_{L4}$</td><td>25</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td></td><td>$f_{L4} + \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>F_{UC}</td><td>$M*25\text{MHz}$</td><td>PSD_0</td><td></td></tr><tr><td></td><td>$f_{H1} - \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>$f_{H1} - F_{UC}$</td><td>25</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td>$f_{H2} - F_{UC}$</td><td>35</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$f_{H3} - F_{UC}$</td><td>50</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$f_{H4} - F_{UC}$</td><td>75</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td colspan="4">NOTE – $PSD_0 = -68$ dBm/Hz</td></tr></table> Table 7-41/G.9960 – Parameters of Limit PSD mask over RF coax for bandplan 100MHz-RF <table><tr><th>Parameters</th><th>Frequency, MHz</th><th>PSD, dBm/Hz (NOTE)</th><th>Note/Description</th></tr><tr><td>$F_{UC} - f_{L1}$</td><td>150</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td>$F_{UC} - f_{L2}$</td><td>100</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$F_{UC} - f_{L3}$</td><td>70</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$F_{UC} - f_{L4}$</td><td>50</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td></td><td>$f_{L4} + \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>F_{UC}</td><td>$M*25\text{MHz}$</td><td>PSD_0</td><td></td></tr><tr><td></td><td>$f_{H1} - \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>$f_{H1} - F_{UC}$</td><td>50</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td>$f_{H2} - F_{UC}$</td><td>70</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$f_{H3} - F_{UC}$</td><td>100</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$f_{H4} - F_{UC}$</td><td>150</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td colspan="4">NOTE – $PSD_0 = -68$ dBm/Hz</td></tr></table> <i>Id.</i> at 104:	Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description	$F_{UC} - f_{L1}$	75	$PSD_0 - 50$		$F_{UC} - f_{L2}$	50	$PSD_0 - 45$		$F_{UC} - f_{L3}$	35	$PSD_0 - 40$		$F_{UC} - f_{L4}$	25	$PSD_0 - 20$			$f_{L4} + \Delta F$	PSD_0	ΔF is an arbitrary small positive value	F_{UC}	$M*25\text{MHz}$	PSD_0			$f_{H1} - \Delta F$	PSD_0	ΔF is an arbitrary small positive value	$f_{H1} - F_{UC}$	25	$PSD_0 - 20$		$f_{H2} - F_{UC}$	35	$PSD_0 - 40$		$f_{H3} - F_{UC}$	50	$PSD_0 - 45$		$f_{H4} - F_{UC}$	75	$PSD_0 - 50$		NOTE – $PSD_0 = -68$ dBm/Hz				Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description	$F_{UC} - f_{L1}$	150	$PSD_0 - 50$		$F_{UC} - f_{L2}$	100	$PSD_0 - 45$		$F_{UC} - f_{L3}$	70	$PSD_0 - 40$		$F_{UC} - f_{L4}$	50	$PSD_0 - 20$			$f_{L4} + \Delta F$	PSD_0	ΔF is an arbitrary small positive value	F_{UC}	$M*25\text{MHz}$	PSD_0			$f_{H1} - \Delta F$	PSD_0	ΔF is an arbitrary small positive value	$f_{H1} - F_{UC}$	50	$PSD_0 - 20$		$f_{H2} - F_{UC}$	70	$PSD_0 - 40$		$f_{H3} - F_{UC}$	100	$PSD_0 - 45$		$f_{H4} - F_{UC}$	150	$PSD_0 - 50$		NOTE – $PSD_0 = -68$ dBm/Hz			
Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description																																																																																																						
$F_{UC} - f_{L1}$	75	$PSD_0 - 50$																																																																																																							
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	$f_{L4} + \Delta F$	PSD_0	ΔF is an arbitrary small positive value																																																																																																						
F_{UC}	$M*25\text{MHz}$	PSD_0																																																																																																							
	$f_{H1} - \Delta F$	PSD_0	ΔF is an arbitrary small positive value																																																																																																						
$f_{H1} - F_{UC}$	25	$PSD_0 - 20$																																																																																																							
$f_{H2} - F_{UC}$	35	$PSD_0 - 40$																																																																																																							
$f_{H3} - F_{UC}$	50	$PSD_0 - 45$																																																																																																							
$f_{H4} - F_{UC}$	75	$PSD_0 - 50$																																																																																																							
NOTE – $PSD_0 = -68$ dBm/Hz																																																																																																									
Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description																																																																																																						
$F_{UC} - f_{L1}$	150	$PSD_0 - 50$																																																																																																							
$F_{UC} - f_{L2}$	100	$PSD_0 - 45$																																																																																																							
$F_{UC} - f_{L3}$	70	$PSD_0 - 40$																																																																																																							
$F_{UC} - f_{L4}$	50	$PSD_0 - 20$																																																																																																							
	$f_{L4} + \Delta F$	PSD_0	ΔF is an arbitrary small positive value																																																																																																						
F_{UC}	$M*25\text{MHz}$	PSD_0																																																																																																							
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$f_{H1} - F_{UC}$	50	$PSD_0 - 20$																																																																																																							
$f_{H2} - F_{UC}$	70	$PSD_0 - 40$																																																																																																							
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Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																														
	<table><tr><th colspan="3">Table III-3/G.9960 – Frequency allocation of other services on coax cable</th></tr><tr><th>Frequency [MHz]</th><th>Usage</th><th>Remarks</th></tr><tr><td>5 – 60 *</td><td> - Upstream CATV signal (cable internet signal, VoIP, VOD, relay broadcast, pilot signal etc.) </td><td> - Being used for Cable Modem(CM) up-stream signals [6][7][8] - Being used for control signals between CM and Cable Modem Termination </td></tr><tr><td>70 – 76 *</td><td> - Downstream pilot signal, analog HT (Home Terminal) control signal, monitoring signal of amplifier </td><td> - Being used for Cable Modem(CM) up-stream signals [6][7][8] </td></tr><tr><td>76 – 90 *</td><td> - Retransmission of radio broadcasting on cable (FM radio signal) </td><td> - Being used for Cable Modem(CM) up-stream signals [8] </td></tr><tr><td>90 – 770 *</td><td> - Analog cable broadcasting (NTSC-VSB) - Digital cable broadcasting (64/256QAM) - Retransmission of terrestrial analogTV broadcasting (NTSC-VSB) - Retransmission of terrestrial digitall TV broadcasting (OFDM) - Downstream cable internet signal, VoIP, VOD control signal etc. </td><td> - Covered by regulation [4] </td></tr><tr><td>770 – 1035 **</td><td> - Other home network services </td><td></td></tr><tr><td>1035 – 2070 *</td><td> - BS-IF/CS-IF retransmission </td><td></td></tr><tr><td>>2070 **</td><td> - Currently not in use at the time of publication </td><td></td></tr><tr><td colspan="3">* Frequency band usage for G.9960 including guard band is for further study. ** Candidate frequency band for G.9960 including guard band.</td></tr></table>	Table III-3/G.9960 – Frequency allocation of other services on coax cable			Frequency [MHz]	Usage	Remarks	5 – 60 *	Upstream CATV signal (cable internet signal, VoIP, VOD, relay broadcast, pilot signal etc.)	- Being used for Cable Modem(CM) up-stream signals [6][7][8] - Being used for control signals between CM and Cable Modem Termination	70 – 76 *	Downstream pilot signal, analog HT (Home Terminal) control signal, monitoring signal of amplifier	Being used for Cable Modem(CM) up-stream signals [6][7][8]	76 – 90 *	Retransmission of radio broadcasting on cable (FM radio signal)	Being used for Cable Modem(CM) up-stream signals [8]	90 – 770 *	- Analog cable broadcasting (NTSC-VSB) - Digital cable broadcasting (64/256QAM) - Retransmission of terrestrial analogTV broadcasting (NTSC-VSB) - Retransmission of terrestrial digitall TV broadcasting (OFDM) - Downstream cable internet signal, VoIP, VOD control signal etc.	Covered by regulation [4]	770 – 1035 **	Other home network services		1035 – 2070 *	BS-IF/CS-IF retransmission		>2070 **	Currently not in use at the time of publication		* Frequency band usage for G.9960 including guard band is for further study. ** Candidate frequency band for G.9960 including guard band.		
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Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate 1/2 a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness.
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Schrum 1:</i> The immediate response frame extended header indication (IREHI) tells receivers if they should respond with a header than contains PHY_H or 2 x PHY_H information bits when transmitting immediate response frames. This allows receivers to know if sufficient time has been allocated for a immediate response frame and for nodes tracking durations to know the duration of a frame transmission sequence. If at some point the definition of the duration field is modified so that it includes immediate response frames (ACK frame), then it may be possible to eliminate the IREHI bit. This contribution proposes two HCS fields to independently protect the content of each set of PHY_H information bits in the PHY header. Two independent HCS fields results more robust protection of the header contents. It also eliminates ambiguity for receivers when determining how to decode the PHY frame header. If a single HCS field were to be defined that protected 2 x PHY_H information bits then the IREHI bit would need to be interpreted and acted on before the bit is verified with the HCS. <i>Kol at 1:</i> The contribution proposes that the number of symbols used for the header of the PHY frame on coax (baseband and RF) be fixed to two exactly. The reason for this proposal is that a single symbol does not provide adequate reliability for the 50 MHz case, as shown below.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>Schrum at 1:</i>

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
information of the first packet in the first narrower frequency band.	Proposed is to define two one-bit fields which are assigned to bits in the PHY frame header that are currently reserved. The extended header indication (EHI) is set to indicate that the PHY header contains 2 x PHY_H information bits, allowing receivers to determine how to decode the PHY header. The immediate response frame extended header indication (IREHI) tells receivers if they should respond with a header than contains PHY_H or 2 x PHY_H information bits when transmitting immediate response frames. This allows receivers to know if sufficient time has been allocated for a immediate response frame and for nodes tracking durations to know the duration of a frame transmission sequence. If at some point the definition of the duration field is modified so that it includes immediate response frames (ACK frame), then it may be possible to eliminate the IREHI bit. This contribution proposes two HCS fields to independently protect the content of each set of PHY_H information bits in the PHY header. Two independent HCS fields results more robust protection of the header contents. It also eliminates ambiguity for receivers when determining how to decode the PHY frame header. If a single HCS field were to be defined that protected 2 x PHY_H information bits then the IREHI bit would need to be interpreted and acted on before the bit is verified with the HCS. <i>Id.</i> at 2-3: 2. Proposed Text Updates <<Start Text – G.9960 Amendment I>> 7.1.2.3 PHY-frame header The PHY-frame header contains ~~is~~ PHY_H information bits ~~if the extended header information (EHI) bit is set to zero and 2 x PHY_H information bits if the EHI bit is set to one, less~~ and is composed of a common part and a variable part. The common part contains fields that are common for all PHY-frame types. The variable part contains fields according to the PHY-frame type. PHY-frame type is indicated by the FT field. The PAD fields fit the length of the header of different PHY frame-types to the standard values of PHY_H bits. The content of the header is protected by the 16-bit header check sequences (HCS, ~~and E. HCS in the case of the extended PHY header~~). The fields of the PHY-frame header are defined in Table 7-1

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown			
	Table 7-1/G.9960 – PHY-frame header fields			
	Field	Octet	Field Size [Bits]	Description
	FT	0	4	Frame type
	DOD	0	4	Domain ID
	SID	1	8	The device ID of the source node
	DID	2	8	The device ID of the destination node
	MI	3	1	Multicast indication identifies whether the DID is a multicast destination
	PHI	3	1	Post header indication identifies whether the first payload symbol after the header is a PRBS symbol or a data symbol
	<u>EHI</u>	<u>3</u>	<u>1</u>	<u>Extended PHY frame header indication.</u>
	<u>IREHI</u>	<u>3</u>	<u>1</u>	<u>Immediate response frame extended PHY frame header indication.</u>
	Reserved	3	<u>46</u>	Reserved by ITU-T
	Duration	4-5	16	The PHY frame transmission duration
	...	6-18		
	HCS	19-20	16	Header check sequence
		<u>21-32 [1]</u>		<u>Variable part 2 (present for extended PHY frame header only)</u>
	<u>E HCS</u>	<u>40- 41 [1]</u>	<u>16</u>	<u>Extended PHY header - header check sequence</u>
				<u>Common part (present for extended PHY frame header only)</u>
	Notes			
	<u>[1] These fields are present only if the PHI bit is set.</u>			

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	<u>7.1.2.3.1.8 Extended header indication (EHI)</u> The EHI field when set indicates that the PHY frame header contains 2 x PHY_H information bits. If the EHI field is zero then the header of the PHY frame contains PHY_H information bits. The EHI field shall be set to zero for all frames types except the ACK frame. In ACK frames this bit may be set to zero or one. <u>7.1.2.3.1.9 Immediate response frame extended header indication (IREHI)</u> The IREHI field when set indicates that receivers shall use for immediate response frames (ACK for example) extended PHY-frame headers. If the IREHI field is zero then immediate response frames shall use standard (non-extended) PHY-frame headers. <u>7.1.2.3.1.810 Header check sequence and Extended header check sequence (HCS and E HCS)</u> The HCS and E HCS fields are intended for PHY-frame header verification. The HCS is a 16-bit cyclic redundancy check (CRC) and shall be computed over all the fields of the first PHY_H information bits of the PHY-frame header in the order they are transmitted, starting with the MSB of the frame type (FT) field and ending with the LSB of the last field in the first PHY_H information bits of the PHY Frame. The E HCS is present only for extended PHY header frames and shall be computed over all the fields of the second set of PHY_H PHY-frame header information bits in the order they are transmitted, starting with the MSB of the first field in the second set of PHY_H information bits of the PHY-frame header and ending with the LSB of the last field in the second set of PHY_H information bits. The HCS and E HCS shall be computed using the following generator polynomial of degree 16: $G(x) = x^{16} + x^{12} + x^5 + 1.$ The value of the HCS and E HCS shall be the remainder after the contents (treated as a polynomial where the first input bit is associated with the highest degree, X^{PHY_H-1}, where PHY_H is the number of header information length in bits over which the HCS or E HCS is computed, and the last input bit is associated with X^0) of the calculation fields is multiplied by x^{16} and then divided by $G(x)$. The HCS and E HCS fields shall be transmitted starting with the coefficient of the highest order term (MSB). Kol at 1: The contribution proposes that the number of symbols used for the header of the PHY frame on coax (baseband and RF) be fixed to two exactly. The reason for this proposal is that a single symbol does not provide adequate reliability for the 50 MHz case, as shown below. Id.:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	The PHY-header of a PHY-frame is defined in G.9960 [1] to contain important information necessary in order to process the payload. The information of the header is encoded in a single FEC block of 168 bits with code rate 1/2. This information is modulated onto either one or two OFDM symbols using QPSK modulation. The effective number of repetitions depends on the number of active subcarriers and on the number of header symbols (1 or 2). It is not specified what the conditions for choosing one or two symbols are. The intention is that there will be a sufficient number of repetitions of the FEC block so that some minimum level of robustness is guaranteed. A straightforward calculation can be carried out in order to assess the required number of OFDM symbols. Let us consider the more challenging setting of 50 MHz devices on coax. Both for baseband and RF, the number of subcarriers is 256. Since the header is modulated using QPSK and rate 1/2 a single copy of the PHY-header FEC block takes 168 subcarriers. Obviously, there is only room for a single complete copy of the FEC block. This situation is problematic, because the header does not have any advantage over the payload in terms of robustness. Decoding a 136-bit FEC block with a BLER level of 10^{-6} requires an SNR of 5 dB or so. On the other hand, decoding a 520-byte FEC block with a BLER level of 10^{-6} requires an SNR of about 3.5 dB – some 1.5 dB less. <i>Id.</i> at 2-3: The FEC codeword enters the HRE. The HRE shall operate as follows: - The FEC codeword shall be first copied M times, where $M = \text{ceiling}(D \times k_H / N_{FEC})$, k_H is the number of bits to be loaded onto the OFDM symbol carrying the header, and D is the number of symbols to be used for header transmission - The encoded header block shall be formed by concatenation of M copies of the header FEC encoder output. As each codeword is cascaded to one another, the bits (b_i) within a codeword shall be cyclically shifted by 2 bits as follows: ○ The 1st FEC codeword copy shall be formed as $\{b_0, b_1, \dots, b_{N_{FEC}-2}, b_{N_{FEC}-1}\}$. ○ The 2nd FEC codeword copy shall be formed as $\{b_2, b_3, \dots, b_{N_{FEC}-1}, b_0, b_1\}$. ○ The 3rd FEC codeword copy shall be formed as $\{b_4, b_5, \dots, b_{N_{FEC}-1}, b_0, b_1, b_2, b_3\}$. ○ ...

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	○ The M^{th} FEC codeword copy, where $M > 3$, shall be formed as $\{b_{(2 \times M - 2)}, b_{(2 \times M - 1)}, \dots, b_{N_{\text{FEC}} - 1}, b_0, b_1, \dots, b_{(2 \times M - 4)}, b_{(2 \times M - 3)}\}$. Valid values of D are either 1 or 2. Details <u>for powerline and phoneline</u> are for further study. <u>For coax (baseband and RF) the number of PHY-frame header shall be two, i.e., $D = 2$.</u> NOTE: Since the coding rate used for header encoding is $\frac{1}{2}$, the number of bits in the FEC codeword is always even, and the number of bits in the encoded header block is even.
[4] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., G.9960 Draft at 76:</i>

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																				
	Table 7-30/G.9960 – OFDM control parameters for phone line <table><tr><th>Domain Type</th><th colspan="2">Phone Line Baseband</th></tr><tr><th>Bandplan Name</th><th>50MHz – TB (NOTE 2)</th><th>100MHz – TB (NOTE 3)</th></tr><tr><td>N</td><td>1024</td><td>2048</td></tr><tr><td>F_{SC}</td><td>48.828125 kHz</td><td>48.828125kHz</td></tr><tr><td>N_{GI}</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-HD}</td><td>$N/4 = 256$ samples @ 50 Msamples/s</td><td>$N/4 = 512$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-DF}</td><td>$N/4=256$ samples @ 50 Msamples/s</td><td>$N/4=512$ samples @ 100 Msamples/s</td></tr><tr><td>β</td><td>$N/32 = 32$ samples @ 50 Msamples/s</td><td>$N/32 = 64$ samples @ 100 Msamples/s</td></tr><tr><td>F_{US}</td><td>25 MHz</td><td>50 MHz</td></tr><tr><td>$F_C = F_{UC} + F_{US}$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td></tr><tr><td>Sub-carrier frequency f for sub-carrier index i (NOTE 1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td></tr><tr><td colspan="3">NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The range of sub-carrier frequencies is between 0 and 50 MHz 3. The range of sub-carrier frequencies is between 0 and 100 MHz</td></tr></table>	Domain Type	Phone Line Baseband		Bandplan Name	50MHz – TB (NOTE 2)	100MHz – TB (NOTE 3)	N	1024	2048	F_{SC}	48.828125 kHz	48.828125kHz	N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	N_{GI-HD}	$N/4 = 256$ samples @ 50 Msamples/s	$N/4 = 512$ samples @ 100 Msamples/s	N_{GI-DF}	$N/4=256$ samples @ 50 Msamples/s	$N/4=512$ samples @ 100 Msamples/s	β	$N/32 = 32$ samples @ 50 Msamples/s	$N/32 = 64$ samples @ 100 Msamples/s	F_{US}	25 MHz	50 MHz	$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The range of sub-carrier frequencies is between 0 and 50 MHz 3. The range of sub-carrier frequencies is between 0 and 100 MHz		
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	<i>Id.</i> at 80:																																				

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																
	Table 7-33/G.9960 – OFDM control parameters for power lines <table><tr><th>Domain Type</th><th colspan="2">Power Line Baseband</th><th>Power Line Passband</th></tr><tr><th>Bandplan Name</th><th>50MHz – PB (NOTE 3)</th><th>100MHz – PB (NOTE 4)</th><th>100MHz – PP (NOTE 5)</th></tr><tr><td>N</td><td>2048</td><td>4096</td><td>1024</td></tr><tr><td>F_{SC}</td><td>24.4140625 kHz</td><td>24.4140625 kHz</td><td>97.65625 kHz</td></tr><tr><td>N_{GI}</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s</td></tr><tr><td>N_{GI-HD}</td><td>$N/4=512$ samples @ 50 Msamples/s</td><td>$N/4=1024$ samples @ 100 Msamples/s</td><td>$N/4=256$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-DF}</td><td>$N/4=512$ samples @ 50 Msamples/s</td><td>$N/4=1024$ samples @ 100 Msamples/s</td><td>$N/4=256$ samples @ 100 Msamples/s</td></tr><tr><td>β</td><td>$N/8 = 256$ samples @ 50 Msamples/s</td><td>$N/8 = 512$ samples @ 100 Msamples/s</td><td>$N/32 = 32$ samples @ 100 Msamples/s</td></tr><tr><td>F_{US}</td><td>25 MHz</td><td>50 MHz</td><td>150 MHz</td></tr><tr><td>$F_C = F_{UC} + F_{US}$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td></tr><tr><td>Sub-carrier frequency f for sub-carrier index i (NOTE 1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = F_{US} - (N/2 - i) \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td></tr><tr><td colspan="4">NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50 MHz and 100 MHz bandplans may be used by nodes operating in the same Power Line Baseband domain. 3. The range of sub-carrier frequencies is between 0 and 50 MHz 4. The range of sub-carrier frequencies is between 0 and 100 MHz 5. The range of sub-carrier frequencies is between 100 MHz and 200 MHz</td></tr></table>	Domain Type	Power Line Baseband		Power Line Passband	Bandplan Name	50MHz – PB (NOTE 3)	100MHz – PB (NOTE 4)	100MHz – PP (NOTE 5)	N	2048	4096	1024	F_{SC}	24.4140625 kHz	24.4140625 kHz	97.65625 kHz	N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s	N_{GI-HD}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s	N_{GI-DF}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s	β	$N/8 = 256$ samples @ 50 Msamples/s	$N/8 = 512$ samples @ 100 Msamples/s	$N/32 = 32$ samples @ 100 Msamples/s	F_{US}	25 MHz	50 MHz	150 MHz	$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_{UC} = 0$	Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = F_{US} - (N/2 - i) \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50 MHz and 100 MHz bandplans may be used by nodes operating in the same Power Line Baseband domain. 3. The range of sub-carrier frequencies is between 0 and 50 MHz 4. The range of sub-carrier frequencies is between 0 and 100 MHz 5. The range of sub-carrier frequencies is between 100 MHz and 200 MHz			
Domain Type	Power Line Baseband		Power Line Passband																																														
Bandplan Name	50MHz – PB (NOTE 3)	100MHz – PB (NOTE 4)	100MHz – PP (NOTE 5)																																														
N	2048	4096	1024																																														
F_{SC}	24.4140625 kHz	24.4140625 kHz	97.65625 kHz																																														
N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100Msamples/s																																														
N_{GI-HD}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s																																														
N_{GI-DF}	$N/4=512$ samples @ 50 Msamples/s	$N/4=1024$ samples @ 100 Msamples/s	$N/4=256$ samples @ 100 Msamples/s																																														
β	$N/8 = 256$ samples @ 50 Msamples/s	$N/8 = 512$ samples @ 100 Msamples/s	$N/32 = 32$ samples @ 100 Msamples/s																																														
F_{US}	25 MHz	50 MHz	150 MHz																																														
$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_{UC} = 0$																																														
Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = F_{US} - (N/2 - i) \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)																																														
NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50 MHz and 100 MHz bandplans may be used by nodes operating in the same Power Line Baseband domain. 3. The range of sub-carrier frequencies is between 0 and 50 MHz 4. The range of sub-carrier frequencies is between 0 and 100 MHz 5. The range of sub-carrier frequencies is between 100 MHz and 200 MHz																																																	
	<i>Id.</i> at 82:																																																

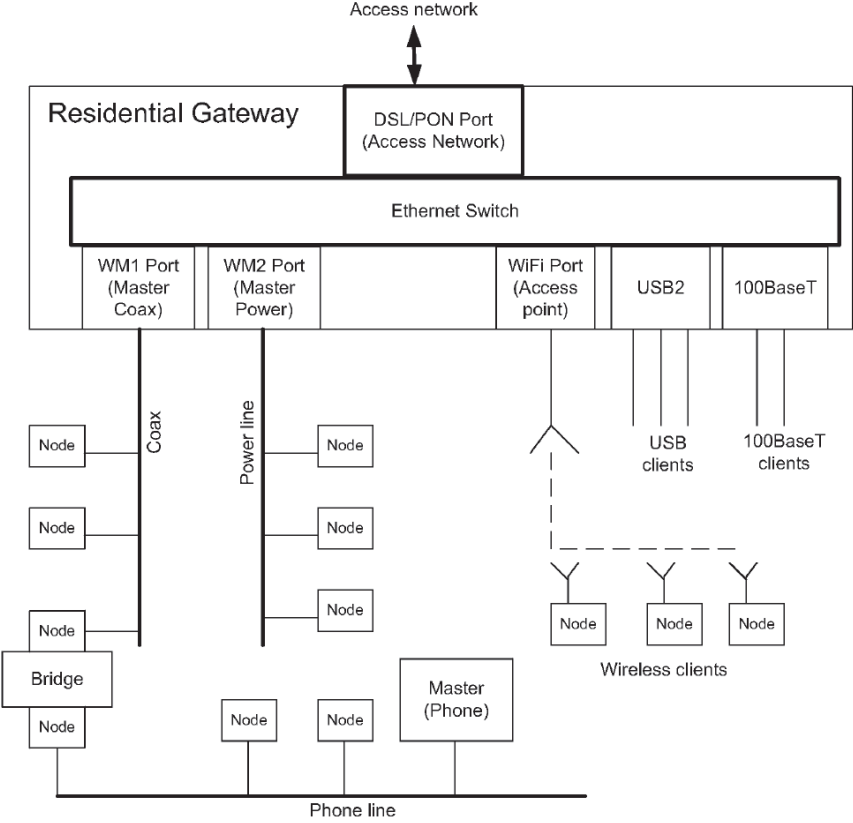
Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																				
	Table 7-35/G.9960 – Parameters of Limit PSD mask for bandplans 50MHz-PB and 100MHz-PB <table><tr><th>Parameters</th><th>Frequency, MHz</th><th>PSD, dBm/Hz</th><th>Note/Description</th></tr><tr><td>f_{L1}</td><td>1.1</td><td>-90</td><td>Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL</td></tr><tr><td>f_{L2}</td><td>1.8</td><td rowspan="2">-80</td><td rowspan="2">Coincides with the Amateur radio band</td></tr><tr><td>f_{L3}</td><td>2.0</td></tr><tr><td>$f_{L3} + \Delta F$</td><td>$2.0 + \Delta F$</td><td>-50</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td>f_{HAM}</td><td>As defined in Table D-1</td><td>-80</td><td>Additional notches could be added based on regional regulations</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td>$f_{H1} - \Delta F$</td><td>$30 - \Delta F$</td><td>-50</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>f_{H1}</td><td>30</td><td rowspan="2">-80</td><td rowspan="2">ΔF is an arbitrary small positive value</td></tr><tr><td>f_{H2}</td><td>$100 - \Delta F$</td></tr><tr><td>f_{H2}</td><td>100</td><td>-100</td><td></td></tr><tr><td>f_{H3}</td><td>110</td><td>-130</td><td></td></tr><tr><td>f_{H4}</td><td>120</td><td>-140</td><td></td></tr></table> NOTE – All sub-carriers below $f_{L3} + \Delta F$, and above $f_{H2} - \Delta F$, and inside the notched Amateur radio bands shall not be used for transmission (neither data nor any auxiliary information). <i>Id.</i> at 84:	Parameters	Frequency, MHz	PSD, dBm/Hz	Note/Description	f_{L1}	1.1	-90	Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL	f_{L2}	1.8	-80	Coincides with the Amateur radio band	f_{L3}	2.0	$f_{L3} + \Delta F$	$2.0 + \Delta F$	-50	ΔF is an arbitrary small positive value					f_{HAM}	As defined in Table D-1	-80	Additional notches could be added based on regional regulations					$f_{H1} - \Delta F$	$30 - \Delta F$	-50	ΔF is an arbitrary small positive value	f_{H1}	30	-80	ΔF is an arbitrary small positive value	f_{H2}	$100 - \Delta F$	f_{H2}	100	-100		f_{H3}	110	-130		f_{H4}	120	-140	
Parameters	Frequency, MHz	PSD, dBm/Hz	Note/Description																																																		
f_{L1}	1.1	-90	Additional reduction below 1.1 MHz is to reduce crosstalk into ADSL																																																		
f_{L2}	1.8	-80	Coincides with the Amateur radio band																																																		
f_{L3}	2.0																																																				
$f_{L3} + \Delta F$	$2.0 + \Delta F$	-50	ΔF is an arbitrary small positive value																																																		
f_{HAM}	As defined in Table D-1	-80	Additional notches could be added based on regional regulations																																																		
$f_{H1} - \Delta F$	$30 - \Delta F$	-50	ΔF is an arbitrary small positive value																																																		
f_{H1}	30	-80	ΔF is an arbitrary small positive value																																																		
f_{H2}	$100 - \Delta F$																																																				
f_{H2}	100	-100																																																			
f_{H3}	110	-130																																																			
f_{H4}	120	-140																																																			

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																							
	Table 7-37/G.9960 – OFDM control parameters for coax cables <table><tr><th>Domain Type</th><th colspan="2">Coax Baseband</th><th colspan="2">Coax RF</th></tr><tr><th>Bandplan Name</th><th>50MHz – CB (NOTE 4)</th><th>100MHz – CB (NOTE 5)</th><th>50MHz – RF (NOTE 6)</th><th>100MHz – RF (NOTE 7)</th></tr><tr><td>N</td><td>256</td><td>512</td><td>256</td><td>512</td></tr><tr><td>F_{SC}</td><td>195.3125 kHz</td><td>195.3125 kHz</td><td>195.3125 kHz</td><td>195.3125 kHz</td></tr><tr><td>N_{GI}</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s</td><td>$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-HD}</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td></tr><tr><td>N_{GI-DF}</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td><td>$N/4=64$ samples @ 50 Msamples/s</td><td>$N/4=128$ samples @ 100 Msamples/s</td></tr><tr><td>β</td><td>$N/32=8$ samples @ 50 Msamples/s</td><td>$N/32=16$ samples @ 100 Msamples/s</td><td>$N/32=8$ samples @ 50 Msamples/s</td><td>$N/32=16$ samples @ 100 Msamples/s</td></tr><tr><td>F_{US}</td><td>25 MHz</td><td>50 MHz</td><td>25 MHz</td><td>50 MHz</td></tr><tr><td>$F_C = F_{UC} + F_{US}$</td><td>$F_{UC} = 0$</td><td>$F_{UC} = 0$</td><td>$F_C = X$ (NOTE 3)</td><td>$F_C = Y$ (NOTE 3)</td></tr><tr><td>Sub-carrier frequency f for sub-carrier index i (NOTE 1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)</td><td>indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)</td><td>indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)</td></tr></table> NOTES: 1. See §7.1.4.1 for more details on sub-carrier indexing rules. 2. The 50MHz and 100MHz bandplans may be used by nodes operating in the same Coax Baseband domain. The same principle applies to 50MHz and 100MHz bandplans defined for Coax RF domain. 3. The values of center frequency F_C shall be selected from the valid set defined in Table 7-28 and may be subject to regional spectrum management rules (see regional Annexes). 4. The range of sub-carrier frequencies is between 0 and 50 MHz 5. The range of sub-carrier frequencies is between 0 and 100MHz 6. The range of sub-carrier frequencies is between $(X - 25)$ MHz and $(X + 25)$ MHz 7. The range of sub-carrier frequencies is between $(Y - 50)$ MHz and $(Y + 50)$ MHz 8. The specific indexing rule is specified in each regional Annex.	Domain Type	Coax Baseband		Coax RF		Bandplan Name	50MHz – CB (NOTE 4)	100MHz – CB (NOTE 5)	50MHz – RF (NOTE 6)	100MHz – RF (NOTE 7)	N	256	512	256	512	F_{SC}	195.3125 kHz	195.3125 kHz	195.3125 kHz	195.3125 kHz	N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	N_{GI-HD}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	N_{GI-DF}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	β	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s	F_{US}	25 MHz	50 MHz	25 MHz	50 MHz	$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_C = X$ (NOTE 3)	$F_C = Y$ (NOTE 3)	Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)
Domain Type	Coax Baseband		Coax RF																																																					
Bandplan Name	50MHz – CB (NOTE 4)	100MHz – CB (NOTE 5)	50MHz – RF (NOTE 6)	100MHz – RF (NOTE 7)																																																				
N	256	512	256	512																																																				
F_{SC}	195.3125 kHz	195.3125 kHz	195.3125 kHz	195.3125 kHz																																																				
N_{GI}	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 50 Msamples/s	$N/32 \times k$ for $k=1, \dots, 8$ samples @ 100 Msamples/s																																																				
N_{GI-HD}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s																																																				
N_{GI-DF}	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s	$N/4=64$ samples @ 50 Msamples/s	$N/4=128$ samples @ 100 Msamples/s																																																				
β	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s	$N/32=8$ samples @ 50 Msamples/s	$N/32=16$ samples @ 100 Msamples/s																																																				
F_{US}	25 MHz	50 MHz	25 MHz	50 MHz																																																				
$F_C = F_{UC} + F_{US}$	$F_{UC} = 0$	$F_{UC} = 0$	$F_C = X$ (NOTE 3)	$F_C = Y$ (NOTE 3)																																																				
Sub-carrier frequency f for sub-carrier index i (NOTE 1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	$f = i \times F_{SC}$ where $i = 0$ to $i = N - 1$ (indexing rule #1)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)	indexing rule #1 if $X \neq Y$, or indexing rule #2 if $X = Y$. (NOTE 8)																																																				
	<i>Id.</i> at 87:																																																							

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																																																																																																								
	Table 7-40/G.9960 – Parameters of Limit PSD mask over RF coax for bandplan 50MHz-RF <table><tr><th>Parameters</th><th>Frequency, MHz</th><th>PSD, dBm/Hz (NOTE)</th><th>Note/Description</th></tr><tr><td>$F_{UC} - f_{L1}$</td><td>75</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td>$F_{UC} - f_{L2}$</td><td>50</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$F_{UC} - f_{L3}$</td><td>35</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$F_{UC} - f_{L4}$</td><td>25</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td></td><td>$f_{L4} + \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>F_{UC}</td><td>$M*25\text{MHz}$</td><td>PSD_0</td><td></td></tr><tr><td></td><td>$f_{H1} - \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>$f_{H1} - F_{UC}$</td><td>25</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td>$f_{H2} - F_{UC}$</td><td>35</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$f_{H3} - F_{UC}$</td><td>50</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$f_{H4} - F_{UC}$</td><td>75</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td colspan="4">NOTE – $PSD_0 = -68$ dBm/Hz</td></tr></table> Table 7-41/G.9960 – Parameters of Limit PSD mask over RF coax for bandplan 100MHz-RF <table><tr><th>Parameters</th><th>Frequency, MHz</th><th>PSD, dBm/Hz (NOTE)</th><th>Note/Description</th></tr><tr><td>$F_{UC} - f_{L1}$</td><td>150</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td>$F_{UC} - f_{L2}$</td><td>100</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$F_{UC} - f_{L3}$</td><td>70</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$F_{UC} - f_{L4}$</td><td>50</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td></td><td>$f_{L4} + \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>F_{UC}</td><td>$M*25\text{MHz}$</td><td>PSD_0</td><td></td></tr><tr><td></td><td>$f_{H1} - \Delta F$</td><td>PSD_0</td><td>ΔF is an arbitrary small positive value</td></tr><tr><td>$f_{H1} - F_{UC}$</td><td>50</td><td>$PSD_0 - 20$</td><td></td></tr><tr><td>$f_{H2} - F_{UC}$</td><td>70</td><td>$PSD_0 - 40$</td><td></td></tr><tr><td>$f_{H3} - F_{UC}$</td><td>100</td><td>$PSD_0 - 45$</td><td></td></tr><tr><td>$f_{H4} - F_{UC}$</td><td>150</td><td>$PSD_0 - 50$</td><td></td></tr><tr><td colspan="4">NOTE – $PSD_0 = -68$ dBm/Hz</td></tr></table> <i>Id.</i> at 104:	Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description	$F_{UC} - f_{L1}$	75	$PSD_0 - 50$		$F_{UC} - f_{L2}$	50	$PSD_0 - 45$		$F_{UC} - f_{L3}$	35	$PSD_0 - 40$		$F_{UC} - f_{L4}$	25	$PSD_0 - 20$			$f_{L4} + \Delta F$	PSD_0	ΔF is an arbitrary small positive value	F_{UC}	$M*25\text{MHz}$	PSD_0			$f_{H1} - \Delta F$	PSD_0	ΔF is an arbitrary small positive value	$f_{H1} - F_{UC}$	25	$PSD_0 - 20$		$f_{H2} - F_{UC}$	35	$PSD_0 - 40$		$f_{H3} - F_{UC}$	50	$PSD_0 - 45$		$f_{H4} - F_{UC}$	75	$PSD_0 - 50$		NOTE – $PSD_0 = -68$ dBm/Hz				Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description	$F_{UC} - f_{L1}$	150	$PSD_0 - 50$		$F_{UC} - f_{L2}$	100	$PSD_0 - 45$		$F_{UC} - f_{L3}$	70	$PSD_0 - 40$		$F_{UC} - f_{L4}$	50	$PSD_0 - 20$			$f_{L4} + \Delta F$	PSD_0	ΔF is an arbitrary small positive value	F_{UC}	$M*25\text{MHz}$	PSD_0			$f_{H1} - \Delta F$	PSD_0	ΔF is an arbitrary small positive value	$f_{H1} - F_{UC}$	50	$PSD_0 - 20$		$f_{H2} - F_{UC}$	70	$PSD_0 - 40$		$f_{H3} - F_{UC}$	100	$PSD_0 - 45$		$f_{H4} - F_{UC}$	150	$PSD_0 - 50$		NOTE – $PSD_0 = -68$ dBm/Hz			
Parameters	Frequency, MHz	PSD, dBm/Hz (NOTE)	Note/Description																																																																																																						
$F_{UC} - f_{L1}$	75	$PSD_0 - 50$																																																																																																							
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Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown																											
	Table III-3/G.9960 – Frequency allocation of other services on coax cable <table><tr><th>Frequency [MHz]</th><th>Usage</th><th>Remarks</th></tr><tr><td>5 – 60 *</td><td> - Upstream CATV signal (cable internet signal, VoIP, VOD, relay broadcast, pilot signal etc.) </td><td> - Being used for Cable Modem(CM) up-stream signals [6][7][8] - Being used for control signals between CM and Cable Modem Termination </td></tr><tr><td>70 – 76 *</td><td> - Downstream pilot signal, analog HT (Home Terminal) control signal, monitoring signal of amplifier </td><td> - Being used for Cable Modem(CM) up-stream signals [6][7][8] </td></tr><tr><td>76 – 90 *</td><td> - Retransmission of radio broadcasting on cable (FM radio signal) </td><td> - Being used for Cable Modem(CM) up-stream signals [8] </td></tr><tr><td>90 – 770 *</td><td> - Analog cable broadcasting (NTSC-VSB) - Digital cable broadcasting (64/256QAM) - Retransmission of terrestrial analogTV broadcasting (NTSC-VSB) - Retransmission of terrestrial digitall TV broadcasting (OFDM) - Downstream cable internet signal, VoIP, VOD control signal etc. </td><td> - Covered by regulation [4] </td></tr><tr><td>770 – 1035 **</td><td> - Other home network services </td><td></td></tr><tr><td>1035 – 2070 *</td><td> - BS-IF/CS-IF retransmission </td><td></td></tr><tr><td>>2070 **</td><td> - Currently not in use at the time of publication </td><td></td></tr><tr><td colspan="3">* Frequency band usage for G.9960 including guard band is for further study. ** Candidate frequency band for G.9960 including guard band.</td></tr></table>	Frequency [MHz]	Usage	Remarks	5 – 60 *	Upstream CATV signal (cable internet signal, VoIP, VOD, relay broadcast, pilot signal etc.)	- Being used for Cable Modem(CM) up-stream signals [6][7][8] - Being used for control signals between CM and Cable Modem Termination	70 – 76 *	Downstream pilot signal, analog HT (Home Terminal) control signal, monitoring signal of amplifier	Being used for Cable Modem(CM) up-stream signals [6][7][8]	76 – 90 *	Retransmission of radio broadcasting on cable (FM radio signal)	Being used for Cable Modem(CM) up-stream signals [8]	90 – 770 *	- Analog cable broadcasting (NTSC-VSB) - Digital cable broadcasting (64/256QAM) - Retransmission of terrestrial analogTV broadcasting (NTSC-VSB) - Retransmission of terrestrial digitall TV broadcasting (OFDM) - Downstream cable internet signal, VoIP, VOD control signal etc.	Covered by regulation [4]	770 – 1035 **	Other home network services		1035 – 2070 *	BS-IF/CS-IF retransmission		>2070 **	Currently not in use at the time of publication		* Frequency band usage for G.9960 including guard band is for further study. ** Candidate frequency band for G.9960 including guard band.		
Frequency [MHz]	Usage	Remarks																										
5 – 60 *	Upstream CATV signal (cable internet signal, VoIP, VOD, relay broadcast, pilot signal etc.)	- Being used for Cable Modem(CM) up-stream signals [6][7][8] - Being used for control signals between CM and Cable Modem Termination																										
70 – 76 *	Downstream pilot signal, analog HT (Home Terminal) control signal, monitoring signal of amplifier	Being used for Cable Modem(CM) up-stream signals [6][7][8]																										
76 – 90 *	Retransmission of radio broadcasting on cable (FM radio signal)	Being used for Cable Modem(CM) up-stream signals [8]																										
90 – 770 *	- Analog cable broadcasting (NTSC-VSB) - Digital cable broadcasting (64/256QAM) - Retransmission of terrestrial analogTV broadcasting (NTSC-VSB) - Retransmission of terrestrial digitall TV broadcasting (OFDM) - Downstream cable internet signal, VoIP, VOD control signal etc.	Covered by regulation [4]																										
770 – 1035 **	Other home network services																											
1035 – 2070 *	BS-IF/CS-IF retransmission																											
>2070 **	Currently not in use at the time of publication																											
* Frequency band usage for G.9960 including guard band is for further study. ** Candidate frequency band for G.9960 including guard band.																												
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports one	The G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown discloses that the wireless transceiver supports one or more wireless standards. For example, the reference discloses the following: See, e.g., G.9960 Draft at 19:																											

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
or more wireless standards.	G.9960 security is designed to address operation over shared media, such as power-line and coax cable. Besides regular network admission procedures, which ensure that only permitted G.9960 nodes are allowed to join a G.9960 network via one of its domains, G.9960 defines point-to-point security, allowing authentication of each pair of nodes prior to communication and unique encryption keys for each pair of communicating nodes or per multicast group. This generally improves security by building another layer of protection against an intruder that has broken through the network admission control, and maintains full confidentiality for all communications within the network. The latter suits G.9960 to be installed in public places (hotels, small businesses, home offices), requiring at least the same grade of security and confidentiality as defined in the most recent specification for wireless LAN (IEEE 802.11-2007). <i>Id.</i> at 99: An example of HN as a part of residential broadband access is presented in Figure II-5. In the example, home network includes three domains established over coax, phone, and power line wiring. Alien domains of the network are established by the Residential Gateway and may include WLAN IEEE 802.11, USB2, and IEEE 802.3 (Ethernet). RG serves as a bridge allowing communication with Alien domains (e.g., 802.11) and with Access Network (e.g. PON or DSL). <i>Id.</i> at 100:

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
	 Figure II-5/G.9960 – Example of HN supporting residential broadband access
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim 1, preamble above.
[9.A] a wireless OFDM communications	See, e.g., claim 1, limitation 1.A above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g., claim 1, limitation 1.B above.</i>
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet	<i>See, e.g., claim 1, limitation 1.C above.</i>

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the	<i>See, e.g.</i> , Claim 2 above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
first narrower frequency band.	
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal	<i>See, e.g.</i> , claim preamble 1.PRE above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
Frequency Division Multiplexing) transceiver comprising:	
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	<i>See, e.g.</i> , claim limitation 1.A above.
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	<i>See, e.g.</i> , claim limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless transceiver of claim 17,	<i>See, e.g.</i> , Claim 4 above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
wherein the second wider frequency band is two times wider than the first narrower frequency band.	
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[24] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	See, e.g., claim limitation 1.A above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	See, e.g., claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency	See, e.g., claim limitation 1.C above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26] The method of claim 25, wherein the at least one repeated	<i>See, e.g.</i> , claim 2 above.

Claim Elements	Disclosures in the G.9960 Draft alone or in combination with Schrum, Kol, and/or Brown
header bit increases reliability of the first packet in the first narrower frequency band.	
[27] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A6

**Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent Application Publication No. 2008/021269 ("Takahashi")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under pre-AIA 35 U.S.C. § 102 as anticipated by Takahashi¹; (2) under pre-AIA 35 U.S.C. § 103 as obvious in view of Takahashi standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Takahashi in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ Takahashi was filed on February 16, 2007.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in Takahashi
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Takahashi discloses a wireless OFDM transceiver. For example, the reference discloses the following: <i>See, e.g.,</i> Takahashi ¶ [0030]: The present invention relates to a radio-communication device configured to receive a MIMO signal in a communication system applying an OFDM-modulation method for MIMO communications. More specifically, the radio-communication device is a MIMO-reception device supporting IEEE802.11n and operates, as an MM terminal configured to receive both a legacy packet used for IEEE802.11a/g and a Mixed Mode (MM) packet including the HT format used for IEEE802.11n.

Claim Elements	Disclosure in Takahashi
	<i>Id.</i> ¶ [0080]: The present invention relates to a radio-communication device configured to receive a MIMO signal, the radio-communication device being used in a communication system performing MIMO communications for which the OFDM-modulation method is used. A MIMO-reception device supporting IEEE802.11n is provided, as an example of the above-described radio-communication device. For IEEE802.11n, an operation mode “Mixed Mode (MM)” compatible with IEEE802.11a/g is being studied, as an HT mode achieving a high throughput. <i>Id.</i> ¶ [0081]: FIG. 1 shows the configuration of a digital-processing part of a MIMO-reception device according to an embodiment of the present invention. The shown reception device includes two reception antennas (not shown) and receives a MIMO signal including two spatial streams. In the following description, it is assumed that . . . the above-described reception device supports an MM packet shown in FIG. 13. <i>Id.</i> at Fig. 1:

Claim Elements	Disclosure in Takahashi
	FIG. 1 <i>Id.</i> ¶ [0083]: When an L-STF is received and a packet is found, a timing-detection unit (Timing Detector) 21 calculates synchronization timing on the basis of autocorrelation of a reception signal in the L-STF, and cross-correlation between a reception signal in an L-LTF and a known training sequence of the reception device. The digital-baseband signal can be cut from each of buffers 1 and 11 for every OFDM symbol according to the synchronization timing. <i>Id.</i> ¶¶ [0094]-[0095]: The outlines of the formats of the legacy packet, the MM packet, and the GF packet that are specified by IEEE802.11n had already been described with reference to FIGS. 12 to 14. FIGS. 2 to 4 also illustrate the above-described packet formats in consideration of the number of tones included in each of the fields.

Claim Elements	Disclosure in Takahashi
	Comparing FIG. 3 with FIG. 4, when the MM packet is received, the first to fifth OFDM symbols of the L-LTF, the L-SIG, and the HT-SIG include 52 tones. However, when the GF packet is received, the first to fifth OFDM symbols of the HT-LTF, the HT-SIG, and the 2nd HT-LTF include 56 tones. That is to say, when comparing the GF packet with the MM packet in terms of the frequency area, each of the first to fifth OFDM symbols of the GF packet is added with two subcarriers at both ends, when compared to the corresponding fields of the MM-packet. <i>Id.</i>, claim 1: 1. A radio-communication device performing packet-reception processing in a communication environment where packets generated in different formats traffic, the radio-communication device comprising: signal-reception means configured to receive a transfer signal transmitted from a packet-transmission source via an antenna; data-decoding means configured to decode a signal received by the signal-reception means; data-processing means configured to process data decoded by the data-decoding means; format-determination means configured to determine a packet format on the basis of the signal received by the signal-reception means; and control means configured to stop an operation of the data-decoding means when the data-processing means does not support the packet format determined by the format-determination means, the operation being performed in a field that comes after the determination is made.
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a	Takahashi discloses a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference discloses the following: <i>See, e.g.</i>, Takahashi ¶ [0004]: For example, where IEEE802.11a/g is used, an OFDM (Orthogonal Frequency Division Multiplexing) modulation method which is one of multi-carrier systems is used, as an ordinary standard of wireless LANs. According to the OFDM-modulation method, transmission data is split across a plurality of carriers to which frequencies that are orthogonal to one another are set, and transferred. Therefore, the

Claim Elements	Disclosure in Takahashi
first number of OFDM symbols that carry a first plurality of header bits;	band of each of the carriers becomes narrow and the frequency-usage efficiency significantly increases, which achieves high endurance for a frequency-selective-phasing interference. <i>Id.</i> ¶¶ [0008]-[0011]: FIGS. 12 to 14 show packet formats used in the operation modes including the legacy mode, the MM, and the GF, respectively. However, in each of the drawings, a single OFDM symbol is determined to be 4 microseconds. The format of a packet used in the legacy mode shown in FIG. 12 (hereinafter referred to as a “legacy packet”) is entirely the same as that of IEEE802.11a/g. The header portion of the legacy packet has an L-STF (Legacy Short Training Field) including a known OFDM symbol provided, so as to find a packet, an L-LTF (Legacy Long Training Field) including a known training symbol provided, so as to perform synchronization acquisition and equalization, and an L-SIG (Legacy SIGNAL Field) wherein the transfer rate and/or the data length is written, as a legacy preamble. Subsequently, a payload (Data) is transmitted. Further, the header portion of a packet shown in FIG. 13 (hereinafter referred to as an “MM packet”) includes a legacy preamble generated in a format which is entirely the same as that used for IEEE802.11a/g, a subsequent preamble generated in a format which is typically used for IEEE802.11n (hereinafter referred to as an “HT format”) (hereinafter referred to as an “HT preamble”), and a data portion. In the MM packet, the portion corresponding to a PHY payload provided in the legacy packet is generated in the HT format, and it may be considered that the HT preamble and the PHY payload are provided in the HT format, reflexively. The HT preamble includes an HT-SIG, an HT-STF, and an HT-LTF. In the HT-SIG, information necessary to understand the HT format is written, the information showing an MCS and/or the payload-data length used for the PHY payload (PSDU). Further, the HT-STF includes a training symbol provided, so as to increase AGC (automatic-gain control) in a MIMO system. Further, the HT-LTF includes a training symbol provided, so as to perform channel estimation for every input signal subjected to spatial modulation (mapping) on the reception-device side. <i>Id.</i> at Fig. 13:

Claim Elements	Disclosure in Takahashi
	FIG. 13  <i>Id.</i> ¶ [0016]: First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for IEEE802.11a. LTF OFDM symbols used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (1) and (2), respectively. <i>Id.</i> ¶¶ [0092]-[0094]: For example, the difference between the number of tones included in OFDM symbols of fields of the MM packet and that of tones included in OFDM symbols of fields of the GF packet can be noted, as the difference between the format of the MM packet and that of the GF packet. In IEEE802.11n EWC PHY Specification, the number of tones of an OFDM symbol included in each of fields of the legacy part and the HT part of a packet is specified, as shown in the following tables (refer to Non-Patent Document 1).

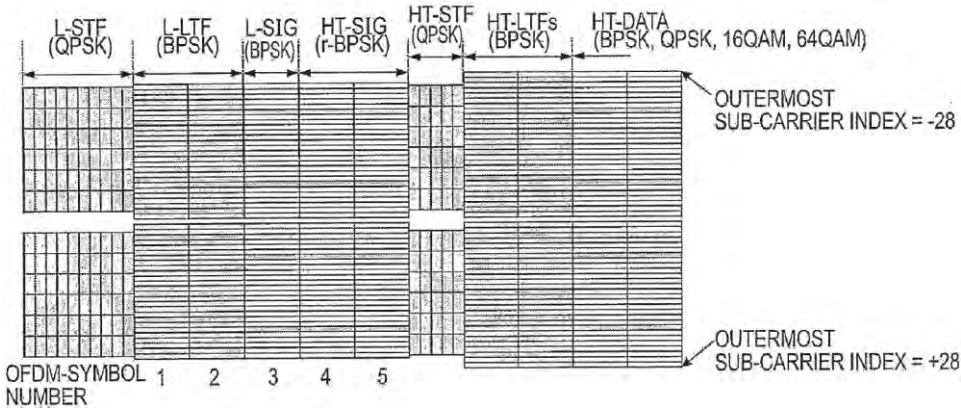
Claim Elements	Disclosure in Takahashi																																					
	TABLE 1 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>L-STF</td><td>12</td><td>24</td></tr><tr><td>L-LTF</td><td>52</td><td>104</td></tr><tr><td>L-SIG</td><td>52</td><td>104</td></tr></table> TABLE 2 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>HT-SIG</td><td>52/56*</td><td>104/114*</td></tr><tr><td>HT-STF</td><td>12</td><td>24</td></tr><tr><td>HT-LTF</td><td>56</td><td>114</td></tr><tr><td>HT-Data</td><td>56</td><td>114</td></tr><tr><td>HT-Data-40 MHz</td><td>—</td><td>104</td></tr><tr><td>Dup. Format</td><td></td><td></td></tr></table> In Table 2, the number of tones included in the HT-SIG of the MM packet is 52 and/or 104, and that of the GF packet is 56 and/or 104. The outlines of the formats of the legacy packet, the MM packet, and the GF packet that are specified by IEEE802.11n had already been described with reference to FIGS. 12 to 14. FIGS. 2 to 4 also illustrate the above-described packet formats in consideration of the number of tones included in each of the fields. <i>Id.</i> ¶ [0132]: When the MM packet is used, the fourth to fifth OFDM symbols of the reception packet correspond to the HT-SIG field, as shown in FIG. 3. Therefore, the controller 30 can determine the format of the reception packet by referring to the result of decoding the corresponding field, the decoding being performed by the decoding unit 26, and detecting an error caused by the CRC. <i>Id.</i> ¶¶ [0134]-[0135]: FIG. 11 shows the steps of communication operations performed by the radio-communication device in the form of a flowchart, where the packet-format determination is made in fields from the L-SIG on down on the basis of the difference between the positions where the HT-SIGs appear. In that case, the	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	L-STF	12	24	L-LTF	52	104	L-SIG	52	104	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	HT-SIG	52/56*	104/114*	HT-STF	12	24	HT-LTF	56	114	HT-Data	56	114	HT-Data-40 MHz	—	104	Dup. Format		
Field	$N_{\text{Field}}^{\text{Tone}}$																																					
	20 MHz	40 MHz																																				
L-STF	12	24																																				
L-LTF	52	104																																				
L-SIG	52	104																																				
Field	$N_{\text{Field}}^{\text{Tone}}$																																					
	20 MHz	40 MHz																																				
HT-SIG	52/56*	104/114*																																				
HT-STF	12	24																																				
HT-LTF	56	114																																				
HT-Data	56	114																																				
HT-Data-40 MHz	—	104																																				
Dup. Format																																						

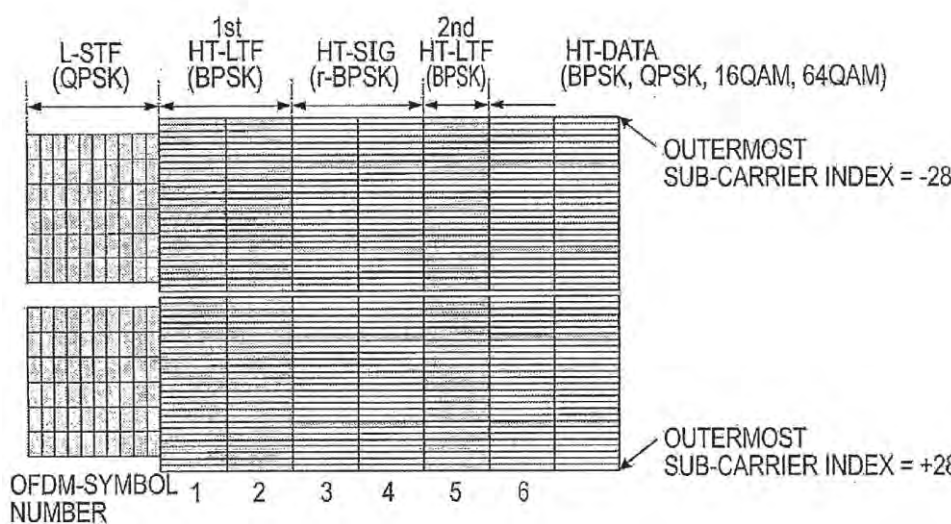
Claim Elements	Disclosure in Takahashi
	radio-communication device performs reception processing based on the premise that the reception packet is generated in the MM-packet format. When the radio-communication device finds a packet by receiving the L-STF field while the radio-communication device waits for the data reception (step S21), the radio-communication device tries to receive and decode the subsequent L-SIG field (step S22). <i>Id.</i> at Abstract: An OFDM symbol including 52 tones is transmitted when the MM packet is used, but an OFDM symbol including 56 tones is transmitted when the GF packet is used. Therefore, it is verified whether or not a signal exists in an FFT output at each of ± 27 and 28 shown in a subcarrier index so that the format of the reception packet is determined. Otherwise, the packet format is determined on the basis of the Cyclic-Shift amount that changes for every format. When the GF packet is used, decoding processing performed in an L-SIG and afterward is stopped.
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is	Takahashi discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. For example, the reference discloses the following: <i>See, e.g.,</i> Takahashi ¶ [0013]: The legacy preamble provided in the MM packet is generated in a format which is entirely the same as that of the preamble of the legacy packet and transferred in a transfer method so that the legacy terminal can decode the legacy preamble. On the other hand, the HT-format portion that comes after the HT preamble is transferred in a transfer method that is not supported by the legacy terminal. The legacy terminal decodes the L-SIG included in the legacy preamble of the MM packet and reads information showing that the MM packet is not addressed to itself, data-length information, and so forth, and sets an NAV (Network Allocation Vector) of an appropriate length, that is, a transmission-wait-time period, so as to avoid a collision. As a result, the MM packet can achieve compatibility with the legacy terminal. However, since the MM packet has the legacy-preamble portion, the format of the MM packet becomes redundant and the MM packet becomes disadvantageous in terms of a throughput. <i>Id.</i> ¶ [0059]:

Claim Elements	Disclosure in Takahashi
repeated on a plurality of OFDM subcarriers;	FIG. 9 shows a mechanism to perform BPSK modulation for the HT-SIG field in phase space rotated by as much as 90 degrees with reference to an L-SIG field. <i>Id.</i> at Fig. 9: FIG. 9  <i>Id.</i> ¶ [0082]: From an RF-processing unit which is not shown, two digital-baseband signals A and B are input, where the two digital-baseband signals A and B are obtained by performing RF processing for a reception signal of each of the reception antennas. On the shown digital-processing part's side, the above-described digital-baseband signals are MIMO-synthesized and separated into two independent spatial streams. Each of the streams is demodulated, and subjected to deinterleave, depuncturing, and channel decoding. After that, an original bit matrix is output. <i>Id.</i> ¶ [0088]: MIMO-synthesized stream signals are transmitted to equalization-and-phase-tracking unit (Equalize & Phase-Timing Track) 4 and 14, respectively, and subjected to correction processing including residual-frequency offset and phase tracking. Then, in demodulation units (Demapper) 5 and 15, the stream signals are demodulated from modulation points to original values on phase space (constellation), and decoded to original data sequences by a decoding unit (Decoder) 26.

Claim Elements	Disclosure in Takahashi
	<i>Id.</i> ¶¶ [0094]-[0096]: FIGS. 2 to 4 also illustrate the above-described packet formats in consideration of the number of tones included in each of the fields. Comparing FIG. 3 with FIG. 4, when the MM packet is received, the first to fifth OFDM symbols of the L-LTF, the L-SIG, and the HT-SIG include 52 tones. However, when the GF packet is received, the first to fifth OFDM symbols of the HT-LTF, the HT-SIG, and the 2nd HT-LTF include 56 tones. That is to say, when comparing the GF packet with the MM packet in terms of the frequency area, each of the first to fifth OFDM symbols of the GF packet is added with two subcarriers at both ends, when compared to the corresponding fields of the MM-packet. Therefore, a controller 30 determines whether or not a signal is included in an output transmitted from each of the FFTs 3 and 13, at ± 27 and 28 shown in the subcarrier index. If the signal is included in each of the above-described subcarrier indexes, it can be estimated that the received packet is the GF packet. Otherwise, it can be estimated that the received packet is the MM packet. <i>Id.</i> at Fig. 2:

Claim Elements	Disclosure in Takahashi
	FIG. 2 <i>Id.</i> at Fig. 3:

Claim Elements	Disclosure in Takahashi
	FIG. 3  <i>Id.</i> at Fig. 4:

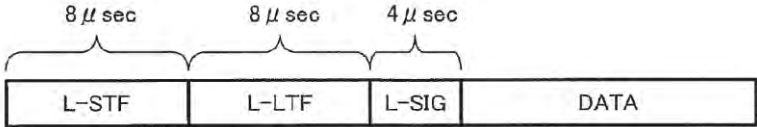
Claim Elements	Disclosure in Takahashi
	FIG. 4  <i>Id.</i> ¶ [0108]: If it is determined that the reception packet is not the GF packet, the L-SIG field following the L-LTF field is received and decoded (step S3), and parity check is performed (step S4). If a parity error occurs, at that time, the decoding processing performed in subsequent fields is stopped. <i>Id.</i> ¶ [0113]: Further, if it is determined that the reception packet is the MM packet (Yes at step S6), the OFDM symbol following the L-SIG is determined to be the HT-SIG and subjected to the decoding processing (step S7). Then, training of AGC (not shown in FIG. 1) is performed by using the HT-STF field and training of a channel matrix H is performed in the 2nd HT-LTF (step S8). <i>Id.</i> ¶ [0119]: The essence of the above-described embodiment is that the position of the OFDM symbol of the MM packet, the OFDM symbol being obtained by performing the phase rotation and the BPSK modulation, is

Claim Elements	Disclosure in Takahashi
	different from that of the OFDM symbol of the GF packet, the OFDM symbol being obtained by performing the phase rotation and the BPSK modulation. When comparing FIG. 3 with FIG. 4 again, where the MM packet is used, the BPSK modulation with the phase rotation of 90 degrees is performed for the fourth to fifth OFDM symbols corresponding to the HT-SIG. However, where the GF packet is used, the BPSK modulation with the phase rotation of 90 degrees is performed for the third to fourth OFDM symbols corresponding to the HT-SIG. Therefore, the controller 30 can determine the format of a reception packet by using any of the following methods by referring to the result of decoding performed by the decoding unit 26. <i>Id.</i> ¶ [0128]: Therefore, the controller 30 refers to a result of decoding the third OFDM symbol, the decoding being performed by the decoding unit 26, and performs parity check on the premise that the L-SIG is used. <i>Id.</i> ¶¶ [0130]-[0132]: As shown in FIG. 8, the HT-SIG includes the first-half HT-SIG1 and the latter-half HT-SIG2. The 0 to 23 bits of the HT-SIG1 and the 0 to 9 bits of the HT-SIG2 are subjected to CRC protection by using a CRC field of 7 bits including the tenth to seventeenth bits of the HT-SIG2. For reference, a calculation method provided, so as to detect a CRC error occurring in the HT-SIG, is shown in the following expression and FIG. 10. [0131] [Expression 5] $crc(D)=M(D)D^8 \text{ modulo } G(D) \quad (5)$ When the MM packet is used, the fourth to fifth. OFDM symbols of the reception packet correspond to the HT-SIG field, as shown in FIG. 3. Therefore, the controller 30 can determine the format of the reception packet by referring to the result of decoding the corresponding field, the decoding being performed by the decoding unit 26, and detecting an error caused by the CRC. <i>Id.</i> ¶¶ [0016]-[0017]: First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for

Claim Elements	Disclosure in Takahashi
	IEEE802.11a. LTF OFDM symbols used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (1) and (2), respectively. [Expression 1] $L_{-26,26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, \quad (1)$ $1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1,$ $-1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1\}$ [Expression 2] $L_{-58,58} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, \quad (2)$ $-1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1,$ $-1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 0, 0, 0, 0, 00,$ $0, 0, 0, 0, 0, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, -1,$ $-1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1,$ $1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1\}$ Further, HT-LTF sequences used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (3) and (4), respectively. [Expression 3] $HTLTF_{-28,28} = \begin{bmatrix} 1, 1, 1, 1, -1, 1, 1, -1, 1, -1, 1, \\ 1, 1, 1, 1, 1, -1, 1, -1, 1, 1, 1, 0, \\ 1, -1, -1, 1, 1, -1, 1, -1, 1, \\ -1, -1, -1, -1, 1, 1, -1, -1, 1, \\ -1, 1, -1, 1, 1, 1, 1, -1, -1 \end{bmatrix} \quad (3)$

Claim Elements	Disclosure in Takahashi
	[Expression 4] $HTLTF_{-58,58} = \quad (4)$ $\{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, \\ 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, \\ -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, \\ 00, 0 - 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, \\ -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, \\ 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\}$ <i>Id.</i> ¶ [0019]: After that, when the MM packet is used, the L-SIG is received. However, when the GF packet is used, the HT-SIG is received (refer to FIGS. 13 and 14). FIG. 15 shows the format of an L-SIG field. As shown in the drawing, the L-SIG includes the mechanism used for the parity check (even parity for 0 to 16 bits is performed at the 17th bit in the decreasing order). However, since only a single bit is provided, the possibility of erroneously receiving the HT-SIG included in the GF packet, as the L-SIG, is not insignificant. Further, when the HT-SIG is confused with the L-SIG, 5 to 16 of the HT-SIG of the first symbol are read, as Length. Here, when the value read, as Length is longer than the real packet length, the retransmission time delays, which induces inefficient communications. Further, if the MM packet is confused with the GF packet, an unnecessary field is decoded, which wastes operation power of the device. <i>Id.</i> at Fig. 15:

Claim Elements	Disclosure in Takahashi
	FIG. 15 Rate (4 bits) R1 R2 R3 R4 0 1 2 3 R 4 Length (12 bits) 5 6 7 8 9 10 11 12 13 14 15 16 P 17 Tail (6 bits) "0" "0" "0" "0" "0" "0" 18 19 20 21 22 23
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits, different than	Takahashi discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following: See, e.g., Takahashi ¶¶ [0008]-[0009]: FIGS. 12 to 14 show packet formats used in the operation modes including the legacy mode, the MM, and the GF, respectively. However, in each of the drawings, a single OFDM symbol is determined to be 4 microseconds. The format of a packet used in the legacy mode shown in FIG. 12 (hereinafter referred to as a “legacy packet”) is entirely the same as that of IEEE802.11a/g. The header portion of the legacy packet has an L-STF (Legacy Short Training Field) including a known OFDM symbol provided, so as to find a packet, an L-LTF (Legacy Long Training Field) including a known training symbol provided, so as to perform synchronization acquisition and equalization, and an L-SIG (Legacy SIGNAL Field) wherein the transfer rate and/or the data length is written, as a legacy preamble. Subsequently, a payload (Data) is transmitted. Id. at Fig. 12:

Claim Elements	Disclosure in Takahashi
the first plurality of header bits;	FIG. 12  <i>Id.</i> ¶ [0016]: First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for IEEE802.11a. LTF OFDM symbols used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (1) and (2), respectively. <i>Id.</i> ¶¶ [0092]-[0094]: For example, the difference between the number of tones included in OFDM symbols of fields of the MM packet and that of tones included in OFDM symbols of fields of the GF packet can be noted, as the difference between the format of the MM packet and that of the GF packet. In IEEE802.11n EWC PHY Specification, the number of tones of an OFDM symbol included in each of fields of the legacy part and the HT part of a packet is specified, as shown in the following tables (refer to Non-Patent Document 1).

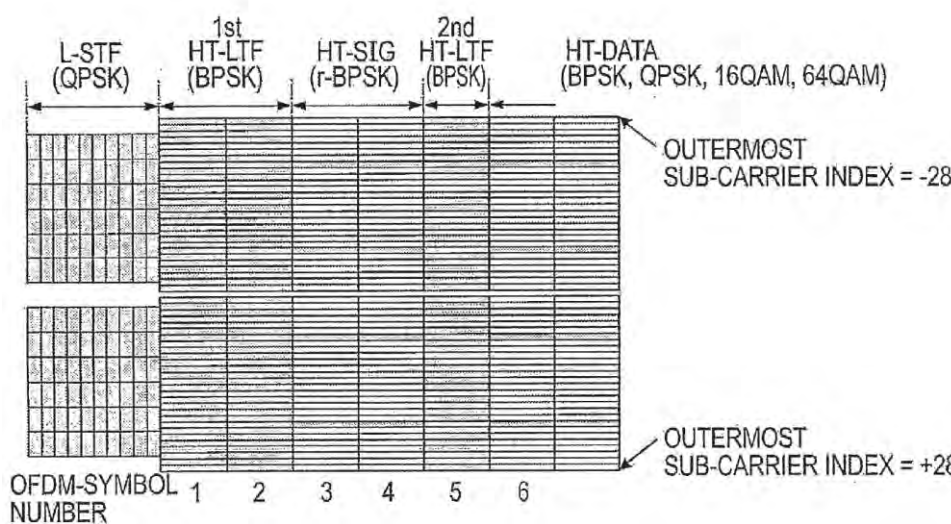
Claim Elements	Disclosure in Takahashi																																					
	TABLE 1 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>L-STF</td><td>12</td><td>24</td></tr><tr><td>L-LTF</td><td>52</td><td>104</td></tr><tr><td>L-SIG</td><td>52</td><td>104</td></tr></table> TABLE 2 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>HT-SIG</td><td>52/56*</td><td>104/114*</td></tr><tr><td>HT-STF</td><td>12</td><td>24</td></tr><tr><td>HT-LTF</td><td>56</td><td>114</td></tr><tr><td>HT-Data</td><td>56</td><td>114</td></tr><tr><td>HT-Data-40 MHz</td><td>—</td><td>104</td></tr><tr><td>Dup. Format</td><td></td><td></td></tr></table> In Table 2, the number of tones included in the HT-SIG of the MM packet is 52 and/or 104, and that of the GF packet is 56 and/or 104. The outlines of the formats of the legacy packet, the MM packet, and the GF packet that are specified by IEEE802.11n had already been described with reference to FIGS. 12 to 14. FIGS. 2 to 4 also illustrate the above-described packet formats in consideration of the number of tones included in each of the fields. <i>Id.</i> ¶ [0132]: When the MM packet is used, the fourth to fifth OFDM symbols of the reception packet correspond to the HT-SIG field, as shown in FIG. 3. Therefore, the controller 30 can determine the format of the reception packet by referring to the result of decoding the corresponding field, the decoding being performed by the decoding unit 26, and detecting an error caused by the CRC. <i>Id.</i> ¶¶ [0134]-[0135]: FIG. 11 shows the steps of communication operations performed by the radio-communication device in the form of a flowchart, where the packet-format determination is made in fields from the L-SIG on down on the basis of the difference between the positions where the HT-SIGs appear. In that case, the	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	L-STF	12	24	L-LTF	52	104	L-SIG	52	104	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	HT-SIG	52/56*	104/114*	HT-STF	12	24	HT-LTF	56	114	HT-Data	56	114	HT-Data-40 MHz	—	104	Dup. Format		
Field	$N_{\text{Field}}^{\text{Tone}}$																																					
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HT-SIG	52/56*	104/114*																																				
HT-STF	12	24																																				
HT-LTF	56	114																																				
HT-Data	56	114																																				
HT-Data-40 MHz	—	104																																				
Dup. Format																																						

Claim Elements	Disclosure in Takahashi
	radio-communication device performs reception processing based on the premise that the reception packet is generated in the MM-packet format. When the radio-communication device finds a packet by receiving the L-STF field while the radio-communication device waits for the data reception (step S21), the radio-communication device tries to receive and decode the subsequent L-SIG field (step S22).
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Takahashi discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference discloses the following: <i>See, e.g.,</i> Takahashi ¶ [0013]: The legacy preamble provided in the MM packet is generated in a format which is entirely the same as that of the preamble of the legacy packet and transferred in a transfer method so that the legacy terminal can decode the legacy preamble. On the other hand, the HT-format portion that comes after the HT preamble is transferred in a transfer method that is not supported by the legacy terminal. The legacy terminal decodes the L-SIG included in the legacy preamble of the MM packet and reads information showing that the MM packet is not addressed to itself, data-length information, and so forth, and sets an NAV (Network Allocation Vector) of an appropriate length, that is, a transmission-wait-time period, so as to avoid a collision. As a result, the MM packet can achieve compatibility with the legacy terminal. However, since the MM packet has the legacy-preamble portion, the format of the MM packet becomes redundant and the MM packet becomes disadvantageous in terms of a throughput. <i>Id.</i> ¶ [0059]: FIG. 9 shows a mechanism to perform BPSK modulation for the HT-SIG field in phase space rotated by as much as 90 degrees with reference to an L-SIG field. <i>Id.</i> at Fig. 9:

Claim Elements	Disclosure in Takahashi
	FIG. 9  <i>Id.</i> ¶ [0082]: From an RF-processing unit which is not shown, two digital-baseband signals A and B are input, where the two digital-baseband signals A and B are obtained by performing RF processing for a reception signal of each of the reception antennas. On the shown digital-processing part's side, the above-described digital-baseband signals are MIMO-synthesized and separated into two independent spatial streams. Each of the streams is demodulated, and subjected to deinterleave, depuncturing, and channel decoding. After that, an original bit matrix is output. <i>Id.</i> ¶ [0088]: MIMO-synthesized stream signals are transmitted to equalization-and-phase-tracking unit (Equalize & Phase-Timing Track) 4 and 14, respectively, and subjected to correction processing including residual-frequency offset and phase tracking. Then, in demodulation units (Demapper) 5 and 15, the stream signals are demodulated from modulation points to original values on phase space (constellation), and decoded to original data sequences by a decoding unit (Decoder) 26. <i>Id.</i> ¶¶ [0094]-[0096]: FIGS. 2 to 4 also illustrate the above-described packet formats in consideration of the number of tones included in each of the fields.

Claim Elements	Disclosure in Takahashi
	Comparing FIG. 3 with FIG. 4, when the MM packet is received, the first to fifth OFDM symbols of the L-LTF, the L-SIG, and the HT-SIG include 52 tones. However, when the GF packet is received, the first to fifth OFDM symbols of the HT-LTF, the HT-SIG, and the 2nd HT-LTF include 56 tones. That is to say, when comparing the GF packet with the MM packet in terms of the frequency area, each of the first to fifth OFDM symbols of the GF packet is added with two subcarriers at both ends, when compared to the corresponding fields of the MM-packet. Therefore, a controller 30 determines whether or not a signal is included in an output transmitted from each of the FFTs 3 and 13, at ± 27 and 28 shown in the subcarrier index. If the signal is included in each of the above-described subcarrier indexes, it can be estimated that the received packet is the GF packet. Otherwise, it can be estimated that the received packet is the MM packet. <i>Id.</i> at Fig. 2: FIG. 2 <i>Id.</i> at Fig. 3:

Id. at Fig. 4:

Claim Elements	Disclosure in Takahashi
	FIG. 4  <i>Id.</i> ¶ [0108]: If it is determined that the reception packet is not the GF packet, the L-SIG field following the L-LTF field is received and decoded (step S3), and parity check is performed (step S4). If a parity error occurs, at that time, the decoding processing performed in subsequent fields is stopped. <i>Id.</i> ¶ [0113]: Further, if it is determined that the reception packet is the MM packet (Yes at step S6), the OFDM symbol following the L-SIG is determined to be the HT-SIG and subjected to the decoding processing (step S7). Then, training of AGC (not shown in FIG. 1) is performed by using the HT-STF field and training of a channel matrix H is performed in the 2nd HT-LTF (step S8). <i>Id.</i> ¶ [0119]: The essence of the above-described embodiment is that the position of the OFDM symbol of the MM packet, the OFDM symbol being obtained by performing the phase rotation and the BPSK modulation, is

Claim Elements	Disclosure in Takahashi
	different from that of the OFDM symbol of the GF packet, the OFDM symbol being obtained by performing the phase rotation and the BPSK modulation. When comparing FIG. 3 with FIG. 4 again, where the MM packet is used, the BPSK modulation with the phase rotation of 90 degrees is performed for the fourth to fifth OFDM symbols corresponding to the HT-SIG. However, where the GF packet is used, the BPSK modulation with the phase rotation of 90 degrees is performed for the third to fourth OFDM symbols corresponding to the HT-SIG. Therefore, the controller 30 can determine the format of a reception packet by using any of the following methods by referring to the result of decoding performed by the decoding unit 26. <i>Id.</i> ¶ [0128]: Therefore, the controller 30 refers to a result of decoding the third OFDM symbol, the decoding being performed by the decoding unit 26, and performs parity check on the premise that the L-SIG is used. <i>Id.</i> ¶¶ [0130]-[0132]: As shown in FIG. 8, the HT-SIG includes the first-half HT-SIG1 and the latter-half HT-SIG2. The 0 to 23 bits of the HT-SIG1 and the 0 to 9 bits of the HT-SIG2 are subjected to CRC protection by using a CRC field of 7 bits including the tenth to seventeenth bits of the HT-SIG2. For reference, a calculation method provided, so as to detect a CRC error occurring in the HT-SIG, is shown in the following expression and FIG. 10. [0131] [Expression 5] $crc(D)=M(D)D^8 \text{ modulo } G(D) \quad (5)$ When the MM packet is used, the fourth to fifth. OFDM symbols of the reception packet correspond to the HT-SIG field, as shown in FIG. 3. Therefore, the controller 30 can determine the format of the reception packet by referring to the result of decoding the corresponding field, the decoding being performed by the decoding unit 26, and detecting an error caused by the CRC.
[1.E] wherein the first narrower and second wider frequency bands	Takahashi discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following: <i>See, e.g.,</i> Takahashi ¶ [0016]:

Claim Elements	Disclosure in Takahashi
have one or more overlapping frequency regions.	First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for IEEE802.11a. LTF OFDM symbols used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (1) and (2), respectively. <i>Id.</i> ¶ [0017]: Further, HT-LTF sequences used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (3) and (4), respectively. <i>Id.</i> ¶ [0036]: More specifically, each of fields including the L-LTF, the L-SIG, and the HT-SIG corresponding to the first to fifth OFDM symbols of the MM packet includes 52 tones. On the other hand, each of fields including the HT-LTF, the HT-SIG, and the 2nd HT-LTF corresponding to the first to fifth OFDM symbols of the GF packet includes 56 tones. Therefore, in the first to fifth OFDM symbols of the reception packet, it is verified whether or not a signal exists in an FFT output at ± 27 and 28 shown in a subcarrier index, so that the format of the reception packet can be determined. <i>Id.</i> ¶¶ [0092]-[0095]: For example, the difference between the number of tones included in OFDM symbols of fields of the MM packet and that of tones included in OFDM symbols of fields of the GF packet can be noted, as the difference between the format of the MM packet and that of the GF packet. In IEEE802.11n EWC PHY Specification, the number of tones of an OFDM symbol included in each of fields of the legacy part and the HT part of a packet is specified, as shown in the following tables (refer to Non-Patent Document 1).

Claim Elements	Disclosure in Takahashi																																					
	TABLE 1 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>L-STF</td><td>12</td><td>24</td></tr><tr><td>L-LTF</td><td>52</td><td>104</td></tr><tr><td>L-SIG</td><td>52</td><td>104</td></tr></table> TABLE 2 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>HT-SIG</td><td>52/56*</td><td>104/114*</td></tr><tr><td>HT-STF</td><td>12</td><td>24</td></tr><tr><td>HT-LTF</td><td>56</td><td>114</td></tr><tr><td>HT-Data</td><td>56</td><td>114</td></tr><tr><td>HT-Data-40 MHz</td><td>—</td><td>104</td></tr><tr><td>Dup. Format</td><td></td><td></td></tr></table> In Table 2, the number of tones included in the HT-SIG of the MM packet is 52 and/or 104, and that of the GF packet is 56 and/or 104. The outlines of the formats of the legacy packet, the MM packet, and the GF packet that are specified by IEEE802.11n had already been described with reference to FIGS. 12 to 14. FIGS. 2 to 4 also illustrate the above-described packet formats in consideration of the number of tones included in each of the fields. Comparing FIG. 3 with FIG. 4, when the MM packet is received, the first to fifth OFDM symbols of the L-LTF, the L-SIG, and the HT-SIG include 52 tones. However, when the GF packet is received, the first to fifth OFDM symbols of the HT-LTF, the HT-SIG, and the 2nd HT-LTF include 56 tones. That is to say, when comparing the GF packet with the MM packet in terms of the frequency area, each of the first to fifth OFDM symbols of the GF packet is added with two subcarriers at both ends, when compared to the corresponding fields of the MM-packet. <i>Id.</i> ¶ [0099]:	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	L-STF	12	24	L-LTF	52	104	L-SIG	52	104	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	HT-SIG	52/56*	104/114*	HT-STF	12	24	HT-LTF	56	114	HT-Data	56	114	HT-Data-40 MHz	—	104	Dup. Format		
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Claim Elements	Disclosure in Takahashi
	Further, it becomes possible to detect a small difference between the symbol power generated in the case where 52 tones (or 104 tones) are used and that generated in the case where 56 tones (or 114 tones) are used, and determine the format of the reception packet on the basis of the detection result. <i>Id.</i> ¶ [0128]: Therefore, the controller 30 refers to a result of decoding the third OFDM symbol, the decoding being performed by the decoding unit 26, and performs parity check on the premise that the L-SIG is used. When an error occurs, the controller 30 can estimate that the MM packet is not used, but the GF packet is used.
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Takahashi discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Takahashi Id.</i> ¶ [0016]: First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for IEEE802.11a. <i>Id.</i> ¶ [0019]: After that, when the MM packet is used, the L-SIG is received. However, when the GF packet is used, the HT-SIG is received (refer to FIGS. 13 and 14). FIG. 15 shows the format of an L-SIG field. As shown in the drawing, the L-SIG includes the mechanism used for the parity check (even parity for 0 to 16 bits is performed at the 17th bit in the decreasing order). However, since only a single bit is provided, the possibility of erroneously receiving the HT-SIG included in the GF packet, as the L-SIG, is not insignificant. Further, when the HT-SIG is confused with the L-SIG, 5 to 16 of the HT-SIG of the first symbol are read, as Length. Here, when the value read, as Length is longer than the real packet length, the retransmission time delays, which induces inefficient communications. Further, if the MM packet is confused with the GF packet, an unnecessary field is decoded, which wastes operation power of the device. <i>Id.</i> ¶ [0044]:

Claim Elements	Disclosure in Takahashi
	Further, it becomes possible to determine whether or not the reception packet is generated in the MM-packet format according to whether or not parity check performed in the L-SIG field included in the legacy part of the MM packet is successful. Further, CRC check is performed by using data obtained by decoding the OFDM symbol corresponding to the HT-SIG field in the MM packet. The accuracy of the format determination can be increased by using results of the above-described processing in combination. <i>Id.</i> ¶ [0101]: When the MIMO communications are performed, an intended beam is generated while signals that are the same as each other and/or similar to each other are transferred through different spatial streams. Therefore, for IEEE802.11n, a method of setting a time difference between the transmission time corresponding to one spatial stream and that corresponding to the other spatial stream is studied, where the time difference is set by the transmission device (refer to Non-Patent Document 1, for example). (Adding a time-difference signal to a spatial stream is referred to as “Cyclic Shift” and/or “Cyclic Delay Diversity (CDD)”. <i>Id.</i> ¶ [0128]: Therefore, the controller 30 refers to a result of decoding the third OFDM symbol, the decoding being performed by the decoding unit 26, and performs parity check on the premise that the L-SIG is used. <i>Id.</i> ¶¶ [0130]-[0132]: As shown in FIG. 8, the HT-SIG includes the first-half HT-SIG1 and the latter-half HT-SIG2. The 0 to 23 bits of the HT-SIG1 and the 0 to 9 bits of the HT-SIG2 are subjected to CRC protection by using a CRC field of 7 bits including the tenth to seventeenth bits of the HT-SIG2. For reference, a calculation method provided, so as to detect a CRC error occurring in the HT-SIG, is shown in the following expression and FIG. 10. [0131] [Expression 5] $crc(D)=M(D)D^8 \text{ modulo } G(D) \quad (5)$ When the MM packet is used, the fourth to fifth. OFDM symbols of the reception packet correspond to the HT-SIG field, as shown in FIG. 3. Therefore, the controller 30 can determine the format of the

Claim Elements	Disclosure in Takahashi
	reception packet by referring to the result of decoding the corresponding field, the decoding being performed by the decoding unit 26, and detecting an error caused by the CRC.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Takahashi discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Takahashi Id.</i> ¶ [0016]: First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for IEEE802.11a. <i>Id.</i> ¶ [0019]: After that, when the MM packet is used, the L-SIG is received. However, when the GF packet is used, the HT-SIG is received (refer to FIGS. 13 and 14). FIG. 15 shows the format of an L-SIG field. As shown in the drawing, the L-SIG includes the mechanism used for the parity check (even parity for 0 to 16 bits is performed at the 17th bit in the decreasing order). However, since only a single bit is provided, the possibility of erroneously receiving the HT-SIG included in the GF packet, as the L-SIG, is not insignificant. Further, when the HT-SIG is confused with the L-SIG, 5 to 16 of the HT-SIG of the first symbol are read, as Length. Here, when the value read, as Length is longer than the real packet length, the retransmission time delays, which induces inefficient communications. Further, if the MM packet is confused with the GF packet, an unnecessary field is decoded, which wastes operation power of the device. <i>Id.</i> ¶ [0044]: Further, it becomes possible to determine whether or not the reception packet is generated in the MM-packet format according to whether or not parity check performed in the L-SIG field included in the legacy part of the MM packet is successful. Further, CRC check is performed by using data obtained by decoding the OFDM symbol corresponding to the HT-SIG field in the MM packet. The accuracy of the format determination can be increased by using results of the above-described processing in combination.

Claim Elements	Disclosure in Takahashi
	<i>Id.</i> ¶ [0101]: When the MIMO communications are performed, an intended beam is generated while signals that are the same as each other and/or similar to each other are transferred through different spatial streams. Therefore, for IEEE802.11n, a method of setting a time difference between the transmission time corresponding to one spatial stream and that corresponding to the other spatial stream is studied, where the time difference is set by the transmission device (refer to Non-Patent Document 1, for example). (Adding a time-difference signal to a spatial stream is referred to as “Cyclic Shift” and/or “Cyclic Delay Diversity (CDD)”. <i>Id.</i> ¶ [0128]: Therefore, the controller 30 refers to a result of decoding the third OFDM symbol, the decoding being performed by the decoding unit 26, and performs parity check on the premise that the L-SIG is used. <i>Id.</i> ¶¶ [0130]-[0132]: As shown in FIG. 8, the HT-SIG includes the first-half HT-SIG1 and the latter-half HT-SIG2. The 0 to 23 bits of the HT-SIG1 and the 0 to 9 bits of the HT-SIG2 are subjected to CRC protection by using a CRC field of 7 bits including the tenth to seventeenth bits of the HT-SIG2. For reference, a calculation method provided, so as to detect a CRC error occurring in the HT-SIG, is shown in the following expression and FIG. 10. [0131] [Expression 5] $crc(D)=M(D)D^8 \text{ modulo } G(D) \quad (5)$ When the MM packet is used, the fourth to fifth. OFDM symbols of the reception packet correspond to the HT-SIG field, as shown in FIG. 3. Therefore, the controller 30 can determine the format of the reception packet by referring to the result of decoding the corresponding field, the decoding being performed by the decoding unit 26, and detecting an error caused by the CRC.
[4] The wireless transceiver of claim 1, wherein the second wider frequency band	Takahashi discloses that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g.</i>, Takahashi ¶ [0074]-[0075]: <i>Id.</i> ¶ [0016]:

Claim Elements	Disclosure in Takahashi																																					
is two times wider than the first narrower frequency band.	First, since the first L-STF of the MM packet is the same as that of the GF packet, the MM terminal can receive the first L-STF without any problem. However, as for subsequent fields, the L-LTF is received, in the case where the MM packet is used. However, the HT-LTF is received in the case where the GF packet is used (refer to FIG. 13 and FIG. 14). The L-LTF is the same as an LTF symbol used for IEEE802.11a. LTF OFDM symbols used at the 20-MHz-operation time and the 40-MHz-operation time are shown by the following expressions (1) and (2), respectively. <i>Id.</i> ¶¶ [0092]-[0093]: For example, the difference between the number of tones included in OFDM symbols of fields of the MM packet and that of tones included in OFDM symbols of fields of the GF packet can be noted, as the difference between the format of the MM packet and that of the GF packet. In IEEE802.11n EWC PHY Specification, the number of tones of an OFDM symbol included in each of fields of the legacy part and the HT part of a packet is specified, as shown in the following tables (refer to Non-Patent Document 1). TABLE 1 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>L-STF</td><td>12</td><td>24</td></tr><tr><td>L-LTF</td><td>52</td><td>104</td></tr><tr><td>L-SIG</td><td>52</td><td>104</td></tr></table> TABLE 2 <table><tr><th rowspan="2">Field</th><th colspan="2">$N_{\text{Field}}^{\text{Tone}}$</th></tr><tr><th>20 MHz</th><th>40 MHz</th></tr><tr><td>HT-SIG</td><td>52/56*</td><td>104/114*</td></tr><tr><td>HT-STF</td><td>12</td><td>24</td></tr><tr><td>HT-LTF</td><td>56</td><td>114</td></tr><tr><td>HT-Data</td><td>56</td><td>114</td></tr><tr><td>HT-Data-40 MHz</td><td>—</td><td>104</td></tr><tr><td>Dup. Format</td><td></td><td></td></tr></table> In Table 2, the number of tones included in the HT-SIG of the MM packet is 52 and/or 104, and that of the GF packet is 56 and/or 104.	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	L-STF	12	24	L-LTF	52	104	L-SIG	52	104	Field	$N_{\text{Field}}^{\text{Tone}}$		20 MHz	40 MHz	HT-SIG	52/56*	104/114*	HT-STF	12	24	HT-LTF	56	114	HT-Data	56	114	HT-Data-40 MHz	—	104	Dup. Format		
Field	$N_{\text{Field}}^{\text{Tone}}$																																					
	20 MHz	40 MHz																																				
L-STF	12	24																																				
L-LTF	52	104																																				
L-SIG	52	104																																				
Field	$N_{\text{Field}}^{\text{Tone}}$																																					
	20 MHz	40 MHz																																				
HT-SIG	52/56*	104/114*																																				
HT-STF	12	24																																				
HT-LTF	56	114																																				
HT-Data	56	114																																				
HT-Data-40 MHz	—	104																																				
Dup. Format																																						

Claim Elements	Disclosure in Takahashi
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Takahashi discloses that the wireless transceiver supports one or more wireless standards. For example, the reference discloses the following: <i>See, e.g.,</i> Takahashi ¶ [0002]: More specifically, the present invention relates to a radio-communication device and a radio-communication method performing reception operations in Mixed Mode that supports IEEE802.11n and that is compatible with IEEE802.11a/g.
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.,</i> claim 1, preamble above.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a	<i>See, e.g.,</i> claim 1, limitation 1.A above.

Claim Elements	Disclosure in Takahashi
first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	See, e.g., claim 1, limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a	See, e.g., claim 1, limitation 1.C above.

Claim Elements	Disclosure in Takahashi
second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first	<i>See, e.g.</i> , claim 1, limitation 1.E above.

Claim Elements	Disclosure in Takahashi
narrower and second wider frequency bands have one or more overlapping frequency regions.	
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in Takahashi
correctly decoding header information of the first packet in the first narrower frequency band.	
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM	<i>See, e.g.</i> , claim preamble 1.PRE above.

Claim Elements	Disclosure in Takahashi
(Orthogonal Frequency Division Multiplexing) transceiver comprising:	
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	See, e.g., claim limitation 1.A above.
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of	See, e.g., claim limitation 1.B above.

Claim Elements	Disclosure in Takahashi
header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	<i>See, e.g., claim limitation 1.C above.</i>

Claim Elements	Disclosure in Takahashi
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless	<i>See, e.g.</i> , Claim 4 above.

Claim Elements	Disclosure in Takahashi
transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[24] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in Takahashi
decoding header information of the first packet in the first narrower frequency band.	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a	See, e.g., claim limitation 1.A above.

Claim Elements	Disclosure in Takahashi
first number of OFDM symbols;	
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency band, by the	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Takahashi
wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.,</i> claim limitation 1.D above.

Claim Elements	Disclosure in Takahashi
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosure in Takahashi
increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A7

Defendant's Invalidity Contentions Comparing the Asserted Claims of U.S. Patent No. 9,584,262 to IEEE 802.11 Wireless LANs TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 (May 18, 2005) ("2005 802.11n TGn Sync Specification") Alone or in Combination With PHY Updates to TGn Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005) ("2005 TGn Sync PHY Updates"), TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 (August 13, 2004) ("TGnSync 2004"), and/or TGn Sync Complete Proposal, Document No. IEEE 802.11-04/888r9 (March 4, 2005)("2005 TGn Sync Proposal") (collectively "TGn Sync Proposal")

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by the TGn Sync Proposal¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of the TGn Sync Proposal standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of the TGn Sync Proposal in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 was published and made publicly available at least as early as May 18, 2005; TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 was published and made publicly available at least as early as August 13, 2004.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 8,675,754 to Yonge, III et al. (“Yonge”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in the TGn Sync Proposal
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	The TGn Sync Proposal disclosed a wireless OFDM transceiver. For example, the reference disclosed: “Our proposal support full backwards compatibility with existing 802.11a/b/g standards. Our preamble design support PHY layer interoperability with the OFDM preamble from 802.11a/g, while providing a robust mechanism for synchronization of the high throughput data.”

Claim Elements	Disclosure in the TGn Sync Proposal
	[TGn Sync Proposal 2005 at 17]

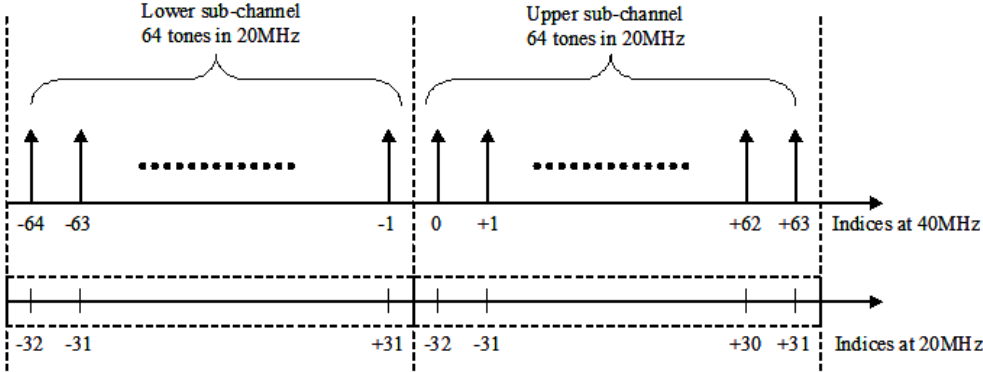
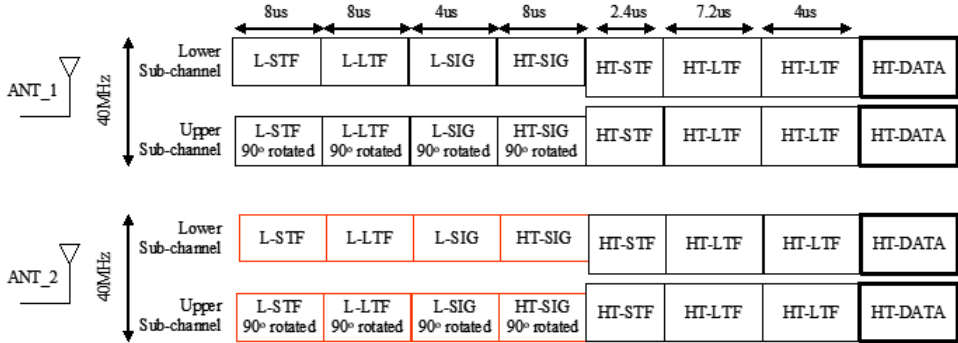
Claim Elements	Disclosure in the TGn Sync Proposal
	Table 18: Summary of OFDM parameters 11.1.1.2.1 Direct Map MIMO Overview Direct map MIMO is the simplest antenna mapping transformation. The Q-matrix is simply the identity mapping, <u>i.e.</u> each spatial stream maps to one antenna. Hence, there is a one-to-one correspondence between spatial streams and transmit antennas. Figure 22 illustrates the simplified datapath for direct map MIMO. <pre> graph LR Input(()) --> Split(()) Split --> P1[] Split --> P2[] Split --> P3[] P1 --> FI1[frequency interleaver] P1 --> QM1[QAM mapping] P1 --> IFFT1[IFFT] P1 --> IG1[Insert GI] P1 --> ARF1[analog & RF] P1 --> Ant1(()) P2 --> FI2[frequency interleaver] P2 --> QM2[QAM mapping] P2 --> IFFT2[IFFT] P2 --> IG2[Insert GI] P2 --> ARF2[analog & RF] P2 --> Ant2(()) P3 --> FI3[frequency interleaver] P3 --> QM3[QAM mapping] P3 --> IFFT3[IFFT] P3 --> IG3[Insert GI] P3 --> ARF3[analog & RF] P3 --> Ant3(()) Ant1 --> Output(()) Ant2 --> Output Ant3 --> Output </pre> N_{ss} spatial streams = N_{tx} antenna streams Figure 22: Direct Map MIMO. 11.1.1.2.2 Spatial Spreading Direct map MIMO only utilizes as many antennas as there are spatial streams; that is $N_{ss} = N_{tx}$. Spatial spreading is one way to map spatial streams when the number of spatial streams is less than the number of transmitting antennas; that is $N_{ss} \leq N_{tx}$. The basic spatial spreading function is achieved using the first N_{ss} columns of a fixed $N_{tx} \times N_{tx}$ unitary matrix $\mathbf{W}$. The same matrix $\mathbf{W}$ is used for all subcarriers. <u>Typically</u> one uses the Walsh matrix for $N_{tx} = 2$ and 4, or the Fourier matrix for $N_{tx} = 3$. A problem with this basic spatial spreading function is that it can result in undesired beamforming effects. To mitigate this effect, time-domain cyclic delays are applied to OFDM symbols prior to GI insertion. The first antenna is not delayed. Linearly increasing cyclic delays are then applied to the remaining antennas. In addition to mitigating undesired beamforming, the cyclic delays can also yield some performance improvement via transmit diversity. Thus, the method is referred to as Cyclic Delay Diversity (CDD). Since the unitary spatial spreading matrix is typically the Walsh matrix, this method is often called “Walsh+CDD.” [TGn Sync Proposal 2005 at 72]

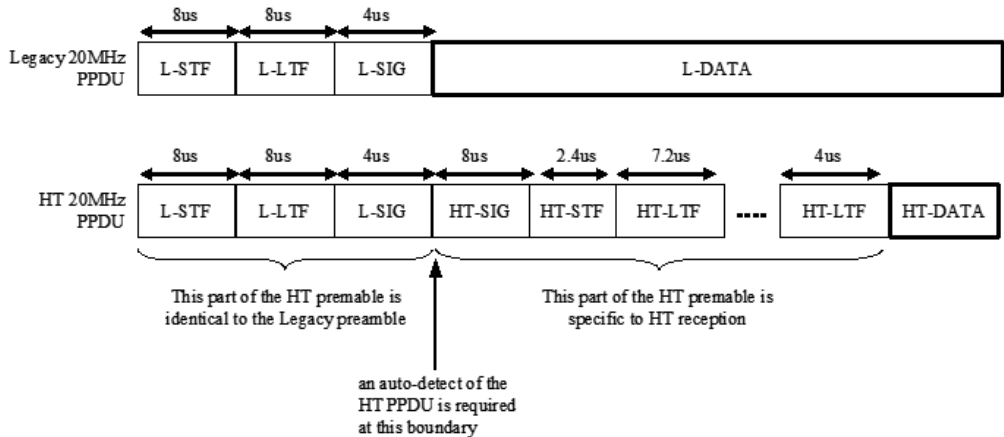
Claim Elements	Disclosure in the TGn Sync Proposal																																							
	11 MIMO-OFDM HT PHY specification 11.1 Overview 11.1.1 Introduction (Informative) The PHY layer introduces several techniques for increasing the rate and reliability of the wireless link, as shown in Table 17: <table><tr><th>Feature</th><th>Mandatory</th><th>Optional</th></tr><tr><td>Number of Spatial Streams</td><td>1 and 2</td><td>3 and 4</td></tr><tr><td>Number of Transmit Antennas</td><td>2</td><td>Greater than 2</td></tr><tr><td>Channelization bandwidth</td><td>20MHz</td><td>40MHz</td></tr><tr><td>Number of Occupied Subcarriers</td><td>56 in 20MHz</td><td>114 in 40MHz</td></tr><tr><td>Number of Data Subcarriers</td><td>52</td><td>108</td></tr><tr><td>Number of Pilot Subcarriers</td><td>4</td><td>6</td></tr><tr><td>Modulation Order</td><td>BPSK, QPSK, 16-QAM, 64-QAM</td><td>256-QAM</td></tr><tr><td>Code Rate</td><td>1/2, 2/3, 3/4, 5/6</td><td></td></tr><tr><td>Guard Interval</td><td>800ns</td><td>400ns</td></tr><tr><td>Convolutional Coding</td><td>R=1/2, K=7, (g₁=133₈, g₂=171₈)</td><td></td></tr><tr><td>LDPC</td><td></td><td>TX and RX Optional</td></tr><tr><td>TX Beamforming</td><td></td><td>TX and RX Optional</td></tr></table> Table 17: PHY Feature Set [2005 802.11n TGn Sync Specification at 70]	Feature	Mandatory	Optional	Number of Spatial Streams	1 and 2	3 and 4	Number of Transmit Antennas	2	Greater than 2	Channelization bandwidth	20MHz	40MHz	Number of Occupied Subcarriers	56 in 20MHz	114 in 40MHz	Number of Data Subcarriers	52	108	Number of Pilot Subcarriers	4	6	Modulation Order	BPSK, QPSK, 16-QAM, 64-QAM	256-QAM	Code Rate	1/2, 2/3, 3/4, 5/6		Guard Interval	800ns	400ns	Convolutional Coding	R=1/2, K=7, (g ₁ =133 ₈ , g ₂ =171 ₈)		LDPC		TX and RX Optional	TX Beamforming		TX and RX Optional
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TX Beamforming		TX and RX Optional																																						

Claim Elements	Disclosure in the TGn Sync Proposal
	11.2.1.3 Legacy Protection All MIMO transmissions are protected against legacy OFDM devices at the physical <u>layer, and</u> protected against legacy CCK/DSSS devices at the MAC layer. The legacy short training field, the legacy long training field and the legacy signal field are transmitted such that a legacy OFDM receiver (802.11g or 802.11a) <u>is able to</u> “understand” these fields. In the basic MIMO mode, the transmitter selects the Modulation Coding Scheme either based on conventional rate selection heuristics or via implicit or explicit feedback. Thus, the RATE and LENGTH fields in the legacy signal field can be “spoofed” to allow the legacy OFDM receivers to correctly set their NAV. [TGn Sync Proposal 2005 at 87]

Claim Elements	Disclosure in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PHY Summary of TGn Sync Proposal • Basic configuration delivers 243 Mbps using only two antennas – Follows historical trend of 5x for 802.11 (.11 → .11b → .11a/g) • Higher optional PHY data rate rates (>600 Mbps) for future generation devices • MIMO evolution of 802.11 OFDM PHY with spatial division multiplexing of spatial streams • Multiple antennas (2 mandatory, greater than 2 optional) • Preamble designed for seamless interoperability with legacy 802.11a/g • Wider bandwidth options with fully interoperable 20 MHz and 40 MHz* channel capability • Support for licensed 10 MHz modes • Optional enhancements – Advanced <u>FEC</u> coding techniques (RS, <u>LDPC</u>) – Transmit beamforming with negligible additional cost in receiving client device – 1/2 guard interval – Rate 7/8 coding *Not required in regulatory domains where prohibited. Submission Slide 5 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 5]
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of	The TGn Sync Proposal disclosed receiving in a first narrower frequency band by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference disclosed:

Claim Elements	Disclosure in the TGn Sync Proposal																								
OFDM symbols that carry a first plurality of header bits;	Table 14 summarizes the OFDM parameters for 20 and 40 MHz channels in comparison to the legacy 802.11 a/g formats. <table><tr><td></td><td>802.11a/g (20 MHz)</td><td>20 MHz Channel (Mandatory)</td><td>40 MHz Channel (Optional)</td></tr><tr><td>FFT size</td><td>64</td><td>64</td><td>128</td></tr><tr><td>Number of data subcarriers</td><td>48</td><td>52</td><td>108</td></tr><tr><td>Number of pilot subcarriers</td><td>4</td><td>4</td><td>6</td></tr></table> <table><tr><td>Subcarrier separation</td><td>312.5 kHz</td><td>312.5 kHz</td><td>312.5 kHz</td></tr><tr><td>Approx. Bandwidth</td><td>16.25 MHz</td><td>17.5 MHz</td><td>36.6 MHz</td></tr></table> Table 18: Summary of OFDM parameters [2005 802.11n TGn Sync Specification at 71-72] 11.1.1.3 PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 24: L-STF L-LTF L-SIG HT-SIG HT-STF HT-LTF ... HT-LTF HT-Data HT-Data ... Figure 24: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 25. A		802.11a/g (20 MHz)	20 MHz Channel (Mandatory)	40 MHz Channel (Optional)	FFT size	64	64	128	Number of data subcarriers	48	52	108	Number of pilot subcarriers	4	4	6	Subcarrier separation	312.5 kHz	312.5 kHz	312.5 kHz	Approx. Bandwidth	16.25 MHz	17.5 MHz	36.6 MHz
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Claim Elements	Disclosure in the TGN Sync Proposal
	40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.  Figure 25: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 26.  Figure 26: PPDU Format for 2x40 Basic MIMO Transmission⁷

Claim Elements	Disclosure in the TGn Sync Proposal
	The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 11.1.1.2.2. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 26. [2005 802.11n TGn Sync Specification at 73-74] The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 27:  Figure 27: HT Preamble format [2005 802.11n TGn Sync Specification at 75]

Claim Elements	Disclosure in the TGn Sync Proposal
	After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in 11.2.1.6.4. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. [2005 802.11n TGn Sync Specification at 76]

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2 PLCP Sublayer 11.2.1 Basic MIMO Mode As described in Table 20, the basic MIMO mode does not involve any spatial steering. The basic MIMO mode can operate in both 20MHz and 40MHz channel bandwidths. 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode: Figure 30: PPDU Format for N_{TX} antennas

Claim Elements	Disclosure in the TGn Sync Proposal
	L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31:

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 31: PPDU format leveraging CDD transmission [2005 802.11n TGN Sync Specification at 83-84] 11.2.1.4 Timing related parameters

Claim Elements	Disclosure in the TGn Sync Proposal		
	Parameter	Value for 20 MHz Channel	Value for 40 MHz Channel
	N_{SD} : Number of data subcarriers	52	108
	N_{SP} : Number of pilot subcarriers	4	6
	N_{SN} : Number of center null subcarriers	1 (tone = 0)	3 (tones = -1, <u>0</u> , +1)
	N_{SR} : Subcarrier range (index range)	28 (-28 ... +28)	58 (-58 ... +58)
	Δ_F : Subcarrier frequency spacing	0.3125 MHz (= 20 MHz / 64)	0.3125 MHz (= 40 MHz / 128)
	T_{FFT} : IFFT/FFT period	3.2 μ sec	3.2 μ sec
	T_{GI} : GI duration	0.8 μ sec	0.8 μ sec
	$T_{ShortGI}$: Short GI duration	0.4 μ sec	0.4 μ sec
	T_{GI2} : Legacy LongTraining symbol GI duration	1.6 μ sec	1.6 μ sec
	T_{SYM} : Symbol interval	4 μ sec	4 μ sec
	T_{L-STF} : Legacy STF duration	8 μ sec	8 μ sec
	T_{L-LTF} : Legacy LTF duration	8 μ sec	8 μ sec
	T_{L-SIG} : Legacy Signal Field duration	4 μ sec	4 μ sec
	T_{HT-SIG} : HT Signal Field duration	8 μ sec	8 μ sec
	T_{HT-STF} : HT Short training field duration	2.4 μ sec	2.4 μ sec
	$T_{HT-LTF1}$: HT Long training field duration	7.2 μ sec	7.2 μ sec
	$T_{HT-LTF2}$: HT Long training field duration	4 μ sec	4 μ sec
	T_S : Nyquist sampling interval	50nsec	25nsec
Table 23: Timing Related Parameters [2005 802.11n TGn Sync Specification at 88]			

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.6.1 Legacy Short Training Field The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is the L-STF is $S_{-28,28} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0\} \quad (17)$ The normalization factor $\sqrt{1/2}$ is the QPSK normalization. The legacy short training OFDM symbol in 40MHz mode is: $S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, 0, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0\} \quad (18)$ The tones in the upper subchannel (see Figure 25) are obtained by phase rotating the 802.11a short OFDM training symbol tones by 90 degrees, whereas the tones in the lower subchannel are identical to the 802.11a short training OFDM symbol tones. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz. The L-STF is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{L-STF}^{Tone}}} w_{L-STF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{TX}}^{L(k)} S_k \exp(j 2\pi k \Delta_F t) \quad (19)$ where we recall that $\mathbf{q}^{L(k)}$ is the column vector that defines the antenna map for the legacy compatible part. Observe that equation (19) is identical to the general expression (15) with $X_k^{(i_{TX})} = q_{i_{TX}}^{L(k)} S_k$.

Claim Elements	Disclosure in the TGn Sync Proposal
	The L-STs has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s, hence there are 10 L-STs in the L-STF. [91] 11.2.1.6.2 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, -1, 1, 1, 1\} \quad (20)$ The legacy long training OFDM signal in the 40MHz mode is given by: $L_{-58,58} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, j, j, -j, -j, j, j, -j, j, -j, j, j, j, j, j, -j, -j, j, j, -j, j, -j, j, j, j, 0, j, -j, -j, j, j, -j, j, -j, j, -j, -j, -j, -j, -j, -j, j, j, -j, -j, j, -j, j, j, j\} \quad (21)$

Claim Elements	Disclosure in the TGn Sync Proposal
	Tones in the upper subchannel (subcarriers +6 to +58) are obtained by phase rotating the 802.11a long OFDM training symbol tones by 90 degrees, whereas the tones within the lower subchannel (subcarriers -58 to -6) are identical to the 802.11a long OFDM training symbol tones. It should be noted that neither the legacy fields (L-STF, L-LTF, LSIG) nor the HT-SIG undergo any phase rotation in the lower subchannel. The subcarriers at ± 32 in 40MHz, which are the DC subcarriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is $r_{L-LTF}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{L-LTF}^{Tone}}} w_{T_{L-LTF}}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} L_k \exp(j 2 \pi k \Delta_F (t - T_{2GI})) \quad (22)$ where $T_{G12} = 1.6 \mu \text{ sec}$. Observe that equation (22) is identical to the general expression (15) with $X_k^{(i_{rx})} = q_{i_{rx}}^{L(k)} L_k$. Since $T_{L-LTF} = 8.0 \mu \text{ sec}$ and the symbol duration is $T_{FFT} = 3.2 \mu \text{ sec}$, we see that the L-LTF consists of a double GI followed by two full symbols. [91-92] 11.2.1.6.3 HT-Short Training Field The HT-STF follows the HT-SIG (see Figure 30), whose purpose it to “fine tune” the AGC for HT MIMO reception. Note that the first AGC operation is performed on the L-STF. The HT-STF for 20MHz is

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-26,26} = \frac{1}{\sqrt{2}} \begin{cases} \{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \quad N_{Tx} = 1 \\ \\ \{0, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, \} \quad N_{Tx} = 2 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 3 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 4 \end{cases} \quad (23)$ The HT-STS for 40 MHz consists of 48 tones, and is given by:

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-58,58} = \frac{1}{\sqrt{2}}$ $\{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, N_{Tx} = 1$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0,$ $0, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0,$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\}$ $N_{Tx} = 2$ $N_{Tx} = 3$ $N_{Tx} = 4$ (24) In the duplicate 6Mbps mode in 40MHz, the HT-STF shown in (24) is used, except for a scaling factor change. The HT-STF signal is then generated by the following rule. $r_{HT-LTS}^{(i_{Tx})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sqrt{N_{TX}}$ $\sum_k q_{i_{Tx}, (k+N_{HT-STF}^{Tone}-u(k)) \% N_{SS}}^{(k)} HTS_k \exp(j2\pi k \Delta_F (t - T_{GI}))$ (25)

Claim Elements	Disclosure in the TGn Sync Proposal
	where $T_{GI} = 0.8 \mu s$, N_{HT-STF}^{Tone} is the number of active tones (= 24 for 20 MHz and 48 for 40 MHz), and $u(k)$ is the unit step function (= 0 for $k < 0$ and = 1 for $k \geq 0$). Tone interleaving across spatial streams works as follows. Define $i(k) = k + N_{HT-STF}^{Tone} - u(k)$, which appears in the column subscript of the Q-matrix. HTS_k is non-zero only for even values of the tone index k between $-N_{HT-STF}^{Tone}$ and $+N_{HT-STF}^{Tone}$, excluding $k = 0$. Thus, $i(k)$ runs through the integer values $0, \dots, N_{HT-STF}^{Tone} - 1$ as k runs through the even values $-N_{HT-STF}^{Tone}, \dots, -2, +2, \dots, +N_{HT-STF}^{Tone}$. The index $i(k)$ can be called the “interleaving index” because it is used to select the column of the Q-matrix, which define to spatial streams, that used on tone index k. We select spatial stream $i(k) \% N_{SS}$ for tone k. The HT-STF signal has a period of $1.6 \mu s$, which is deemed sufficient for power measurement purposes. Since the HT-STF is tone-interleaved at the transmitter, the power periodicity of the HT-STF is also $1.6 \mu s$. [2005 802.11n TGn Sync Specification at 92-94] 11.2.1.6.4 HT-Long Training Field The HT-LTFs are transmitted after the HT-STF. The number of HT-LTFs is equal to N_{LTF}. For any PPDU, there must be at least as many HT-LTFs as spatial streams in the HT Data portion of the PPDU, i.e., $N_{LTF} = N_{SS}$ (the number of spatial streams). For a sounding PPDU $N_{LTF} \geq N_{SS}$, because these PPDU provide channel measurement capability for potentially more spatial dimensions than the number of spatial streams. In the case of a sounding packet, the HT-LTFs are partitioned as data HT-LTFs and extension HT-LTFs. The data HT-LTFs are the first N_{SS} fields, which are indexed $i_{LTF} = 0, \dots, N_{SS} - 1$. The last $N_{LTF} - N_{SS}$ HT-LTFs are the extension fields, which are indexed $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. The result is referred to as a segmented HT-LTF. As always, spatial streams are defined by columns of an orthogonal antenna map matrix $\mathbf{Q}^{(k)}$, with the first N_{SS} columns defining the spatial streams used for data transmission, and the last $N_{LTF} - N_{SS}$ columns defining the extension spatial streams. Thus, for the purpose of defining HT-LTFs, $\mathbf{Q}^{(k)}$ is an $N_{Tx} \times N_{LTF}$ dimension matrix.

Claim Elements	Disclosure in the TGn Sync Proposal																																								
	The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second and all subsequent HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. To minimize the power fluctuation between the HT-LTF and the AGC setting (which is derived from the HT-STF), the HT-LTS is tone-interleaved across spatial streams, <u>similar to</u> the HT-STF definition. There are a total of 9 sequences. These sequences are defined to minimize PAPR for both direct MAP and spatial spreading, with tone-interleaving. Table 25: List of HT Long Training Fields <table><tr><th>Sequence Number</th><th>N_{TX}</th><th>BW</th><th>Comment</th></tr><tr><td>1</td><td>1</td><td>20MHz</td><td>56 tones</td></tr><tr><td>2</td><td>2</td><td>20MHz</td><td>56 tones</td></tr><tr><td>3</td><td>3</td><td>20MHz</td><td>56 tones</td></tr><tr><td>4</td><td>4</td><td>20MHz</td><td>56 tones</td></tr><tr><td>5</td><td>1</td><td>40MHz</td><td>Duplicate format, 6Mbps in 40MHz (104 Tones)</td></tr><tr><td>6</td><td>1</td><td>40MHz</td><td>114 tones</td></tr><tr><td>7</td><td>2</td><td>40MHz</td><td>114 tones</td></tr><tr><td>8</td><td>3</td><td>40MHz</td><td>114 tones</td></tr><tr><td>9</td><td>4</td><td>40MHz</td><td>114 tones</td></tr></table> In 20MHz, for $N_{TX} = 1$, sequence 1 is: $\text{HTL}_{-28:28} = [-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, 1, -1, 1, 0, -1, -1, -1, 1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1] \quad (26)$	Sequence Number	N _{TX}	BW	Comment	1	1	20MHz	56 tones	2	2	20MHz	56 tones	3	3	20MHz	56 tones	4	4	20MHz	56 tones	5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)	6	1	40MHz	114 tones	7	2	40MHz	114 tones	8	3	40MHz	114 tones	9	4	40MHz	114 tones
Sequence Number	N _{TX}	BW	Comment																																						
1	1	20MHz	56 tones																																						
2	2	20MHz	56 tones																																						
3	3	20MHz	56 tones																																						
4	4	20MHz	56 tones																																						
5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)																																						
6	1	40MHz	114 tones																																						
7	2	40MHz	114 tones																																						
8	3	40MHz	114 tones																																						
9	4	40MHz	114 tones																																						

Claim Elements	Disclosure in the TGn Sync Proposal
	In 20MHz, for $N_{TX} = 2$, sequence 2 is: $\text{HTL}_{-28:28} = [-1, -1, 1, 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 0, \\ -1, -1, -1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1, 1, 1, 1, 1, 1, 1, 1] \quad (27)$ In 20MHz, for $N_{TX} = 3$, sequence 3 is: $\text{HTL}_{-28:28} = [1, -1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, -1, 1, -1, -1, -1, 0, \\ 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, 1, -1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1] \quad (28)$ (29) In 20MHz, for $N_{TX} = 4$, sequence 4 is: $\text{HTL}_{-28:28} = [1, 1, 1, 1, -1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, 1, -1, 1, 1, 1, -1, 1, -1, -1, -1, -1, -1, 0, \\ -1, 1, 1, -1, -1, -1, 1, 1, 1, -1, -1, -1, 1, 1, -1, 1, 1, -1, -1, 1, -1, -1, 1, -1, -1, 1] \quad (30)$ In the 40MHz mode, the subcarriers at $k = \pm 32$ are populated in the HT-STSS. In 40MHz, for $N_{TX} = 1$, sequence 5 is identical to sequence 6. Sequence 5 is used in the duplicate 6Mbps mode, whereby only 104 tones are needed, whereas sequence 6 corresponds to the 114 tones. Note that all 114 tones are transmitted in the 6Mbps duplicate mode. $\begin{aligned} \text{HTL}_{-58:+58} = \{ & -1 \ 1 \ 1 \ 1 \ 1 \ -1 \ 1 \ 1 \ -1 \ -1 \ -1 \ -1 \ 1 \ 1 \ 1 \ 1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \\ & 1 \ 1 \ -1 \ -1 \ 1 \ 1 \ -1 \ -1 \ -1 \ -1 \ -1 \ 1 \ -1 \ 1 \ 1 \ -1 \ -1 \ 1 \ -1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1 \\ & 0 \ 0 \ 0 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ 1 \ 1 \ 1 \ -1 \ 1 \ -1 \ 1 \ 1 \ -1 \ -1 \ 1 \ -1 \ 1 \ -1 \ 1 \\ & -1 \ 1 \ -1 \ -1 \ -1 \ -1 \ 1 \ 1 \ -1 \ 1 \ -1 \ -1 \ -1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ -1 \ -1 \ 1 \ -1 \ 1 \ 1 \} \end{aligned} \quad (31)$

Claim Elements	Disclosure in the TGN Sync Proposal
	In 40MHz, for $N_{TX} = 2$, sequence 7 is: $\begin{aligned} HTL_{-58,+58} = \{-1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ 1 \\ -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ -1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ -1\ 1\ -1\ 1 \\ 0\ 0\ 0\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ 1\ -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1 \\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\} \end{aligned} \quad (32)$ In 40MHz, for $N_{TX} = 3$, sequence 8 is: $\begin{aligned} HTL_{-58,+58} = \{-1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1 \\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 0 \\ 0\ 0\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1 \\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\} \end{aligned} \quad (33)$ The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets: In 40MHz, for $N_{TX} = 4$, sequence 9 is: $\begin{aligned} HTL_{-58,+58} = \{-1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ 1\ -1 \\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ -1\ 1\ -1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 0 \\ 0\ 0\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ -1\ 1\ 1\ -1 \\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ 1\ -1\ 1\ -1\ 1\ 1\} \end{aligned} \quad (34)$

$$HTL_{-58,+58} = \{-1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ -1$$

 $-1\ 1\ 1\ 1\ -1\ -1\ 1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ -1\ 1$
 $0\ 0\ 0\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1$
 $1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\}$ (32)

In 40MHz, for $N_{TX} = 3$, sequence 8 is:

$$HTL_{-58,+58} = \{-1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1 1$$
$$1 1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0$$
$$0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1$$
$$-1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1\}$$
(33)

The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets:

In 40MHz, for $N_{TX} = 4$, sequence 9 is:

$$HTL_{-58,+58} = \{-1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ -1\ 1\ -1$$
$$1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ -1\ -1\ 1\ -1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 0$$
$$0\ 0\ -1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ -1\ -1\ -1\ 1\ -1\ 1\ -1$$
$$-1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ 1\ -1\ -1\ 1\ 1\}$$
 (34)

Claim Elements	Disclosure in the TGN Sync Proposal
	The HT-LTF is generated similarly to the HT-STF. For the data HT-LTFs $i_{LTF} = 0, \dots, N_{SS} - 1$, the signal is $r_{HT-LTF}^{(i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} \mathcal{Q}_{i_{LTF}, (k+i_{LTF}+N_{SR}-u(k))\%N_{SS}}^{(k)} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (35)$ where $N_{SR} = 28$ for 20 MHz and 58 for 40 MHz, $u(k) = \begin{cases} 1 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 20 MHz} \quad (36)$ and $u(k) = \begin{cases} 3 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 40 MHz.} \quad (37)$ In the case of a sounding packet, the extension HT-LTFs are tone interleaved over the extension spatial dimensions. Thus, the extension HT-LTFs are $r_{HT-LTF}^{(i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{LTF}, N_{SS} + (k + (i_{LTF} - N_{SS}) + N_{SR} - u(k))\%(N_{LTF} - N_{SS})}^{(k)} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (38)$ for $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$.

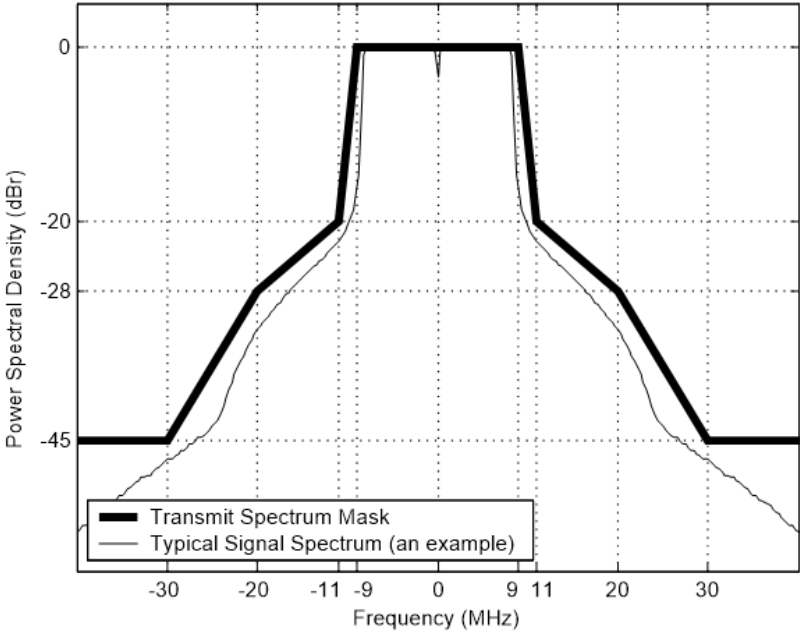
Claim Elements	Disclosure in the TGN Sync Proposal																																																		
	Since the HT-LTF is tone interleaved across antennas, the 56 tones are partitioned across the antenna array during each OFDM symbol. Tone partitioning into sets for 20MHz is shown in Table 26. At each OFDM symbol interval, each set of tones maps to one transmit antenna. And over time, all sets get mapped to an antenna. <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-28:1:-1] [1:1:+28]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-28:2:-2] [2:2:28]</td><td>[-27:2:-1] [1:2:27]</td><td></td><td></td></tr><tr><td>3</td><td>[-28:3:-1] [2:3:26]</td><td>[-27:3:-3] [3:3:27]</td><td>[-26:3:-2] [1:3:28]</td><td></td></tr><tr><td>4</td><td>[-28:4:-4] [1:4:25]</td><td>[-27:4:-3] [2:4:26]</td><td>[-26:4:-2] [3:4:27]</td><td>[-25:4:-2] [4:4:28]</td></tr></table> Table 26: Tone partitioning into sets for 20MHz (56 tones) <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-58:1:-2] [2:1:+58]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-58:2:-2] [2:2:+58]</td><td>[-57:2:-3] [3:2:57]</td><td></td><td></td></tr><tr><td>3</td><td>[-58:3:-4] [2:3:56]</td><td>[-57:3:-3] [3:3:57]</td><td>[-56:3:-2] [4:3:58]</td><td></td></tr><tr><td>4</td><td>[-58:4:-2] [5:4:57]</td><td>[-57:4:-5] [2:4:58]</td><td>[-56:4:-4] [3:4:55]</td><td>[-55:4:-3] [4:4:56]</td></tr></table> Table 27: Tone partitioning into sets for 40MHz (114 tones) An example of tone interleaving across 4 transmit antennas is shown in Figure 34.	Nss	Set 0	Set 1	Set 2	Set 3	1	[-28:1:-1] [1:1:+28]				2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]			3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]		4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]	Nss	Set 0	Set 1	Set 2	Set 3	1	[-58:1:-2] [2:1:+58]				2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]			3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]		4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]
Nss	Set 0	Set 1	Set 2	Set 3																																															
1	[-28:1:-1] [1:1:+28]																																																		
2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]																																																	
3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]																																																
4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]																																															
Nss	Set 0	Set 1	Set 2	Set 3																																															
1	[-58:1:-2] [2:1:+58]																																																		
2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]																																																	
3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]																																																
4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]																																															

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 34: HT-LTF tone interleaving across 4 spatial streams [2005 802.11n TGn Sync Specification at 94-98] 11.2.1.7.1 L-SIG Figure 36: SIGNAL field bit assignment In the 20MHz mode, the format of the L-SIG field shall be the same as the SIGNAL field as defined in figure 111 in 17.3.4 in [1]. The combination of RATE and LENGTH is used to signal a station (OFDM mode only) the duration of a HT transmission. This duration does not have to be the actual duration of the HT frame. It can be used to reserve the medium beyond the actual transmission. The reservation of the medium through this kind of signalling is called “spoofing”.

Claim Elements	Disclosure in the TGn Sync Proposal
	To prevent a legacy station from accessing the medium during a HT frame transmission, the “duration” calculated from the RATE and LENGTH fields shall be at least as large as the actual duration of the HT frame, which is measured from the end of the L-SIG field to the end of the DATA field. During an HT transmission, the RATE field is set to 6Mbps, whereas the LENGTH field is set based on the “duration” value. In the 40MHz mode, the legacy signal field is duplicated such that tones are filled from -58 to -6 (lower-subchannel), and from +6 to +58 (upper-subchannel). The upper subchannel shall be phase rotated by 90 degrees, in the same way as the LTS as described in 11.2.1.6.2 The LSIG shall be transmitted in the same fashion as the legacy short and the legacy long training fields. If L-STF and L-LTF are transmitted from a single antenna, we index that antenna as $i_{Tx} = 1$ to be consistent with 11.2.1.6.2. Denote $LSIG_{-26,26}$ and $LSIG_{-58,58}$ as the LSIG OFDM symbol generated for 20 MHz and 40 MHz respectively. The L-SIG waveform is $r_{L-SIG}^{i_{Tx}}(t) = \frac{1}{\sqrt{N_{L-SIG}^{Tone}}} w_{L-SIG}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} LSIG_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (39)$ [2005 802.11n TGn Sync Specification at 98-99] 11.2.1.7.2 HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause 11.2.1.7.

Claim Elements	Disclosure in the TGN Sync Proposal
	In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in 11.2.1.6.2 Figure 37 shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t - nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t - T_{GI} - nT_{Symb})) \quad (40)$ where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration.

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 37: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment [2005 802.11n TGn Sync Specification at 100-101] 11.2.1.7.2.10 SIGNALTAIL The bits 18-23 constitute the SIGNALTAIL field, and all 6 bits shall be set to zero. [2005 802.11n TGn Sync Specification at 104]

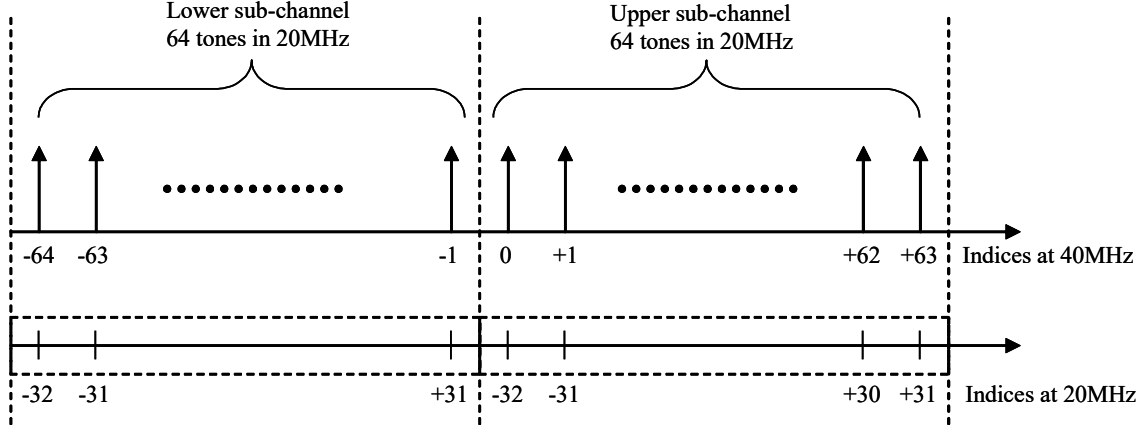
Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.10.1 Transmit spectral mask 11.2.1.10.1.1 20MHz channel spacing In the 20 MHz bandwidth mode the HT PHY shall follow 17.3.9.2 in ref [1]. The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18MHz, -20dBr at 11 MHz frequency offset, -28dBr at 20MHz frequency offset and -45dBr at 30MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 1. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. 20 MHz 802.11n Transmit Spectrum Mask  Figure 43: Transmit Spectrum Mask for 20MHz channelization

Claim Elements	Disclosure in the TGn Sync Proposal
	[2005 802.11n TGn Sync Specification at 114] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would have been obvious in view of the combination with PHY Updates to TGn Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005)(“2005 TGn Sync PHY Updates”). One of ordinary skill in the art would have been motivated to combine the 2005 802.11n TGn Sync Specification with the 2005 TGn Sync PHY Updates because the documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync PHY Updates disclosed, for example:

Claim Elements	Disclosure in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 Legacy Compatible Preamble ➔ Format remains unchanged from before The diagram illustrates the structure of the Legacy Compatible Preamble. It consists of six fields arranged horizontally: L-STF, GI2, L-LTS, L-LTS, GI, and L-SIG. Below each field is a double-headed arrow indicating its duration: L-STF is 8 us, GI2 is 1.6us, the first L-LTS is 3.2 us, the second L-LTS is 3.2 us, GI is 0.8us, and L-SIG is 3.2 us. ➔ The legacy compatible preamble may be transmitted either from one antenna or from multiple antennas using CDD Submission Slide 8 Syed Aon Mujtaba, Agere Systems, et. al [2005 TGn Sync PHY Updates, at Slide 8]

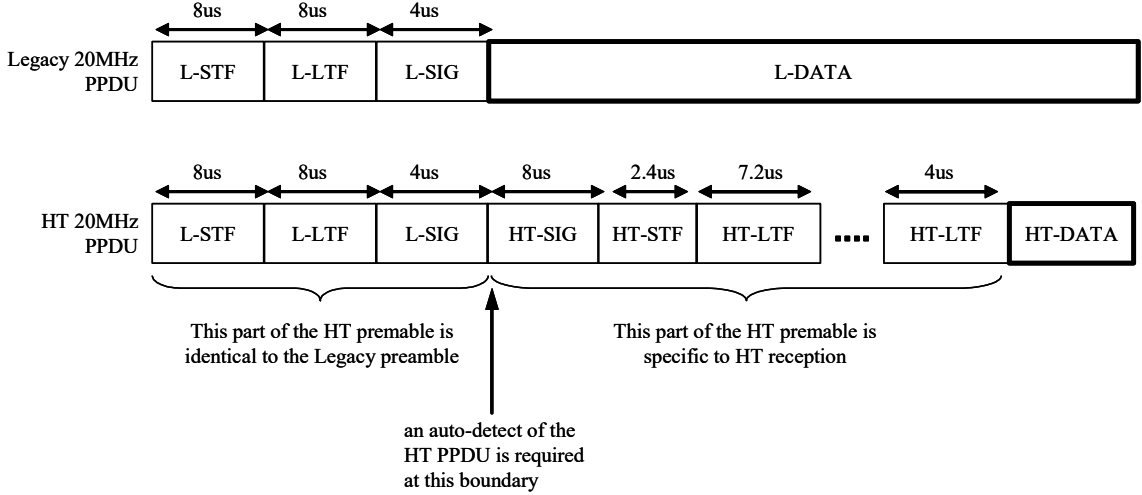
Claim Elements	Disclosure in the TGN Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF The diagram illustrates the HT-LTF structure for different values of N_{ss}. The structure is as follows: $N_{ss}=1$: GI, HT-LTS, HT-LTS (Total duration: 7.2us) $N_{ss}=2$: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS (Total duration: 7.2us + 4us) $N_{ss}=3$: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS (Total duration: 7.2us + 4us + 4us) $N_{ss}=4$: GI, Tone interleaved HT-LTS, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS, GI, Tone interleaved HT-LTS (Total duration: 7.2us + 4us + 4us + 4us) Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

Claim Elements	Disclosure in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1: L-STF L-LTF L-SIG HT-SIG HT-STF HT-LTF ... HT-LTF HT-Data HT-Data ...

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 1: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.  Figure 2: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

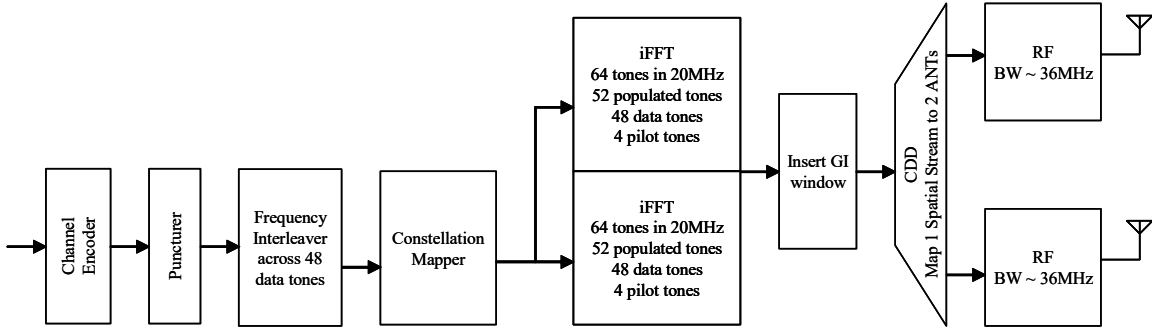
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 3: PPDU Format for 2x40 Basic MIMO Transmission³ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

³ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

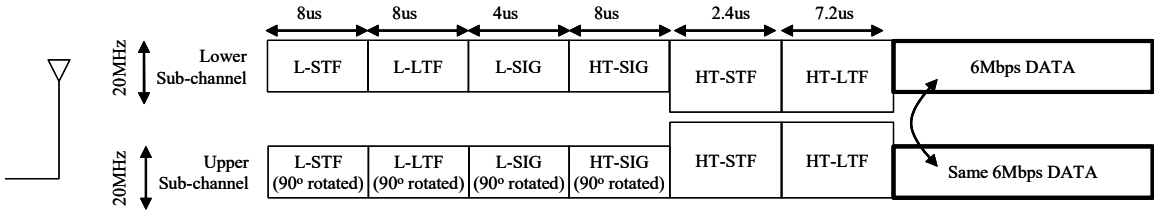
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 4: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGn Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 5: Transmitter configuration for 6Mbps in 40MHz⁴ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

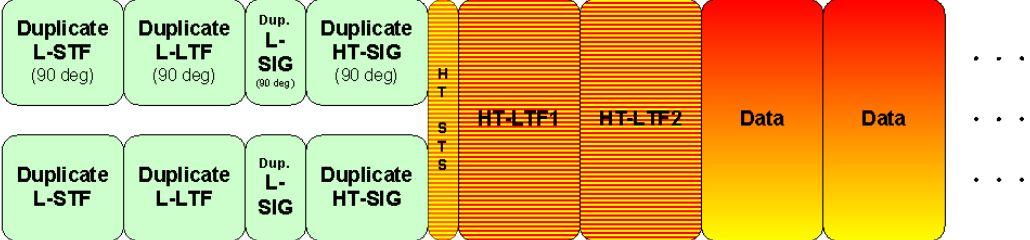
⁴ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

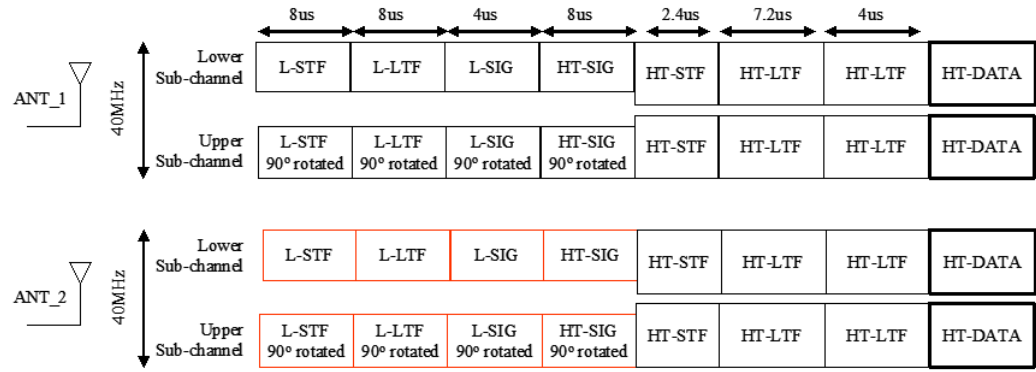
Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 6: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data ← Legacy Compatible Preamble HT Part → <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna STF L LTF L SIG HT SIG HT STF HT LTF HT LTF Data These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The diagram illustrates the transmission of a Legacy Compatible Preamble using CDD across three antennas. Each antenna (1, 2, 3) transmits a sequence of fields: L-STF, L-LTF, L-SIG, and HT-SIG. The fields are represented by colored blocks: L-STF (green), L-LTF (green), L-SIG (green), and HT-SIG (orange). The diagram shows that the L-STF, L-LTF, L-SIG, and HT-SIG fields are transmitted as a single spatial stream across all three antennas. or single antenna Antenna The diagram illustrates the transmission of a Legacy Compatible Preamble using a single antenna across three antennas (1, 2, 3). The fields L-STF, L-LTF, L-SIG, and HT-SIG are transmitted as a single spatial stream across all three antennas. The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein	The TGN Sync Proposal disclosed demodulating, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers. For example, the reference disclosed:

Claim Elements	Disclosure in the TGn Sync Proposal
at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 26.  Figure 26: PPDU Format for 2x40 Basic MIMO Transmission⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 11.1.1.2.2. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 26. [2005 802.11n TGn Sync Specification at 74] The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF).

Claim Elements	Disclosure in the TGn Sync Proposal
	Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. [2005 802.11n TGn Sync Specification at 75] 11.2 PLCP Sublayer 11.2.1 Basic MIMO Mode As described in Table 20, the basic MIMO mode does not involve any spatial steering. The basic MIMO mode can operate in both 20MHz and 40MHz channel bandwidths. 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode:

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 30: PPDU Format for N_{TX} antennas L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of

Claim Elements	Disclosure in the TGN Sync Proposal
	the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31: Figure 31: PPDU format leveraging CDD transmission [2005 802.11n TGN Sync Specification at 83-84] 11.2.1.4 Timing related parameters

Claim Elements	Disclosure in the TGn Sync Proposal		
	Parameter	Value for 20 MHz Channel	Value for 40 MHz Channel
	N_{SD} : Number of data subcarriers	52	108
	N_{SP} : Number of pilot subcarriers	4	6
	N_{SN} : Number of center null subcarriers	1 (tone = 0)	3 (tones = -1, <u>0</u> , +1)
	N_{SR} : Subcarrier range (index range)	28 (-28 ... +28)	58 (-58 ... +58)
	Δ_F : Subcarrier frequency spacing	0.3125 MHz (= 20 MHz / 64)	0.3125 MHz (= 40 MHz / 128)
	T_{FFT} : IFFT/FFT period	3.2 μ sec	3.2 μ sec
	T_{GI} : GI duration	0.8 μ sec	0.8 μ sec
	$T_{ShortGI}$: Short GI duration	0.4 μ sec	0.4 μ sec
	T_{GI2} : Legacy LongTraining symbol GI duration	1.6 μ sec	1.6 μ sec
	T_{SYM} : Symbol interval	4 μ sec	4 μ sec
	T_{L-STF} : Legacy STF duration	8 μ sec	8 μ sec
	T_{L-LTF} : Legacy LTF duration	8 μ sec	8 μ sec
	T_{L-SIG} : Legacy Signal Field duration	4 μ sec	4 μ sec
	T_{HT-SIG} : HT Signal Field duration	8 μ sec	8 μ sec
	T_{HT-STF} : HT Short training field duration	2.4 μ sec	2.4 μ sec
	$T_{HT-LTF1}$: HT Long training field duration	7.2 μ sec	7.2 μ sec
	$T_{HT-LTF2}$: HT Long training field duration	4 μ sec	4 μ sec
	T_S : Nyquist sampling interval	50nsec	25nsec
Table 23: Timing Related Parameters [2005 802.11n TGn Sync Specification at 88]			

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.6.1 Legacy Short Training Field The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is the L-STF is $S_{-28,28} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0\} \quad (17)$ The normalization factor $\sqrt{1/2}$ is the QPSK normalization. The legacy short training OFDM symbol in 40MHz mode is: $S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, 0, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0\} \quad (18)$ The tones in the upper subchannel (see Figure 25) are obtained by phase rotating the 802.11a short OFDM training symbol tones by 90 degrees, whereas the tones in the lower subchannel are identical to the 802.11a short training OFDM symbol tones. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz. The L-STF is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{L-STF}^{Tone}}} w_{L-STF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{TX}}^{L(k)} S_k \exp(j 2\pi k \Delta_F t) \quad (19)$ where we recall that $\mathbf{q}^{L(k)}$ is the column vector that defines the antenna map for the legacy compatible part. Observe that equation (19) is identical to the general expression (15) with $X_k^{(i_{TX})} = q_{i_{TX}}^{L(k)} S_k$. The L-STF has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s, hence there are 10 L-STFs in the L-STF.

11.2.1.6.2 Legacy Long Training Field

The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by

$$L_{-26,26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, 1, 1, 1, 0, \\ 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, 1, 1, 1\} \quad (20)$$

The legacy long training OFDM signal in the 40MHz mode is given by:

$$L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,0,0,0,0,0,0, \\ 0,0,0,0,0,0,0,j,j,-j,-j,j,j,-j,j,-j,j,j,j,j,-j,-j,j,j,-j,j,j,j,0, \\ j,-j,-j,j,j,-j,j,-j,j,-j,-j,-j,-j,-j,j,j,-j,-j,j,-j,j,-j,j,j,j\} \quad (21)$$

Claim Elements	Disclosure in the TGN Sync Proposal
	Tones in the upper subchannel (subcarriers +6 to +58) are obtained by phase rotating the 802.11a long OFDM training symbol tones by 90 degrees, whereas the tones within the lower subchannel (subcarriers -58 to -6) are identical to the 802.11a long OFDM training symbol tones. It should be noted that neither the legacy fields (L-STF, L-LTF, LSIG) nor the HT-SIG undergo any phase rotation in the lower subchannel. The subcarriers at ± 32 in 40MHz, which are the DC subcarriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is $r_{L-LTF}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{L-LTF}}} w_{L-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} L_k \exp(j 2\pi k \Delta_F (t - T_{GI})) \quad (22)$ where $T_{GI} = 1.6 \mu \text{ sec}$. Observe that equation (22) is identical to the general expression (15) with $X_k^{(i_{rx})} = q_{i_{rx}}^{L(k)} L_k$. Since $T_{L-LTF} = 8.0 \mu \text{ sec}$ and the symbol duration is $T_{FFT} = 3.2 \mu \text{ sec}$, we see that the L-LTF consists of a double GI followed by two full symbols. [91-92] 11.2.1.6.3 HT-Short Training Field The HT-STF follows the HT-SIG (see Figure 30), whose purpose it to “fine tune” the AGC for HT MIMO reception. Note that the first AGC operation is performed on the L-STF. The HT-STF for 20MHz is

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-26,26} = \frac{1}{\sqrt{2}} \left\{ \begin{array}{l} \{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 0\} \quad N_{Tx} = 1 \\ \\ \{0, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, \} \quad N_{Tx} = 2 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 3 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \quad N_{Tx} = 4 \end{array} \right. \quad (23)$ The HT-STS for 40 MHz consists of 48 tones, and is given by:

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Claim Elements	Disclosure in the TGn Sync Proposal
	where $T_{GI} = 0.8\mu s$, N_{HT-STF}^{Tone} is the number of active tones (= 24 for 20 MHz and 48 for 40 MHz), and $u(k)$ is the unit step function (= 0 for $k < 0$ and = 1 for $k \geq 0$). Tone interleaving across spatial streams works as follows. Define $i(k) = k + N_{HT-STF}^{Tone} - u(k)$, which appears in the column subscript of the Q-matrix. HTS_k is non-zero only for even values of the tone index k between $-N_{HT-STF}^{Tone}$ and $+N_{HT-STF}^{Tone}$, excluding $k = 0$. Thus, $i(k)$ runs through the integer values $0, \dots, N_{HT-STF}^{Tone} - 1$ as k runs through the even values $-N_{HT-STF}^{Tone}, \dots, -2, +2, \dots, +N_{HT-STF}^{Tone}$. The index $i(k)$ can be called the “interleaving index” because it is used to select the column of the Q-matrix, which define to spatial streams, that used on tone index k. We select spatial stream $i(k) \% N_{SS}$ for tone k. The HT-STF signal has a period of $1.6\mu s$, which is deemed sufficient for power measurement purposes. Since the HT-STF is tone-interleaved at the transmitter, the power periodicity of the HT-STF is also $1.6\mu s$. [2005 802.11n TGn Sync Specification at 92-94] 11.2.1.6.4 HT-Long Training Field The HT-LTFs are transmitted after the HT-STF. The number of HT-LTFs is equal to N_{LTF}. For any PPDU, there must be at least as many HT-LTFs as spatial streams in the HT Data portion of the PPDU, i.e. $N_{LTF} = N_{SS}$ (the number of spatial streams). For a sounding PPDU $N_{LTF} \geq N_{SS}$, because these PPDU provide channel measurement capability for potentially more spatial dimensions than the number of spatial streams. In the case of a sounding packet, the HT-LTFs are partitioned as data HT-LTFs and extension HT-LTFs. The data HT-LTFs are the first N_{SS} fields, which are indexed $i_{LTF} = 0, \dots, N_{SS} - 1$. The last $N_{LTF} - N_{SS}$ HT-LTFs are the extension fields, which are indexed $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. The result is referred to as a segmented HT-LTF. As always, spatial streams are defined by columns of an orthogonal antenna map matrix $\mathbf{Q}^{(k)}$, with the first N_{SS} columns defining the spatial streams used for data transmission, and the last $N_{LTF} - N_{SS}$ columns defining the extension spatial streams. Thus, for the purpose of defining HT-LTFs, $\mathbf{Q}^{(k)}$ is an $N_{Tx} \times N_{LTF}$ dimension matrix.

Claim Elements	Disclosure in the TGn Sync Proposal																																								
	The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second and all subsequent HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. To minimize the power fluctuation between the HT-LTF and the AGC setting (which is derived from the HT-STF), the HT-LTS is tone-interleaved across spatial streams, similar to the HT-STF definition. There are a total of 9 sequences. These sequences are defined to minimize PAPR for both direct MAP and spatial spreading, with tone-interleaving. Table 25: List of HT Long Training Fields <table><tr><th>Sequence Number</th><th>N_{TX}</th><th>BW</th><th>Comment</th></tr><tr><td>1</td><td>1</td><td>20MHz</td><td>56 tones</td></tr><tr><td>2</td><td>2</td><td>20MHz</td><td>56 tones</td></tr><tr><td>3</td><td>3</td><td>20MHz</td><td>56 tones</td></tr><tr><td>4</td><td>4</td><td>20MHz</td><td>56 tones</td></tr><tr><td>5</td><td>1</td><td>40MHz</td><td>Duplicate format, 6Mbps in 40MHz (104 Tones)</td></tr><tr><td>6</td><td>1</td><td>40MHz</td><td>114 tones</td></tr><tr><td>7</td><td>2</td><td>40MHz</td><td>114 tones</td></tr><tr><td>8</td><td>3</td><td>40MHz</td><td>114 tones</td></tr><tr><td>9</td><td>4</td><td>40MHz</td><td>114 tones</td></tr></table> In 20MHz, for $N_{TX} = 1$, sequence 1 is: $\text{HTL}_{-28:28} = [-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, 1, -1, 1, 0, -1, -1, -1, 1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1] \quad (26)$	Sequence Number	N _{TX}	BW	Comment	1	1	20MHz	56 tones	2	2	20MHz	56 tones	3	3	20MHz	56 tones	4	4	20MHz	56 tones	5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)	6	1	40MHz	114 tones	7	2	40MHz	114 tones	8	3	40MHz	114 tones	9	4	40MHz	114 tones
Sequence Number	N _{TX}	BW	Comment																																						
1	1	20MHz	56 tones																																						
2	2	20MHz	56 tones																																						
3	3	20MHz	56 tones																																						
4	4	20MHz	56 tones																																						
5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)																																						
6	1	40MHz	114 tones																																						
7	2	40MHz	114 tones																																						
8	3	40MHz	114 tones																																						
9	4	40MHz	114 tones																																						

Claim Elements	Disclosure in the TGn Sync Proposal
	In 20MHz, for $N_{TX} = 2$, sequence 2 is: $\text{HTL}_{-28:28} = [-1, -1, 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, -1, 1, 0, \\ -1, -1, -1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1, 1, 1, 1, 1, 1, 1, 1] \quad (27)$ In 20MHz, for $N_{TX} = 3$, sequence 3 is: $\text{HTL}_{-28:28} = [1, -1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, -1, 1, -1, -1, -1, 0, \\ 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, 1, -1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1] \quad (28)$ (29) In 20MHz, for $N_{TX} = 4$, sequence 4 is: $\text{HTL}_{-28:28} = [1, 1, 1, 1, -1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, 1, -1, 1, 1, 1, -1, 1, -1, -1, -1, -1, -1, 0, \\ -1, 1, 1, -1, -1, -1, 1, 1, 1, -1, -1, -1, 1, 1, -1, 1, 1, -1, -1, 1, -1, -1, 1, -1, -1, 1] \quad (30)$ In the 40MHz mode, the subcarriers at $k = \pm 32$ are populated in the HT-STSS. In 40MHz, for $N_{TX} = 1$, sequence 5 is identical to sequence 6. Sequence 5 is used in the duplicate 6Mbps mode, whereby only 104 tones are needed, whereas sequence 6 corresponds to the 114 tones. Note that all 114 tones are transmitted in the 6Mbps duplicate mode. $\begin{aligned} \text{HTL}_{-58,+58} = \{ & -1 \ 1 \ 1 \ 1 \ 1 \ -1 \ 1 \ 1 \ -1 \ -1 \ -1 \ -1 \ 1 \ 1 \ 1 \ 1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \\ & 1 \ 1 \ -1 \ -1 \ 1 \ 1 \ -1 \ -1 \ -1 \ -1 \ -1 \ 1 \ -1 \ 1 \ 1 \ -1 \ -1 \ 1 \ -1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1 \\ & 0 \ 0 \ 0 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ 1 \ 1 \ 1 \ -1 \ 1 \ -1 \ 1 \ 1 \ -1 \ -1 \ 1 \ -1 \ 1 \ -1 \ 1 \\ & -1 \ 1 \ -1 \ -1 \ -1 \ -1 \ 1 \ 1 \ -1 \ 1 \ -1 \ -1 \ -1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ -1 \ -1 \ 1 \ -1 \ 1 \ 1 \} \end{aligned} \quad (31)$

Claim Elements	Disclosure in the TGn Sync Proposal
	In 40MHz, for $N_{TX} = 2$, sequence 7 is: $\begin{aligned} HTL_{-58,+58} = \{ & -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ 1 \\ & -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ -1\ -1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ -1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1 \\ & 0\ 0\ 0\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ 1\ -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ 1\ 1 \\ & 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\} \end{aligned} \quad (32)$ In 40MHz, for $N_{TX} = 3$, sequence 8 is: $\begin{aligned} HTL_{-58,+58} = \{ & -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1 \\ & 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 0 \\ & 0\ 0\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1 \\ & -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\} \end{aligned} \quad (33)$ The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets: In 40MHz, for $N_{TX} = 4$, sequence 9 is: $\begin{aligned} HTL_{-58,+58} = \{ & -1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ 1\ -1 \\ & 1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ -1\ 1\ -1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 0 \\ & 0\ 0\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ 1\ -1\ -1\ -1\ 1\ 1\ -1\ -1\ 1\ 1\ -1\ 1\ -1 \\ & -1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ -1\ -1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ 1\ 1\ -1\ 1\ 1\ -1\ -1\ 1\ -1\ 1\ -1\ 1\ 1\} \end{aligned} \quad (34)$

[illegible]

In 40MHz, for $N_{TX} = 3$, sequence 8 is:

$$HTL_{-58,+58} = \{-1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1$$
$$1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0$$
$$0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1$$
$$-1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1\}$$
(33)

The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets:

In 40MHz, for $N_{TX} = 4$, sequence 9 is:

[illegible]

Claim Elements	Disclosure in the TGN Sync Proposal
	The HT-LTF is generated similarly to the HT-STF. For the data HT-LTFs $i_{LTF} = 0, \dots, N_{SS} - 1$, the signal is $r_{HT-LTF}^{(i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} \mathcal{Q}_{i_{LTF}, (k+i_{LTF}+N_{SR}-u(k))\%N_{SS}}^{(k)} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (35)$ where $N_{SR} = 28$ for 20 MHz and 58 for 40 MHz, $u(k) = \begin{cases} 1 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 20 MHz} \quad (36)$ and $u(k) = \begin{cases} 3 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 40 MHz.} \quad (37)$ In the case of a sounding packet, the extension HT-LTFs are tone interleaved over the extension spatial dimensions. Thus, the extension HT-LTFs are $r_{HT-LTF}^{(i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{LTF}, N_{SS} + (k + (i_{LTF} - N_{SS}) + N_{SR} - u(k))\%(N_{LTF} - N_{SS})}^{(k)} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (38)$ for $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$.

Claim Elements	Disclosure in the TGN Sync Proposal																																																		
	Since the HT-LTF is tone interleaved across antennas, the 56 tones are partitioned across the antenna array during each OFDM symbol. Tone partitioning into sets for 20MHz is shown in Table 26. At each OFDM symbol interval, each set of tones maps to one transmit antenna. And over time, all sets get mapped to an antenna. <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-28:1:-1] [1:1:+28]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-28:2:-2] [2:2:28]</td><td>[-27:2:-1] [1:2:27]</td><td></td><td></td></tr><tr><td>3</td><td>[-28:3:-1] [2:3:26]</td><td>[-27:3:-3] [3:3:27]</td><td>[-26:3:-2] [1:3:28]</td><td></td></tr><tr><td>4</td><td>[-28:4:-4] [1:4:25]</td><td>[-27:4:-3] [2:4:26]</td><td>[-26:4:-2] [3:4:27]</td><td>[-25:4:-2] [4:4:28]</td></tr></table> Table 26: Tone partitioning into sets for 20MHz (56 tones) <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-58:1:-2] [2:1:+58]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-58:2:-2] [2:2:+58]</td><td>[-57:2:-3] [3:2:57]</td><td></td><td></td></tr><tr><td>3</td><td>[-58:3:-4] [2:3:56]</td><td>[-57:3:-3] [3:3:57]</td><td>[-56:3:-2] [4:3:58]</td><td></td></tr><tr><td>4</td><td>[-58:4:-2] [5:4:57]</td><td>[-57:4:-5] [2:4:58]</td><td>[-56:4:-4] [3:4:55]</td><td>[-55:4:-3] [4:4:56]</td></tr></table> Table 27: Tone partitioning into sets for 40MHz (114 tones) An example of tone interleaving across 4 transmit antennas is shown in Figure 34.	Nss	Set 0	Set 1	Set 2	Set 3	1	[-28:1:-1] [1:1:+28]				2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]			3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]		4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]	Nss	Set 0	Set 1	Set 2	Set 3	1	[-58:1:-2] [2:1:+58]				2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]			3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]		4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]
Nss	Set 0	Set 1	Set 2	Set 3																																															
1	[-28:1:-1] [1:1:+28]																																																		
2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]																																																	
3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]																																																
4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]																																															
Nss	Set 0	Set 1	Set 2	Set 3																																															
1	[-58:1:-2] [2:1:+58]																																																		
2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]																																																	
3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]																																																
4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]																																															

Claim Elements	Disclosure in the TGn Sync Proposal
	time Figure 34: HT-LTF tone interleaving across 4 spatial streams [2005 802.11n TGn Sync Specification at 94-98] 11.2.1.7.1 L-SIG Figure 36: SIGNAL field bit assignment In the 20MHz mode, the format of the LSIG field shall be the same as the SIGNAL field as defined in figure 111 in 17.3.4 in [1]. The combination of RATE and LENGTH is used to signal a station (OFDM mode only) the duration of a HT transmission. This duration does not have to be the actual duration of the HT frame. It can be used to reserve the medium beyond the actual transmission. The reservation of the medium through this kind of signalling is called “spoofing”.

Claim Elements	Disclosure in the TGn Sync Proposal
	To prevent a legacy station from accessing the medium during a HT frame transmission, the “duration” calculated from the RATE and LENGTH fields shall be at least as large as the actual duration of the HT frame, which is measured from the end of the L-SIG field to the end of the DATA field. During an HT transmission, the RATE field is set to 6Mbps, whereas the LENGTH field is set based on the “duration” value. In the 40MHz mode, the legacy signal field is duplicated such that tones are filled from -58 to -6 (lower-subchannel), and from +6 to +58 (upper-subchannel). The upper subchannel shall be phase rotated by 90 degrees, in the same way as the LTS as described in 11.2.1.6.2 The LSIG shall be transmitted in the same fashion as the legacy short and the legacy long training fields. If L-STF and L-LTF are transmitted from a single antenna, we index that antenna as $i_{Tx} = 1$ to be consistent with 11.2.1.6.2. Denote $LSIG_{-26,26}$ and $LSIG_{-58,58}$ as the LSIG OFDM symbol generated for 20 MHz and 40 MHz respectively. The L-SIG waveform is $r_{L-SIG}^{i_{Tx}}(t) = \frac{1}{\sqrt{N_{L-SIG}^{Tone}}} w_{L-SIG}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} LSIG_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (39)$ [2005 802.11n TGn Sync Specification at 98-99] 11.2.1.7.2 HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause 11.2.1.7.

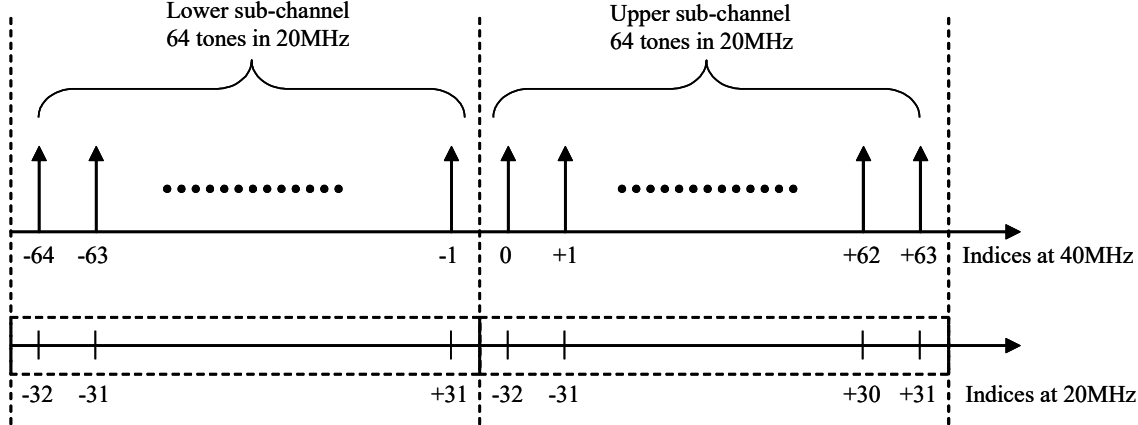
Claim Elements	Disclosure in the TGN Sync Proposal
	In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in 11.2.1.6.2. Figure 37 shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t - nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t - T_{GI} - nT_{Symb})) \quad (40)$ where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration.

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 37: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment [2005 802.11n TGn Sync Specification at 100-101] 11.2.1.7.2.10 SIGNALTAIL The bits 18-23 constitute the SIGNALTAIL field, and all 6 bits shall be set to zero. [2005 802.11n TGn Sync Specification at 104] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would have been obvious in view of the combination with PHY Updates to TGn Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005) (“2005 TGn Sync PHY Updates”). One of ordinary skill in the art would have been motivated to combine the 2005 802.11n TGn Sync Specification with the 2005 TGn Sync PHY Updates because the

Claim Elements	Disclosure in the TGn Sync Proposal
	documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync PHY Updates disclosed, for example: <u>May 2005</u> <u>doc.: IEEE 802.11-05/0418r0</u> Legacy Compatible Preamble ➔ Format remains unchanged from before The diagram illustrates the structure of the Legacy Compatible Preamble. It consists of six sequential fields, each represented by a rounded rectangle. Below each field is a double-headed arrow indicating its duration in microseconds (us). The fields and their durations are: L-STF (8 us), GI2 (1.6 us), L-LTS (3.2 us), L-LTS (3.2 us), GI (0.8 us), and L-SIG (3.2 us). The L-STF field is the largest, followed by the two L-LTS fields, and then the GI2, GI, and L-SIG fields. ➔ The legacy compatible preamble may be transmitted either from one antenna or from multiple antennas using CDD Submission Slide 8 Syed Aon Mujtaba, Agere Systems, et. al [2005 TGn Sync PHY Updates, at Slide 8]

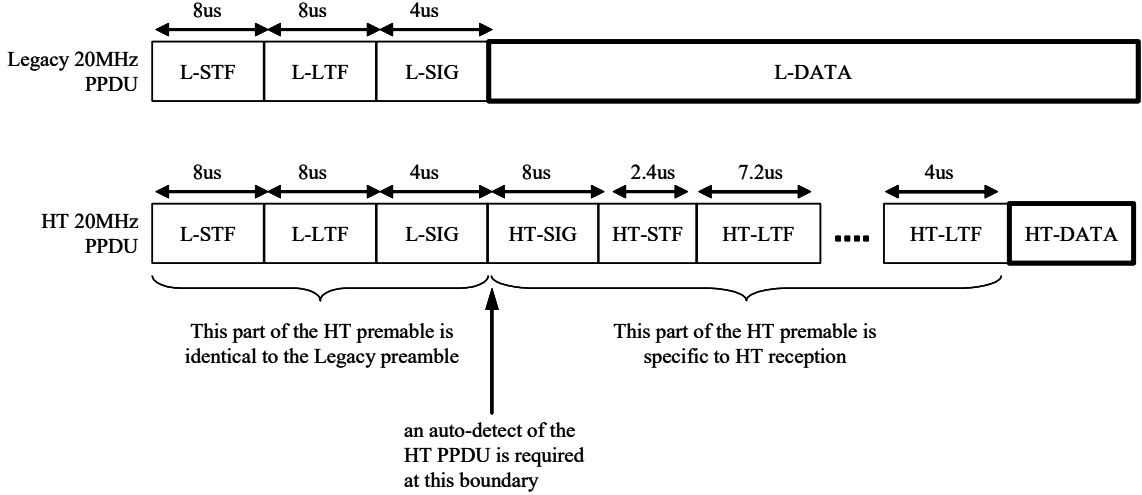
Claim Elements	Disclosure in the TGn Sync Proposal	
	May 2005	doc.: IEEE 802.11-05/0418r0
	HT-LTF 7.2us 4us 4us 4us $N_{ss}=1$ GI HT-LTS HT-LTS $N_{ss}=2$ GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS $N_{ss}=3$ GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS $N_{ss}=4$ GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS	
	Submission	Slide 11
	Syed Aon Mujtaba, Agere Systems, et. al.	

Claim Elements	Disclosure in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1: L-STF L-LTF L-SIG HT-SIG HT-STF HT-LTF ... HT-LTF HT-Data HT-Data ...

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 7: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.  Figure 8: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

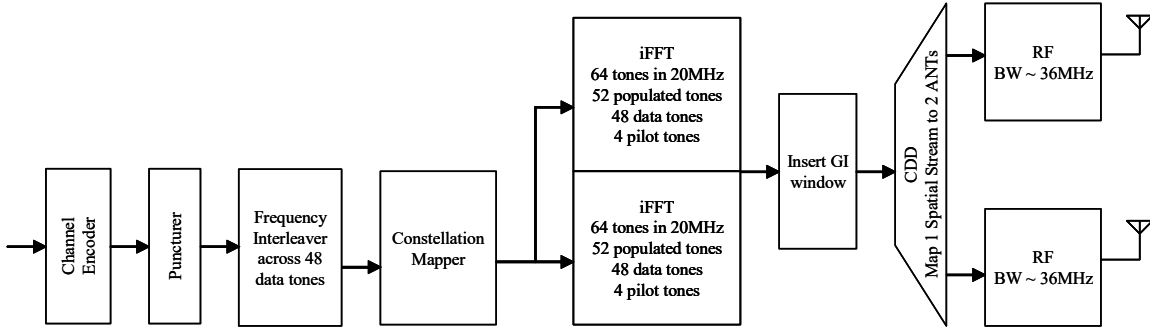
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 9: PPDU Format for 2x40 Basic MIMO Transmission⁵ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found.. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

⁵ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

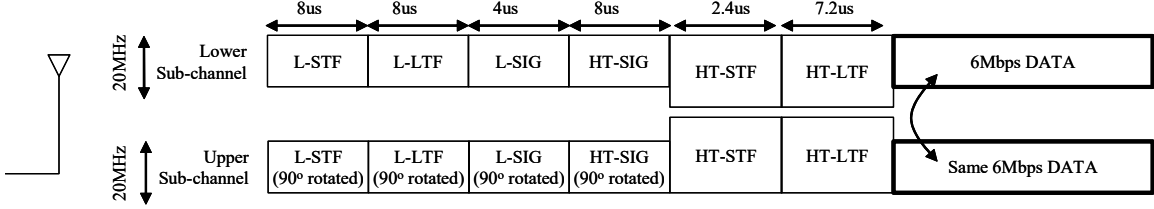
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 10: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGn Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 11: Transmitter configuration for 6Mbps in 40MHz⁶ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

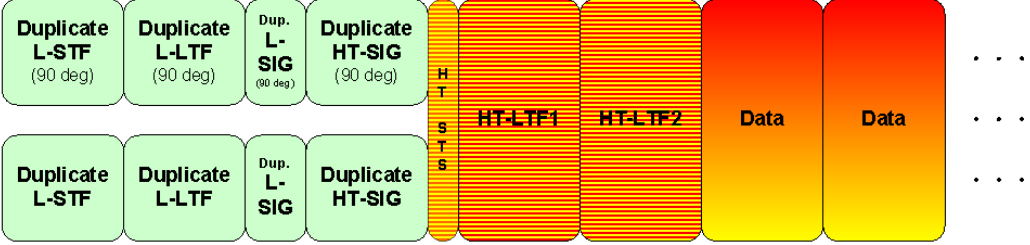
⁶ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 12: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, at 73-77]

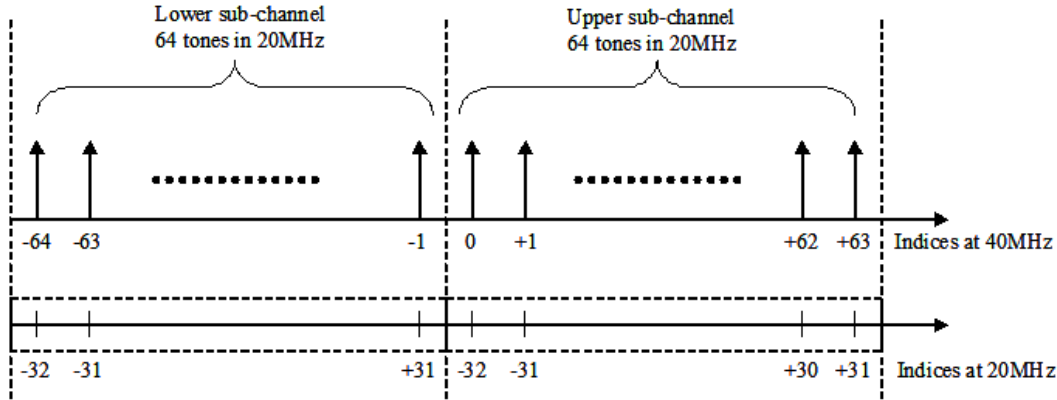
Claim Elements	Disclosure in the TGn Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> PPDU Format <u>Legend</u> L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field <u>Legacy Compatible</u> Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna  The diagrams show three antennas (1, 2, 3) each with a sequence of training fields. The fields are: STF (Space-Time Field), L LTF (Long LTF), L SIG (Long SIG), HT SIG (High Throughput SIG), HT STF (High Throughput STF), HT LTF (High Throughput LTF), and Data. The fields are color-coded: STF is green, L LTF is light green, L SIG is light green, HT SIG is light green, HT STF is orange, HT LTF is orange, and Data is red. The sequence of fields is: STF, L LTF, L SIG, HT SIG, HT STF, HT LTF, and Data. The diagrams are labeled 1, 2, and 3 for the three antennas. These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

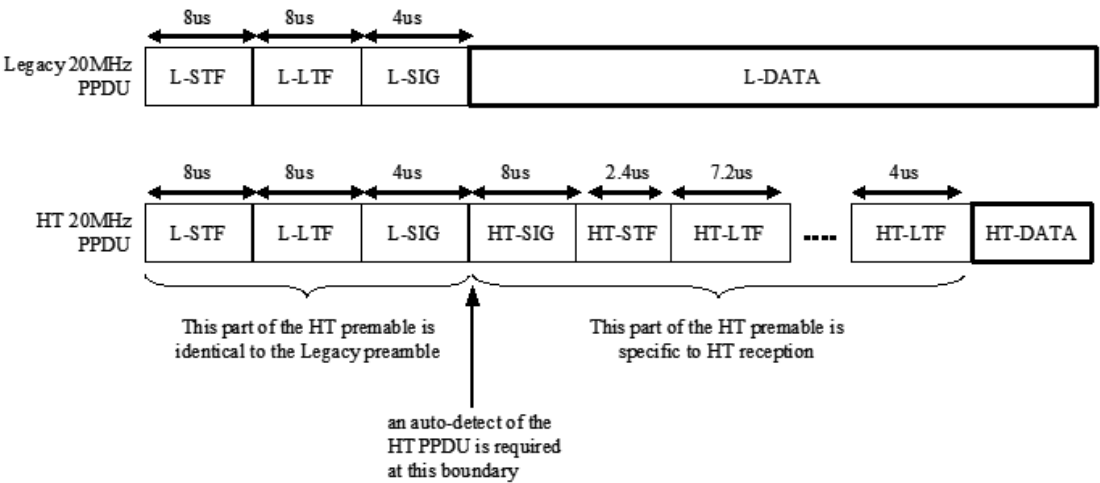
Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The diagram shows three antennas (1, 2, 3) transmitting a Legacy Compatible Preamble. Each antenna transmits a sequence of fields: L-STF, L-LTF, L-SIG, and HT-SIG. The L-STF, L-LTF, and L-SIG fields are shown as green rectangles, while the HT-SIG field is shown as an orange rectangle. The diagram illustrates that the L-STF, L-LTF, L-SIG, and HT-SIG fields are transmitted as a single spatial stream across all three antennas. or single antenna Antenna The diagram shows three antennas (1, 2, 3) transmitting a Legacy Compatible Preamble. Each antenna transmits a sequence of fields: L-STF, L-LTF, L-SIG, and HT-SIG. The L-STF, L-LTF, and L-SIG fields are shown as green rectangles, while the HT-SIG field is shown as an orange rectangle. The diagram illustrates that the L-STF, L-LTF, L-SIG, and HT-SIG fields are transmitted as a single spatial stream across all three antennas. The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the	The TGn Sync Proposal disclosed receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference disclosed:

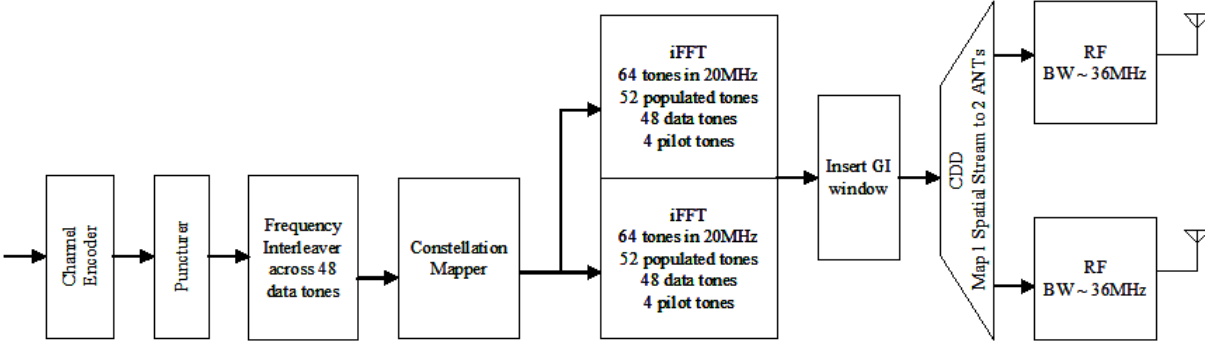
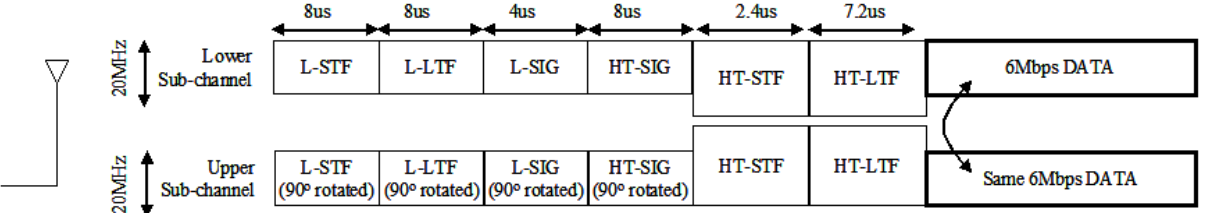
Claim Elements	Disclosure in the TGn Sync Proposal																								
first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	Table 14 summarizes the OFDM parameters for 20 and 40 MHz channels in comparison to the legacy 802.11 a/g formats. <table><tr><td></td><td>802.11a/g (20 MHz)</td><td>20 MHz Channel (Mandatory)</td><td>40 MHz Channel (Optional)</td></tr><tr><td>FFT size</td><td>64</td><td>64</td><td>128</td></tr><tr><td>Number of data subcarriers</td><td>48</td><td>52</td><td>108</td></tr><tr><td>Number of pilot subcarriers</td><td>4</td><td>4</td><td>6</td></tr></table> <table><tr><td>Subcarrier separation</td><td>312.5 kHz</td><td>312.5 kHz</td><td>312.5 kHz</td></tr><tr><td>Approx. Bandwidth</td><td>16.25 MHz</td><td>17.5 MHz</td><td>36.6 MHz</td></tr></table> Table 18: Summary of OFDM parameters [2005 802.11n TGn Sync Specification at 71-72] 11.1.1.3 PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 24: L-STF L-LTF L-SIG HT-SIG HT-STF HT-LTF ... HT-LTF HT-Data HT-Data ... Figure 24: PPDU Format		802.11a/g (20 MHz)	20 MHz Channel (Mandatory)	40 MHz Channel (Optional)	FFT size	64	64	128	Number of data subcarriers	48	52	108	Number of pilot subcarriers	4	4	6	Subcarrier separation	312.5 kHz	312.5 kHz	312.5 kHz	Approx. Bandwidth	16.25 MHz	17.5 MHz	36.6 MHz
	802.11a/g (20 MHz)	20 MHz Channel (Mandatory)	40 MHz Channel (Optional)																						
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Approx. Bandwidth	16.25 MHz	17.5 MHz	36.6 MHz																						

Claim Elements	Disclosure in the TGn Sync Proposal
	The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 25. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.  Figure 25: Upper and Lower sub-channel specification in 40MHz

Claim Elements	Disclosure in the TGn Sync Proposal
	The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 26. Figure 26: PPDU Format for 2x40 Basic MIMO Transmission⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 11.1.1.2.2. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 26. [2005 802.11n TGn Sync Specification at 73-74]

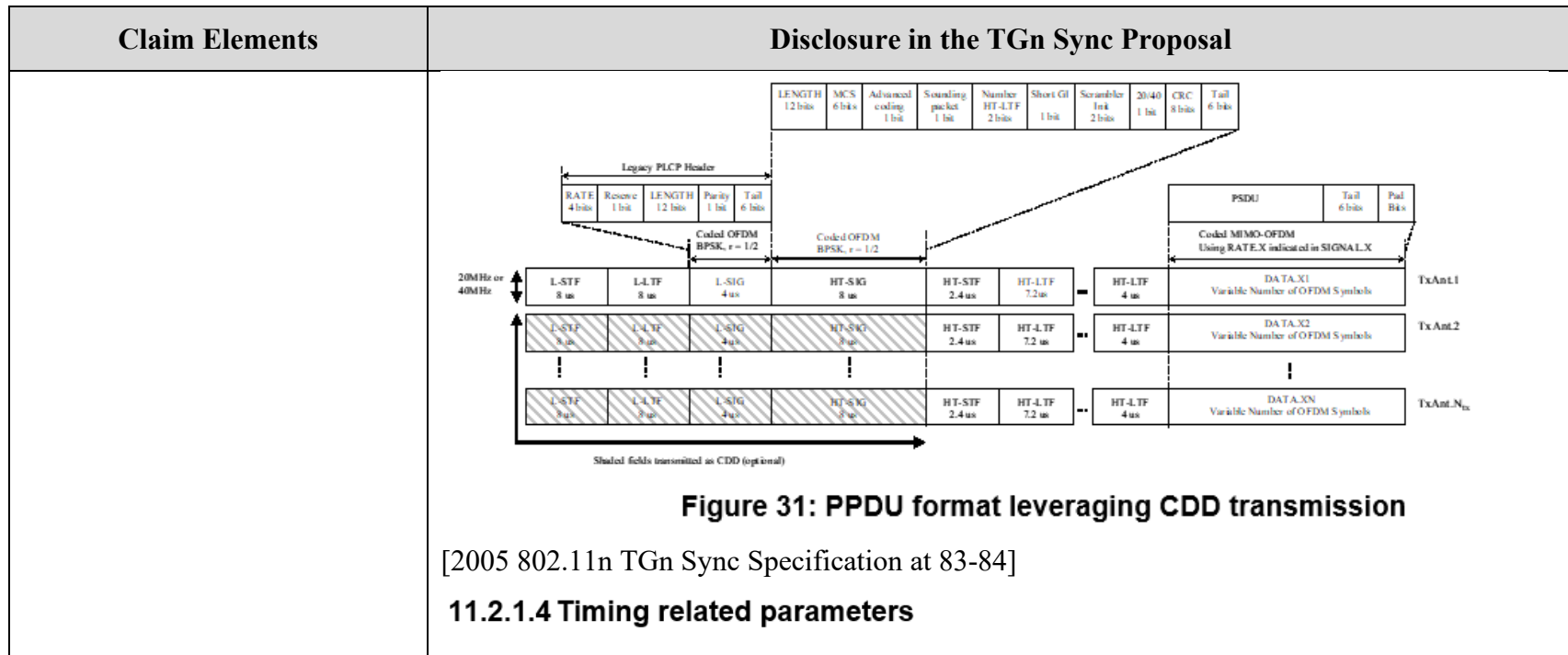
Claim Elements	Disclosure in the TGn Sync Proposal
	The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 27:  Figure 27: HT Preamble format [2005 802.11n TGn Sync Specification at 75]

Claim Elements	Disclosure in the TGn Sync Proposal
	After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in 11.2.1.6.4. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. [2005 802.11n TGn Sync Specification at 76] 11.1.1.5 Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 28.

Claim Elements	Disclosure in the TGN Sync Proposal
	 Figure 28: Transmitter configuration for 6Mbps in 40MHz⁸ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 26. The PPDU format for the 6Mbps duplicate mode is shown in Figure 29:  Figure 29: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Table 21). [2005 802.11n TGN Sync Specification at 77]

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2 PLCP Sublayer 11.2.1 Basic MIMO Mode As described in Table 20, the basic MIMO mode does not involve any spatial steering. The basic MIMO mode can operate in both 20MHz and 40MHz channel bandwidths. 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode: Figure 30: PPDU Format for N_{Tx} antennas

Claim Elements	Disclosure in the TGn Sync Proposal
	L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31:



Claim Elements	Disclosure in the TGn Sync Proposal		
	Parameter	Value for 20 MHz Channel	Value for 40 MHz Channel
	N_{SD} : Number of data subcarriers	52	108
	N_{SP} : Number of pilot subcarriers	4	6
	N_{SN} : Number of center null subcarriers	1 (tone = 0)	3 (tones = -1, <u>0</u> , +1)
	N_{SR} : Subcarrier range (index range)	28 (-28 ... +28)	58 (-58 ... +58)
	Δ_F : Subcarrier frequency spacing	0.3125 MHz (= 20 MHz / 64)	0.3125 MHz (= 40 MHz / 128)
	T_{FFT} : IFFT/FFT period	3.2 μ sec	3.2 μ sec
	T_{GI} : GI duration	0.8 μ sec	0.8 μ sec
	$T_{ShortGI}$: Short GI duration	0.4 μ sec	0.4 μ sec
	T_{GI2} : Legacy LongTraining symbol GI duration	1.6 μ sec	1.6 μ sec
	T_{SYM} : Symbol interval	4 μ sec	4 μ sec
	T_{L-STF} : Legacy STF duration	8 μ sec	8 μ sec
	T_{L-LTF} : Legacy LTF duration	8 μ sec	8 μ sec
	T_{L-SIG} : Legacy Signal Field duration	4 μ sec	4 μ sec
	T_{HT-SIG} : HT Signal Field duration	8 μ sec	8 μ sec
	T_{HT-STF} : HT Short training field duration	2.4 μ sec	2.4 μ sec
	$T_{HT-LTF1}$: HT Long training field duration	7.2 μ sec	7.2 μ sec
	$T_{HT-LTF2}$: HT Long training field duration	4 μ sec	4 μ sec
	T_S : Nyquist sampling interval	50nsec	25nsec
Table 23: Timing Related Parameters [2005 802.11n TGn Sync Specification at 88]			

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.6.1 Legacy Short Training Field The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is the L-STF is $S_{-28,28} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0\} \quad (17)$ The normalization factor $\sqrt{1/2}$ is the QPSK normalization. The legacy short training OFDM symbol in 40MHz mode is: $S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, 0, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0\} \quad (18)$ The tones in the upper subchannel (see Figure 25) are obtained by phase rotating the 802.11a short OFDM training symbol tones by 90 degrees, whereas the tones in the lower subchannel are identical to the 802.11a short training OFDM symbol tones. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz. The L-STF is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{L-STF}^{Tone}}} w_{L-STF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{TX}}^{L(k)} S_k \exp(j 2\pi k \Delta_F t) \quad (19)$ where we recall that $\mathbf{q}^{L(k)}$ is the column vector that defines the antenna map for the legacy compatible part. Observe that equation (19) is identical to the general expression (15) with $X_k^{(i_{TX})} = q_{i_{TX}}^{L(k)} S_k$.

Claim Elements	Disclosure in the TGn Sync Proposal
	The L-STs has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s, hence there are 10 L-STs in the L-STF. [2005 802.11n TGn Sync Specification at 91] 11.2.1.6.2 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\} \quad (20)$ The legacy long training OFDM signal in the 40MHz mode is given by: $L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0, \\ 1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,0,0,0,0,0, \\ 0,0,0,0,0,0,j,j,-j,-j,j,j,-j,j,-j,j,j,j,j,-j,-j,j,j,-j,j,-j,j,j,j,0, \\ j,-j,-j,j,j,-j,j,-j,j,-j,-j,-j,-j,-j,j,j,-j,-j,-j,j,j,j,j\} \quad (21)$

Claim Elements	Disclosure in the TGn Sync Proposal
	Tones in the upper subchannel (subcarriers +6 to +58) are obtained by phase rotating the 802.11a long OFDM training symbol tones by 90 degrees, whereas the tones within the lower subchannel (subcarriers -58 to -6) are identical to the 802.11a long OFDM training symbol tones. It should be noted that neither the legacy fields (L-STF, L-LTF, LSIG) nor the HT-SIG undergo any phase rotation in the lower subchannel. The subcarriers at ± 32 in 40MHz, which are the DC subcarriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is $r_{L-LTF}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{L-LTF}^{Tones}}} w_{T_{L-LTF}}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} L_k \exp(j 2 \pi k \Delta_F (t - T_{2GI})) \quad (22)$ where $T_{G12} = 1.6 \mu \text{ sec}$. Observe that equation (22) is identical to the general expression (15) with $X_k^{(i_{rx})} = q_{i_{rx}}^{L(k)} L_k$. Since $T_{L-LTF} = 8.0 \mu \text{ sec}$ and the symbol duration is $T_{FFT} = 3.2 \mu \text{ sec}$, we see that the L-LTF consists of a double GI followed by two full symbols. [2005 802.11n TGn Sync Specification at 91-92] 11.2.1.6.3 HT-Short Training Field The HT-STF follows the HT-SIG (see Figure 30), whose purpose it to “fine tune” the AGC for HT MIMO reception. Note that the first AGC operation is performed on the L-STF. The HT-STF for 20MHz is

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-26,26} = \frac{1}{\sqrt{2}} \left\{ \begin{array}{l} \{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 0\} \quad N_{Tx} = 1 \\ \\ \{0, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, \} \quad N_{Tx} = 2 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 3 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 4 \end{array} \right. \quad (23)$ The HT-STS for 40 MHz consists of 48 tones, and is given by:

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-58,58} = \frac{1}{\sqrt{2}}$ $\left\{ \begin{aligned} &\{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ &0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0, 0, 0, 0, \\ &0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, \\ &0, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 0\} \\ &\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, \\ &0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, \\ &0, 0, 0, 0, 0, 0, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, \\ &0, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \\ &\{0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ &0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0, \\ &0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, \\ &0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 0\} \\ &\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ &0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 0, 0, 0, 0, 0, \\ &0, 0, 0, 0, 0, 0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, \\ &0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \end{aligned} \right\}$ $N_{Tx} = 1$ $N_{Tx} = 2$ $N_{Tx} = 3$ $N_{Tx} = 4$ (24) In the duplicate 6Mbps mode in 40MHz, the HT-STF shown in (24) is used, except for a scaling factor change. The HT-STF signal is then generated by the following rule. $r_{HT-LTS}^{(i_{Tx})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sqrt{N_{TX}}$ $\sum_k q_{i_{Tx}, (k+N_{HT-STF}^{Tone}-u(k)) \% N_{SS}}^{(k)} HTS_k \exp(j2\pi k \Delta_F (t - T_{GI}))$ (25)

Claim Elements	Disclosure in the TGn Sync Proposal
	where $T_{GI} = 0.8 \mu s$, N_{HT-STF}^{Tone} is the number of active tones (= 24 for 20 MHz and 48 for 40 MHz), and $u(k)$ is the unit step function (= 0 for $k < 0$ and = 1 for $k \geq 0$). Tone interleaving across spatial streams works as follows. Define $i(k) = k + N_{HT-STF}^{Tone} - u(k)$, which appears in the column subscript of the Q-matrix. HTS_k is non-zero only for even values of the tone index k between $-N_{HT-STF}^{Tone}$ and $+N_{HT-STF}^{Tone}$, excluding $k = 0$. Thus, $i(k)$ runs through the integer values $0, \dots, N_{HT-STF}^{Tone} - 1$ as k runs through the even values $-N_{HT-STF}^{Tone}, \dots, -2, +2, \dots, +N_{HT-STF}^{Tone}$. The index $i(k)$ can be called the “interleaving index” because it is used to select the column of the Q-matrix, which define to spatial streams, that used on tone index k. We select spatial stream $i(k) \% N_{SS}$ for tone k. The HT-STF signal has a period of $1.6 \mu s$, which is deemed sufficient for power measurement purposes. Since the HT-STF is tone-interleaved at the transmitter, the power periodicity of the HT-STF is also $1.6 \mu s$. [2005 802.11n TGn Sync Specification at 92-94]

Claim Elements	Disclosure in the TGn Sync Proposal
	11.2.1.6.4 HT-Long Training Field The HT-LTFs are transmitted after the HT-STF. The number of HT-LTFs is equal to N_{LTF}. For any PPDU, there must be at least as many HT-LTFs as spatial streams in the HT Data portion of the PPDU, <u>i.e.</u> $N_{LTF} = N_{SS}$ (the number of spatial streams). For a sounding PPDU $N_{LTF} \geq N_{SS}$, because these PPDUs provide channel measurement capability for potentially more spatial dimensions than the number of spatial streams. In the case of a sounding packet, the HT-LTFs are partitioned as data HT-LTFs and extension HT-LTFs. The data HT-LTFs are the first N_{SS} fields, which are indexed $i_{LTF} = 0, \dots, N_{SS} - 1$. The last $N_{LTF} - N_{SS}$ HT-LTFs are the extension fields, which are indexed $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. The result is referred to as a segmented HT-LTF. As always, spatial streams are defined by columns of an orthogonal antenna map matrix $\mathbf{Q}^{(k)}$, with the first N_{SS} columns defining the spatial streams used for data transmission, and the last $N_{LTF} - N_{SS}$ columns defining the extension spatial streams. Thus, for the purpose of defining HT-LTFs, $\mathbf{Q}^{(k)}$ is an $N_{Tx} \times N_{LTF}$ dimension matrix. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second and all subsequent HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. To minimize the power fluctuation between the HT-LTF and the AGC setting (which is derived from the HT-STF), the HT-LTS is tone-interleaved across spatial streams, <u>similar to</u> the HT-STF definition. There are a total of 9 sequences. These sequences are defined to minimize PAPR for both direct MAP and spatial spreading, with tone-interleaving.

Claim Elements	Disclosure in the TGN Sync Proposal																																								
	Table 25: List of HT Long Training Fields <table><tr><th>Sequence Number</th><th>N_{TX}</th><th>BW</th><th>Comment</th></tr><tr><td>1</td><td>1</td><td>20MHz</td><td>56 tones</td></tr><tr><td>2</td><td>2</td><td>20MHz</td><td>56 tones</td></tr><tr><td>3</td><td>3</td><td>20MHz</td><td>56 tones</td></tr><tr><td>4</td><td>4</td><td>20MHz</td><td>56 tones</td></tr><tr><td>5</td><td>1</td><td>40MHz</td><td>Duplicate format, 6Mbps in 40MHz (104 Tones)</td></tr><tr><td>6</td><td>1</td><td>40MHz</td><td>114 tones</td></tr><tr><td>7</td><td>2</td><td>40MHz</td><td>114 tones</td></tr><tr><td>8</td><td>3</td><td>40MHz</td><td>114 tones</td></tr><tr><td>9</td><td>4</td><td>40MHz</td><td>114 tones</td></tr></table> In 20MHz, for $N_{TX} = 1$, sequence 1 is: $\text{HTL}_{-28:28} = [-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, 1, -1, 1, 0, -1, -1, -1, 1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1] \quad (26)$ In 20MHz, for $N_{TX} = 2$, sequence 2 is: $\text{HTL}_{-28:28} = [-1, -1, 1, 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, -1, 1, 0, -1, -1, -1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, 1, 1, 1, 1] \quad (27)$ In 20MHz, for $N_{TX} = 3$, sequence 3 is: $\text{HTL}_{-28:28} = [1, -1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, -1, 1, -1, -1, -1, 0, 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, -1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1] \quad (28)$	Sequence Number	N _{TX}	BW	Comment	1	1	20MHz	56 tones	2	2	20MHz	56 tones	3	3	20MHz	56 tones	4	4	20MHz	56 tones	5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)	6	1	40MHz	114 tones	7	2	40MHz	114 tones	8	3	40MHz	114 tones	9	4	40MHz	114 tones
Sequence Number	N _{TX}	BW	Comment																																						
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8	3	40MHz	114 tones																																						
9	4	40MHz	114 tones																																						

- 99 -

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTL_{-58,+58} = \{-1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1$ $1 1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 \quad (33)$ $0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1$ $-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1 \}$ The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets: In 40MHz, for $N_{TX} = 4$, sequence 9 is: $HTL_{-58,+58} = \{-1 1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 1 -1 1 -1$ $1 -1 -1 -1 -1 1 1 -1 -1 -1 1 1 1 1 -1 1 -1 -1 -1 1 1 1 1 1 -1 -1 -1 1 0 \quad (34)$ $0 0 -1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 1 1 -1 -1 -1 1 -1 -1 -1 1 -1 1 -1$ $-1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 -1 1 -1 -1 1 1 \}$ The HT-LTF is generated similarly to the HT-STF. For the data HT-LTFs $i_{LTF} = 0, \dots, N_{SS} - 1$, the signal is $r_{HT-LTF}^{(i_{TX}, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \quad (35)$ $\sum_{k=-N_{SR}}^{N_{SR}} \mathcal{Q}_{i_{TX}+(k+i_{LTF}+N_{SR}-u(k))\%N_{SS}}^{(k)} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI}))$

Claim Elements	Disclosure in the TGN Sync Proposal
	where $N_{SR} = 28$ for 20 MHz and 58 for 40 MHz, $u(k) = \begin{cases} 1 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 20 MHz} \quad (36)$ and $u(k) = \begin{cases} 3 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 40 MHz.} \quad (37)$ In the case of a sounding packet, the extension HT-LTFs are tone interleaved over the extension spatial dimensions. Thus, the extension HT-LTFs are $r_{HT-LTF}^{(i_D, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_D, N_{SS} + (k + (i_{LTF} - N_{SS}) + N_{SR} - u(k)) \% (N_{LTF} - N_{SS})} HTL_k \exp(j 2\pi k \Delta_F (t - T_{GI})) \quad (38)$ for $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. Since the HT-LTF is tone interleaved across antennas, the 56 tones are partitioned across the antenna array during each OFDM symbol. Tone partitioning into sets for 20MHz is shown in Table 26. At each OFDM symbol interval, each set of tones maps to one transmit antenna. And over time, all sets get mapped to an antenna.

Claim Elements	Disclosure in the TGN Sync Proposal																																																						
	<table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-28:1:-1] [1:1:+28]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-28:2:-2] [2:2:28]</td><td>[-27:2:-1] [1:2:27]</td><td></td><td></td></tr><tr><td>3</td><td>[-28:3:-1] [2:3:26]</td><td>[-27:3:-3] [3:3:27]</td><td>[-26:3:-2] [1:3:28]</td><td></td></tr><tr><td>4</td><td>[-28:4:-4] [1:4:25]</td><td>[-27:4:-3] [2:4:26]</td><td>[-26:4:-2] [3:4:27]</td><td>[-25:4:-2] [4:4:28]</td></tr></table> Table 26: Tone partitioning into sets for 20MHz (56 tones) <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-58:1:-2] [2:1:+58]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-58:2:-2] [2:2:+58]</td><td>[-57:2:-3] [3:2:57]</td><td></td><td></td></tr><tr><td>3</td><td>[-58:3:-4] [2:3:56]</td><td>[-57:3:-3] [3:3:57]</td><td>[-56:3:-2] [4:3:58]</td><td></td></tr><tr><td>4</td><td>[-58:4:-2] [5:4:57]</td><td>[-57:4:-5] [2:4:58]</td><td>[-56:4:-4] [3:4:55]</td><td>[-55:4:-3] [4:4:56]</td></tr></table> Table 27: Tone partitioning into sets for 40MHz (114 tones) An example of tone interleaving across 4 transmit antennas is shown in Figure 34.					Nss	Set 0	Set 1	Set 2	Set 3	1	[-28:1:-1] [1:1:+28]				2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]			3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]		4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]	Nss	Set 0	Set 1	Set 2	Set 3	1	[-58:1:-2] [2:1:+58]				2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]			3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]		4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]
Nss	Set 0	Set 1	Set 2	Set 3																																																			
1	[-28:1:-1] [1:1:+28]																																																						
2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]																																																					
3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]																																																				
4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]																																																			
Nss	Set 0	Set 1	Set 2	Set 3																																																			
1	[-58:1:-2] [2:1:+58]																																																						
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3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]																																																				
4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]																																																			

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 34: HT-LTF tone interleaving across 4 spatial streams [2005 802.11n TGn Sync Specification at 94-98] 11.2.1.7.1 L-SIG Figure 36: SIGNAL field bit assignment In the 20MHz mode, the format of the L-SIG field shall be the same as the SIGNAL field as defined in figure 111 in 17.3.4 in [1]. The combination of RATE and LENGTH is used to signal a station (OFDM mode only) the duration of a HT transmission. This duration does not have to be the actual duration of the HT frame. It can be used to reserve the medium beyond the actual transmission. The reservation of the medium through this kind of signalling is called “spoofing”.

Claim Elements	Disclosure in the TGn Sync Proposal
	To prevent a legacy station from accessing the medium during a HT frame transmission, the “duration” calculated from the RATE and LENGTH fields shall be at least as large as the actual duration of the HT frame, which is measured from the end of the L-SIG field to the end of the DATA field. During an HT transmission, the RATE field is set to 6Mbps, whereas the LENGTH field is set based on the “duration” value. In the 40MHz mode, the legacy signal field is duplicated such that tones are filled from -58 to -6 (lower-subchannel), and from +6 to +58 (upper-subchannel). The upper subchannel shall be phase rotated by 90 degrees, in the same way as the LTS as described in 11.2.1.6.2 The LSIG shall be transmitted in the same fashion as the legacy short and the legacy long training fields. If L-STF and L-LTF are transmitted from a single antenna, we index that antenna as $i_{Tx} = 1$ to be consistent with 11.2.1.6.2. Denote $LSIG_{-26,26}$ and $LSIG_{-58,58}$ as the LSIG OFDM symbol generated for 20 MHz and 40 MHz respectively. The L-SIG waveform is $r_{L-SIG}^{i_{Tx}}(t) = \frac{1}{\sqrt{N_{L-SIG}^{Tone}}} w_{L-SIG}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} LSIG_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (39)$ [2005 802.11n TGn Sync Specification at 98-99] 11.2.1.7.2 HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause 11.2.1.7.

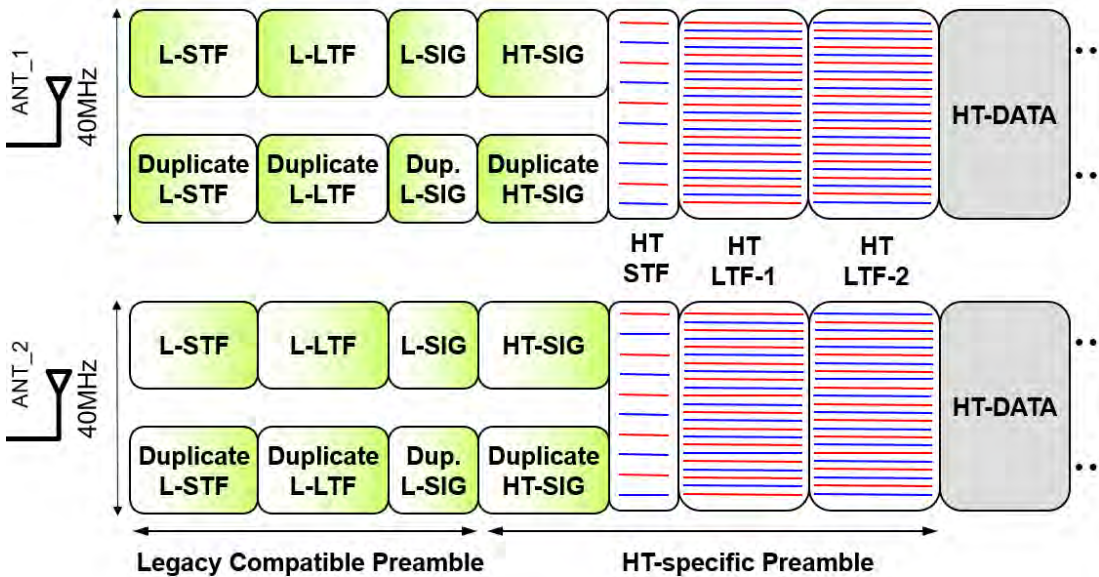
Claim Elements	Disclosure in the TGN Sync Proposal
	In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in 11.2.1.6.2 Figure 37 shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t - nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t - T_{GI} - nT_{Symb})) \quad (40)$ where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration.

Claim Elements	Disclosure in the TGn Sync Proposal																																																																																																																																																																																																																
	<table><tr><td colspan="12">HTLENGTH (12 bits)</td><td colspan="5">RESERVED (5 bits)</td><td colspan="7">MCS (7 bits)</td></tr><tr><td colspan="12">LSB</td><td colspan="5">MSB</td><td colspan="7">LSB</td><td colspan="2">MSB</td></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table> <table><tr><td colspan="12" rowspan="2"> ADV CODING (1 bit) RESERVED (1 bit) SOUNDING PACKET (1 bit) NUMBER HT-LTF (2 bit) SHORT GI (1 bit) RESERVED (1 bit) SCRAMBLER INIT (2 bits) 20/40 BW (1 bit) </td><td colspan="12">HT-SIG₁</td></tr><tr><td colspan="8">CRC (8 bits)</td><td colspan="6">SIGNAL TAIL (6 bits)</td></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table> <table><tr><td colspan="12"></td><td colspan="12">HT-SIG₂</td></tr><tr><td colspan="12">LSB</td><td colspan="12">MSB</td></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td></tr></table> Transmit Order Figure 37: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment [2005 802.11n TGn Sync Specification at 100-101] 11.2.1.7.2.10 SIGNALTAIL The bits 18-23 constitute the SIGNALTAIL field, and all 6 bits shall be set to zero. [2005 802.11n TGn Sync Specification at 104]	HTLENGTH (12 bits)												RESERVED (5 bits)					MCS (7 bits)							LSB												MSB					LSB							MSB		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	ADV CODING (1 bit) RESERVED (1 bit) SOUNDING PACKET (1 bit) NUMBER HT-LTF (2 bit) SHORT GI (1 bit) RESERVED (1 bit) SCRAMBLER INIT (2 bits) 20/40 BW (1 bit)												HT-SIG ₁												CRC (8 bits)								SIGNAL TAIL (6 bits)						0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23													HT-SIG ₂												LSB												MSB												0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
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Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.10.1.2 40MHz channel spacing The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 38MHz, -20dBr at 21 MHz frequency offset, and -45dBr at 60MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 2. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. Figure 44: Transmit spectrum mask for 40MHz channelization A HT device transmitting a 20MHz signal in a 40MHz BSS shall conform to the spectral mask shown in Figure 44. [2005 802.11n TGN Sync Specification at 115]

Claim Elements	Disclosure in the TGn Sync Proposal
	To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would have been obvious in view of the combination with PHY Updates to TGn Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005) (“2005 TGn Sync PHY Updates”). One of ordinary skill in the art would have been motivated to combine the 2005 802.11n TGn Sync Specification with the 2005 TGn Sync PHY Updates because the documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync PHY Updates disclosed, for example: <u>May 2005</u> <u>doc.: IEEE 802.11-05/0418r0</u> HT-LTF 7.2us 4us 4us 4us $N_{ss}=1$ GI HT-LTS HT-LTS $N_{ss}=2$ GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS $N_{ss}=3$ GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS $N_{ss}=4$ GI Tone interleaved HT-LTS Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS GI Tone interleaved HT-LTS Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

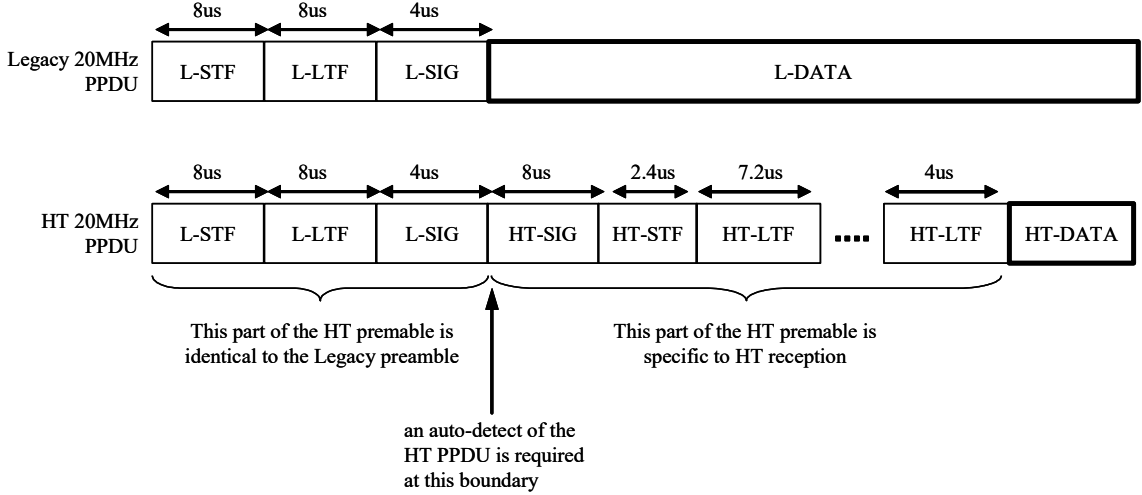
Claim Elements	Disclosure in the TGn Sync Proposal
	May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would also have been obvious in view of the combination with TGn Sync Complete Proposal, Document No. IEEE.11-04/888r9 (March 4, 2005) (“2005 TGn Sync Proposal Presentation”). One of ordinary skill in the art would have been motivated to combine the 2005 802.11n TGn Sync Specification and/or 2005 TGn Sync PHY Updates with the 2005

Claim Elements	Disclosure in the TGn Sync Proposal
	TGn Sync Proposal Presentation because the documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync Proposal Presentation disclosed, for example: <u>March 2005</u> <u>doc.: IEEE 802.11-04/888r9</u> HT-PPDU Format in 40MHz  Legacy Compatible Preamble HT-specific Preamble Submission Slide 50 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync Proposal Presentation, at Slide 50] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 13: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active. Figure 14: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

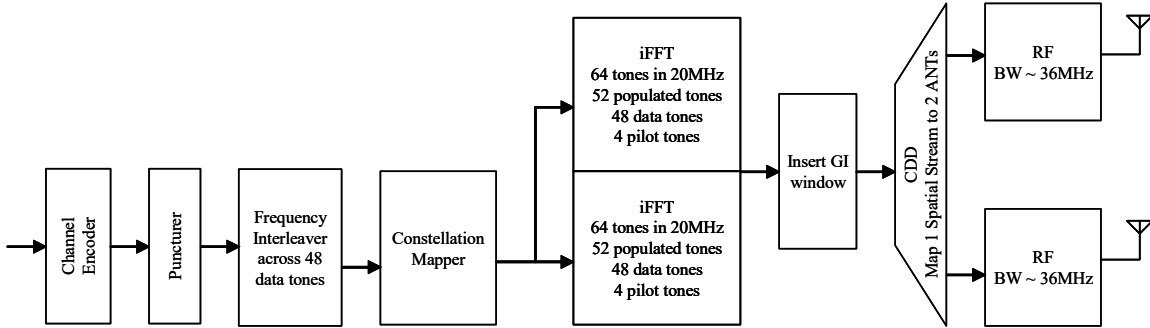
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 15: PPDU Format for 2x40 Basic MIMO Transmission⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

⁷ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

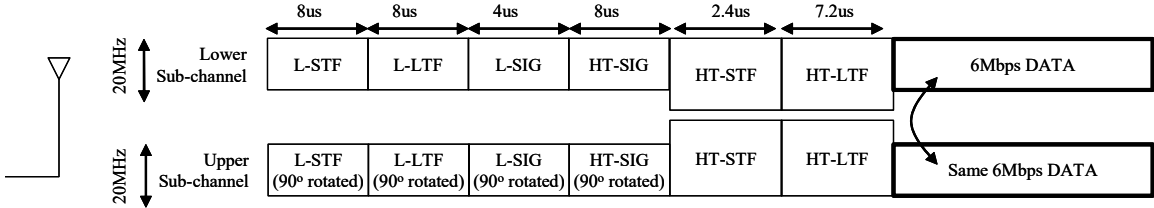
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 16: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGN Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 17: Transmitter configuration for 6Mbps in 40MHz⁸ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

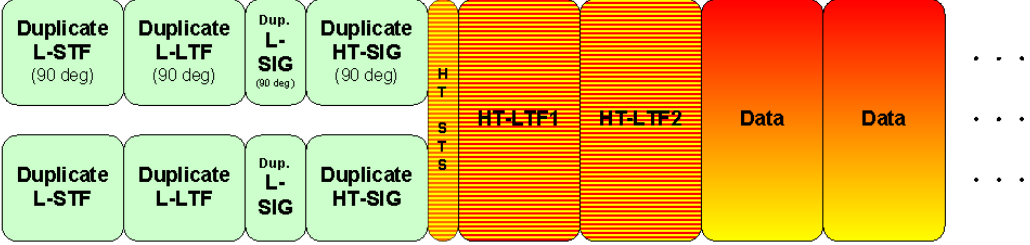
⁸ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 18: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, at 73-77]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data Legacy Compatible Preamble HT Part Legend L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field Legacy Compatible Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna  The diagrams show three antennas (1, 2, 3) over time. Each antenna's signal is represented by a sequence of colored blocks: green for STF, L LTF, L SIG; yellow for HT SIG, HT STF, HT LTF; and red for Data. The sequence is identical for all three antennas. Below the diagrams, the field names are listed: STF, L LTF, L SIG, HT SIG, HT STF, HT LTF, and Data. These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna L-STF L-LTF L-SIG HT-SIG or single antenna Antenna L-STF L-LTF L-SIG HT-SIG The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  The diagram illustrates the 40 MHz PPDU Format. It consists of two rows of duplicated fields. The top row contains: Duplicate L-STF (90 deg), Duplicate L-LTF (90 deg), Dup. L-SIG (90 deg), and Duplicate HT-SIG (90 deg). The bottom row contains: Duplicate L-STF, Duplicate L-LTF, Dup. L-SIG, and Duplicate HT-SIG. These are followed by a vertical column of four small yellow boxes labeled H, T, S, and S. To the right of these are two orange boxes labeled HT-LTF1 and HT-LTF2, followed by two red boxes labeled Data. Three sets of three dots (..., ..., ...) are shown to the right of the Data fields. • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	The TGn Sync Proposal disclosed demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference disclosed the following:

Claim Elements	Disclosure in the TGn Sync Proposal
	The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 26. Figure 26: PPDU Format for 2x40 Basic MIMO Transmission⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in 11.1.1.2.2. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 26. [2005 802.11n TGn Sync Specification at 74] The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF).

Claim Elements	Disclosure in the TGn Sync Proposal
	Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. [2005 802.11n TGn Sync Specification at 75] 11.2 PLCP Sublayer 11.2.1 Basic MIMO Mode As described in Table 20, the basic MIMO mode does not involve any spatial steering. The basic MIMO mode can operate in both 20MHz and 40MHz channel bandwidths. 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode:

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 30: PPDU Format for N_{TX} antennas L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of

Claim Elements	Disclosure in the TGN Sync Proposal
	the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2. The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31: Figure 31: PPDU format leveraging CDD transmission [2005 802.11n TGN Sync Specification at 83-84] 11.2.1.4 Timing related parameters

Claim Elements	Disclosure in the TGn Sync Proposal		
	Parameter	Value for 20 MHz Channel	Value for 40 MHz Channel
	N_{SD} : Number of data subcarriers	52	108
	N_{SP} : Number of pilot subcarriers	4	6
	N_{SN} : Number of center null subcarriers	1 (tone = 0)	3 (tones = -1, <u>0</u> , +1)
	N_{SR} : Subcarrier range (index range)	28 (-28 ... +28)	58 (-58 ... +58)
	Δ_F : Subcarrier frequency spacing	0.3125 MHz (= 20 MHz / 64)	0.3125 MHz (= 40 MHz / 128)
	T_{FFT} : IFFT/FFT period	3.2 μ sec	3.2 μ sec
	T_{GI} : GI duration	0.8 μ sec	0.8 μ sec
	$T_{ShortGI}$: Short GI duration	0.4 μ sec	0.4 μ sec
	T_{GI2} : Legacy LongTraining symbol GI duration	1.6 μ sec	1.6 μ sec
	T_{SYM} : Symbol interval	4 μ sec	4 μ sec
	T_{L-STF} : Legacy STF duration	8 μ sec	8 μ sec
	T_{L-LTF} : Legacy LTF duration	8 μ sec	8 μ sec
	T_{L-SIG} : Legacy Signal Field duration	4 μ sec	4 μ sec
	T_{HT-SIG} : HT Signal Field duration	8 μ sec	8 μ sec
	T_{HT-STF} : HT Short training field duration	2.4 μ sec	2.4 μ sec
	$T_{HT-LTF1}$: HT Long training field duration	7.2 μ sec	7.2 μ sec
	$T_{HT-LTF2}$: HT Long training field duration	4 μ sec	4 μ sec
	T_S : Nyquist sampling interval	50nsec	25nsec
Table 23: Timing Related Parameters [2005 802.11n TGn Sync Specification at 88]			

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.6.1 Legacy Short Training Field The L-STF is identical to the 802.11a short training symbol. The legacy short training OFDM symbol in the 20MHz mode is the L-STF is $S_{-28,28} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0\} \quad (17)$ The normalization factor $\sqrt{1/2}$ is the QPSK normalization. The legacy short training OFDM symbol in 40MHz mode is: $S_{-58,58} = \sqrt{1/2} \{0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, -1 - j, 0, 0, 0, -1 - j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 1 + j, 0, 0, 0, 0, 0, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, 0, 0, 0, 0, -j + 1, 0, 0, 0, -j + 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0, j - 1, 0, 0, 0\} \quad (18)$ The tones in the upper subchannel (see Figure 25) are obtained by phase rotating the 802.11a short OFDM training symbol tones by 90 degrees, whereas the tones in the lower subchannel are identical to the 802.11a short training OFDM symbol tones. The 90° rotation helps keep the PAPR of the STF in 40MHz comparable to that in 20MHz. The L-STF is $r_{L-STF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{L-STF}^{Tone}}} w_{L-STF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{TX}}^{L(k)} S_k \exp(j 2\pi k \Delta_F t) \quad (19)$ where we recall that $\mathbf{q}^{L(k)}$ is the column vector that defines the antenna map for the legacy compatible part. Observe that equation (19) is identical to the general expression (15) with $X_k^{(i_{TX})} = q_{i_{TX}}^{L(k)} S_k$.

Claim Elements	Disclosure in the TGn Sync Proposal
	The L-STs has a period of 0.8 μs. The entire short training field includes ten such periods, with a total duration of $T_{L-STF} = 8 \mu$s, hence there are 10 L-STs in the L-STF. [91] 11.2.1.6.2 Legacy Long Training Field The legacy long training OFDM symbol is identical to the 802.11a long training OFDM symbol. In the 20MHz mode, the long training OFDM symbol is given by $L_{-26,26} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, -1, 1, 1, 1, 1\} \quad (20)$ The legacy long training OFDM signal in the 40MHz mode is given by: $L_{-58,58} = \{1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 0, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, -1, -1, -1, -1, 1, 1, -1, -1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, j, j, -j, -j, j, j, -j, j, -j, j, j, j, j, j, -j, -j, j, j, -j, j, -j, j, j, j, 0, j, -j, -j, j, j, -j, j, -j, j, -j, -j, -j, -j, -j, -j, j, j, -j, -j, j, j, -j, j, j, j\} \quad (21)$

Claim Elements	Disclosure in the TGN Sync Proposal
	Tones in the upper subchannel (subcarriers +6 to +58) are obtained by phase rotating the 802.11a long OFDM training symbol tones by 90 degrees, whereas the tones within the lower subchannel (subcarriers -58 to -6) are identical to the 802.11a long OFDM training symbol tones. It should be noted that neither the legacy fields (L-STF, L-LTF, LSIG) nor the HT-SIG undergo any phase rotation in the lower subchannel. The subcarriers at ± 32 in 40MHz, which are the DC subcarriers for the legacy 20MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20MHz legacy device. The L-LTF waveform is $r_{L-LTF}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{L-LTF}^{Tone}}} w_{T_{L-LTF}}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} L_k \exp(j 2 \pi k \Delta_F (t - T_{GI})) \quad (22)$ where $T_{GI} = 1.6 \mu \text{ sec}$. Observe that equation (22) is identical to the general expression (15) with $X_k^{(i_{rx})} = q_{i_{rx}}^{L(k)} L_k$. Since $T_{L-LTF} = 8.0 \mu \text{ sec}$ and the symbol duration is $T_{FFT} = 3.2 \mu \text{ sec}$, we see that the L-LTF consists of a double GI followed by two full symbols. [91-92] 11.2.1.6.3 HT-Short Training Field The HT-STF follows the HT-SIG (see Figure 30), whose purpose it to “fine tune” the AGC for HT MIMO reception. Note that the first AGC operation is performed on the L-STF. The HT-STF for 20MHz is

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-26,26} = \frac{1}{\sqrt{2}} \begin{cases} \{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\} \quad N_{Tx} = 1 \\ \\ \{0, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, \\ 0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, \} \quad N_{Tx} = 2 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 3 \\ \\ \{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, \\ 0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\} \quad N_{Tx} = 4 \end{cases} \quad (23)$ The HT-STS for 40 MHz consists of 48 tones, and is given by:

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTS_{-58,58} = \frac{1}{\sqrt{2}}$ $\{0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, N_{Tx} = 1$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0,$ $0, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0, -1-j, 0, 1+j, 0,$ $0, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 0\}$ $\{0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 0, 0, 0, 0, 0,$ $0, 0, 0, 0, 0, 0, 0, 1+j, 0, -1-j, 0, 1+j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, 1+j, 0, -1-j, 0, -1-j, 0,$ $0, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, -1-j, 0, -1-j, 0, 1+j, 0, 1+j, 0, -1-j, 0, 0\}$ $N_{Tx} = 2$ $N_{Tx} = 3$ $N_{Tx} = 4$ (24) In the duplicate 6Mbps mode in 40MHz, the HT-STF shown in (24) is used, except for a scaling factor change. The HT-STF signal is then generated by the following rule. $r_{HT-LTS}^{(i_{Tx})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sqrt{N_{TX}}$ $\sum_k q_{i_{Tx}, (k+N_{HT-STF}^{Tone}-u(k)) \% N_{SS}}^{(k)} HTS_k \exp(j2\pi k \Delta_F(t - T_{GI}))$ (25)

Claim Elements	Disclosure in the TGn Sync Proposal
	where $T_{GI} = 0.8 \mu s$, N_{HT-STF}^{Tone} is the number of active tones (= 24 for 20 MHz and 48 for 40 MHz), and $u(k)$ is the unit step function (= 0 for $k < 0$ and = 1 for $k \geq 0$). Tone interleaving across spatial streams works as follows. Define $i(k) = k + N_{HT-STF}^{Tone} - u(k)$, which appears in the column subscript of the Q-matrix. HTS_k is non-zero only for even values of the tone index k between $-N_{HT-STF}^{Tone}$ and $+N_{HT-STF}^{Tone}$, excluding $k = 0$. Thus, $i(k)$ runs through the integer values $0, \dots, N_{HT-STF}^{Tone} - 1$ as k runs through the even values $-N_{HT-STF}^{Tone}, \dots, -2, +2, \dots, +N_{HT-STF}^{Tone}$. The index $i(k)$ can be called the “interleaving index” because it is used to select the column of the Q-matrix, which define to spatial streams, that used on tone index k. We select spatial stream $i(k) \% N_{SS}$ for tone k. The HT-STF signal has a period of $1.6 \mu s$, which is deemed sufficient for power measurement purposes. Since the HT-STF is tone-interleaved at the transmitter, the power periodicity of the HT-STF is also $1.6 \mu s$. [2005 802.11n TGn Sync Specification at 92-94]

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.6.4 HT-Long Training Field The HT-LTFs are transmitted after the HT-STF. The number of HT-LTFs is equal to N_{LTF}. For any PPDU, there must be at least as many HT-LTFs as spatial streams in the HT Data portion of the PPDU, <u>i.e.</u> $N_{LTF} = N_{SS}$ (the number of spatial streams). For a sounding PPDU $N_{LTF} \geq N_{SS}$, because these PPDUs provide channel measurement capability for potentially more spatial dimensions than the number of spatial streams. In the case of a sounding packet, the HT-LTFs are partitioned as data HT-LTFs and extension HT-LTFs. The data HT-LTFs are the first N_{SS} fields, which are indexed $i_{LTF} = 0, \dots, N_{SS} - 1$. The last $N_{LTF} - N_{SS}$ HT-LTFs are the extension fields, which are indexed $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. The result is referred to as a segmented HT-LTF. As always, spatial streams are defined by columns of an orthogonal antenna map matrix $\mathbf{Q}^{(k)}$, with the first N_{SS} columns defining the spatial streams used for data transmission, and the last $N_{LTF} - N_{SS}$ columns defining the extension spatial streams. Thus, for the purpose of defining HT-LTFs, $\mathbf{Q}^{(k)}$ is an $N_{Tx} \times N_{LTF}$ dimension matrix. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second and all subsequent HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. To minimize the power fluctuation between the HT-LTF and the AGC setting (which is derived from the HT-STF), the HT-LTS is tone-interleaved across spatial streams, <u>similar to</u> the HT-STF definition. There are a total of 9 sequences. These sequences are defined to minimize PAPR for both direct MAP and spatial spreading, with tone-interleaving.

Claim Elements	Disclosure in the TGN Sync Proposal																																								
	Table 25: List of HT Long Training Fields <table><tr><th>Sequence Number</th><th>N_{TX}</th><th>BW</th><th>Comment</th></tr><tr><td>1</td><td>1</td><td>20MHz</td><td>56 tones</td></tr><tr><td>2</td><td>2</td><td>20MHz</td><td>56 tones</td></tr><tr><td>3</td><td>3</td><td>20MHz</td><td>56 tones</td></tr><tr><td>4</td><td>4</td><td>20MHz</td><td>56 tones</td></tr><tr><td>5</td><td>1</td><td>40MHz</td><td>Duplicate format, 6Mbps in 40MHz (104 Tones)</td></tr><tr><td>6</td><td>1</td><td>40MHz</td><td>114 tones</td></tr><tr><td>7</td><td>2</td><td>40MHz</td><td>114 tones</td></tr><tr><td>8</td><td>3</td><td>40MHz</td><td>114 tones</td></tr><tr><td>9</td><td>4</td><td>40MHz</td><td>114 tones</td></tr></table> In 20MHz, for $N_{TX} = 1$, sequence 1 is: $\text{HTL}_{-28:28} = [-1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, 1, -1, 1, 0, -1, -1, -1, 1, -1, -1, -1, -1, -1, -1, 1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1, 1, -1, -1, -1] \quad (26)$ In 20MHz, for $N_{TX} = 2$, sequence 2 is: $\text{HTL}_{-28:28} = [-1, -1, 1, 1, 1, -1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, 1, -1, 0, -1, -1, -1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, 1, 1, 1] \quad (27)$ In 20MHz, for $N_{TX} = 3$, sequence 3 is: $\text{HTL}_{-28:28} = [1, -1, -1, -1, 1, 1, 1, 1, -1, 1, -1, -1, -1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, -1, 1, -1, -1, -1, 0, 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, 1, -1, -1, -1, -1, -1, 1, 1, 1, -1, -1, 1] \quad (28)$	Sequence Number	N _{TX}	BW	Comment	1	1	20MHz	56 tones	2	2	20MHz	56 tones	3	3	20MHz	56 tones	4	4	20MHz	56 tones	5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)	6	1	40MHz	114 tones	7	2	40MHz	114 tones	8	3	40MHz	114 tones	9	4	40MHz	114 tones
Sequence Number	N _{TX}	BW	Comment																																						
1	1	20MHz	56 tones																																						
2	2	20MHz	56 tones																																						
3	3	20MHz	56 tones																																						
4	4	20MHz	56 tones																																						
5	1	40MHz	Duplicate format, 6Mbps in 40MHz (104 Tones)																																						
6	1	40MHz	114 tones																																						
7	2	40MHz	114 tones																																						
8	3	40MHz	114 tones																																						
9	4	40MHz	114 tones																																						

Claim Elements	Disclosure in the TGn Sync Proposal
	(29) In 20MHz, for $N_{TX} = 4$, sequence 4 is: $\text{HTL}_{-28,28}=[1, 1, 1, 1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, 1, -1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 0, \\ -1, 1, 1, -1, -1, -1, 1, 1, 1, -1, -1, -1, 1, 1, -1, 1, 1, -1, -1, 1, -1, -1, 1] \quad (30)$ In the 40MHz mode, the subcarriers at $k = \pm 32$ are populated in the HT-STSS. In 40MHz, for $N_{TX} = 1$, sequence 5 is identical to sequence 6. Sequence 5 is used in the duplicate 6Mbps mode, whereby only 104 tones are needed, whereas sequence 6 corresponds to the 114 tones. Note that all 114 tones are transmitted in the 6Mbps duplicate mode. $\begin{aligned} \text{HTL}_{-58,+58} = \{-1 & 1 1 1 1 -1 1 1 -1 -1 -1 -1 1 1 1 1 1 -1 1 1 -1 1 -1 1 1 -1 -1 \\ & 1 1 -1 -1 1 1 -1 -1 -1 -1 -1 1 -1 1 1 -1 -1 -1 -1 1 1 -1 1 1 1 \\ & 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 1 -1 1 1 -1 -1 1 -1 1 -1 1 \\ & -1 1 -1 -1 -1 -1 1 1 -1 1 -1 -1 -1 1 -1 1 -1 1 1 -1 1 -1 -1 1 -1 1 1\} \end{aligned} \quad (31)$ In 40MHz, for $N_{TX} = 2$, sequence 7 is: $\begin{aligned} \text{HTL}_{-58,+58} = \{-1 & 1 1 1 1 1 -1 1 1 -1 -1 -1 -1 1 1 -1 1 1 -1 1 1 -1 1 1 -1 \\ & -1 1 1 -1 -1 1 1 -1 -1 -1 1 -1 1 -1 1 1 -1 -1 -1 -1 -1 1 -1 1 -1 1 \\ & 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 1 -1 1 1 -1 1 1 -1 1 1 \\ & 1 -1 -1 -1 -1 1 1 -1 1 -1 -1 -1 -1 1 1 1 1 -1 1 1 -1 1 1 1\} \end{aligned} \quad (32)$ In 40MHz, for $N_{TX} = 3$, sequence 8 is:

Claim Elements	Disclosure in the TGN Sync Proposal
	$HTL_{-58,+58} = \{-1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1 1$ $1 1 1 1 1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 \quad (33)$ $0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1$ $-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1 \}$ The tone-interleaving rule across 3 antennas in 40MHz is grouped into 3 sets: In 40MHz, for $N_{TX} = 4$, sequence 9 is: $HTL_{-58,+58} = \{-1 1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 1 1 -1 -1 -1 -1 1 -1 -1 1 -1 1 -1$ $1 -1 -1 -1 -1 1 1 -1 -1 -1 1 1 1 1 -1 1 -1 1 -1 1 1 1 1 1 -1 -1 -1 1 0 \quad (34)$ $0 0 -1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 1 1 -1 -1 -1 1 -1 -1 -1 1 -1 1 -1$ $-1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 1 1 1 -1 1 1 -1 1 -1 -1 1 1 \}$ The HT-LTF is generated similarly to the HT-STF. For the data HT-LTFs $i_{LTF} = 0, \dots, N_{SS} - 1$, the signal is $r_{HT-LTF}^{(i_{TX}, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} \mathcal{Q}_{i_{TX}+(k+i_{LTF}+N_{SR}-u(k))\%N_{SS}}^{(k)} HTL_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (35)$

Claim Elements	Disclosure in the TGN Sync Proposal
	where $N_{SR} = 28$ for 20 MHz and 58 for 40 MHz, $u(k) = \begin{cases} 1 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 20 MHz} \quad (36)$ and $u(k) = \begin{cases} 3 & k > 0 \\ 0 & k < 0 \end{cases} \quad \text{for 40 MHz.} \quad (37)$ In the case of a sounding packet, the extension HT-LTFs are tone interleaved over the extension spatial dimensions. Thus, the extension HT-LTFs are $r_{HT-LTF}^{(i_D, i_{LTF})}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone}}} w_{HT-LTF}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_D, N_{SS} + (k + (i_{LTF} - N_{SS}) + N_{SR} - u(k)) \% (N_{LTF} - N_{SS})} HTL_k \exp(j 2\pi k \Delta_F (t - T_{GI})) \quad (38)$ for $i_{LTF} = N_{SS}, \dots, N_{LTF} - 1$. Since the HT-LTF is tone interleaved across antennas, the 56 tones are partitioned across the antenna array during each OFDM symbol. Tone partitioning into sets for 20MHz is shown in Table 26. At each OFDM symbol interval, each set of tones maps to one transmit antenna. And over time, all sets get mapped to an antenna.

Claim Elements	Disclosure in the TGN Sync Proposal																																																						
	<table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-28:1:-1] [1:1:+28]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-28:2:-2] [2:2:28]</td><td>[-27:2:-1] [1:2:27]</td><td></td><td></td></tr><tr><td>3</td><td>[-28:3:-1] [2:3:26]</td><td>[-27:3:-3] [3:3:27]</td><td>[-26:3:-2] [1:3:28]</td><td></td></tr><tr><td>4</td><td>[-28:4:-4] [1:4:25]</td><td>[-27:4:-3] [2:4:26]</td><td>[-26:4:-2] [3:4:27]</td><td>[-25:4:-2] [4:4:28]</td></tr></table> Table 26: Tone partitioning into sets for 20MHz (56 tones) <table><tr><th>Nss</th><th>Set 0</th><th>Set 1</th><th>Set 2</th><th>Set 3</th></tr><tr><td>1</td><td>[-58:1:-2] [2:1:+58]</td><td></td><td></td><td></td></tr><tr><td>2</td><td>[-58:2:-2] [2:2:+58]</td><td>[-57:2:-3] [3:2:57]</td><td></td><td></td></tr><tr><td>3</td><td>[-58:3:-4] [2:3:56]</td><td>[-57:3:-3] [3:3:57]</td><td>[-56:3:-2] [4:3:58]</td><td></td></tr><tr><td>4</td><td>[-58:4:-2] [5:4:57]</td><td>[-57:4:-5] [2:4:58]</td><td>[-56:4:-4] [3:4:55]</td><td>[-55:4:-3] [4:4:56]</td></tr></table> Table 27: Tone partitioning into sets for 40MHz (114 tones) An example of tone interleaving across 4 transmit antennas is shown in Figure 34.					Nss	Set 0	Set 1	Set 2	Set 3	1	[-28:1:-1] [1:1:+28]				2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]			3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]		4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]	Nss	Set 0	Set 1	Set 2	Set 3	1	[-58:1:-2] [2:1:+58]				2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]			3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]		4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]
Nss	Set 0	Set 1	Set 2	Set 3																																																			
1	[-28:1:-1] [1:1:+28]																																																						
2	[-28:2:-2] [2:2:28]	[-27:2:-1] [1:2:27]																																																					
3	[-28:3:-1] [2:3:26]	[-27:3:-3] [3:3:27]	[-26:3:-2] [1:3:28]																																																				
4	[-28:4:-4] [1:4:25]	[-27:4:-3] [2:4:26]	[-26:4:-2] [3:4:27]	[-25:4:-2] [4:4:28]																																																			
Nss	Set 0	Set 1	Set 2	Set 3																																																			
1	[-58:1:-2] [2:1:+58]																																																						
2	[-58:2:-2] [2:2:+58]	[-57:2:-3] [3:2:57]																																																					
3	[-58:3:-4] [2:3:56]	[-57:3:-3] [3:3:57]	[-56:3:-2] [4:3:58]																																																				
4	[-58:4:-2] [5:4:57]	[-57:4:-5] [2:4:58]	[-56:4:-4] [3:4:55]	[-55:4:-3] [4:4:56]																																																			

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 34: HT-LTF tone interleaving across 4 spatial streams [2005 802.11n TGn Sync Specification at 94-98] 11.2.1.7.1 L-SIG Figure 36: SIGNAL field bit assignment In the 20MHz mode, the format of the LSIG field shall be the same as the SIGNAL field as defined in figure 111 in 17.3.4 in [1]. The combination of RATE and LENGTH is used to signal a station (OFDM mode only) the duration of a HT transmission. This duration does not have to be the actual duration of the HT frame. It can be used to reserve the medium beyond the actual transmission. The reservation of the medium through this kind of signalling is called “spoofing”.

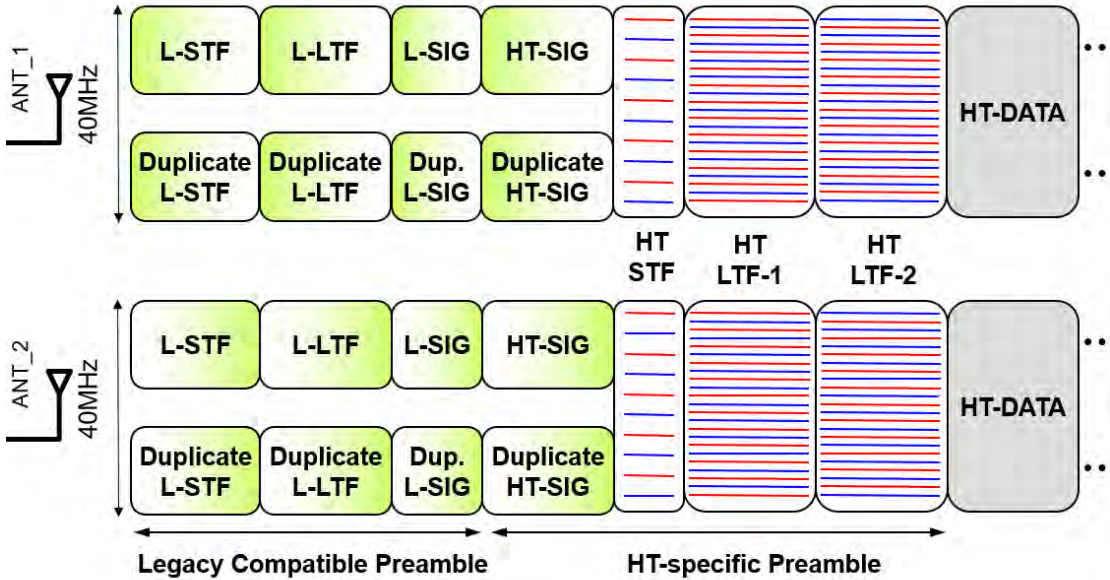
Claim Elements	Disclosure in the TGn Sync Proposal
	To prevent a legacy station from accessing the medium during a HT frame transmission, the “duration” calculated from the RATE and LENGTH fields shall be at least as large as the actual duration of the HT frame, which is measured from the end of the L-SIG field to the end of the DATA field. During an HT transmission, the RATE field is set to 6Mbps, whereas the LENGTH field is set based on the “duration” value. In the 40MHz mode, the legacy signal field is duplicated such that tones are filled from -58 to -6 (lower-subchannel), and from +6 to +58 (upper-subchannel). The upper subchannel shall be phase rotated by 90 degrees, in the same way as the LTS as described in 11.2.1.6.2 The LSIG shall be transmitted in the same fashion as the legacy short and the legacy long training fields. If L-STF and L-LTF are transmitted from a single antenna, we index that antenna as $i_{Tx} = 1$ to be consistent with 11.2.1.6.2. Denote $LSIG_{-26,26}$ and $LSIG_{-58,58}$ as the LSIG OFDM symbol generated for 20 MHz and 40 MHz respectively. The L-SIG waveform is $r_{L-SIG}^{i_{Tx}}(t) = \frac{1}{\sqrt{N_{L-SIG}^{Tone}}} w_{L-SIG}(t) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{Tx}}^{L(k)} LSIG_k \exp(j2\pi k \Delta_F(t - T_{GI})) \quad (39)$ [2005 802.11n TGn Sync Specification at 98-99] 11.2.1.7.2 HT-SIG The L-SIG field shall be followed by the HT-SIG, which serves as the signal field for the HT PHY. HT-SIG consists of two OFDM symbols: HT-SIG1 and HT-SIG2. HT-SIG1 shall be transmitted first in time. The encoding of HT-SIG-1 and HT-SIG-2 shall be the same as L-SIG, with the exception that the BPSK modulation is rotated 90 degrees as described in clause 11.2.1.7.

Claim Elements	Disclosure in the TGN Sync Proposal
	In the 40MHz mode, the HT-SIG-1 and HT-SIG-2 are duplicated. The upper sub-channel shall be phase rotated by 90 degrees in the same way as the L-LTF, as described in 11.2.1.6.2 Figure 37 shows the bit assignment for the two symbols. They will be described in the next clauses. HT-SIG-1 and HT-SIG-2 shall be transmitted in a similar fashion as the LSIG. Denote $HTSIG_{-26,26}^0$ and $HTSIG_{-58,58}^1$ as the first and second OFDM symbol of the following defined HT-SIG as a data field. Then $r_{HT-SIG}^{(i_{rx})}(t) = \frac{1}{\sqrt{N_{HT-SIG}^{Tone}}} \sum_{n=0}^1 w_{Symb}(t - nT_{Symb}) \sum_{k=-N_{SR}}^{N_{SR}} q_{i_{rx}}^{L(k)} HTSIG_k^n \exp(j2\pi k\Delta_F(t - T_{GI} - nT_{Symb})) \quad (40)$ where $T_{Symb} = 4 \mu \text{ sec}$ is the OFDM symbol duration.

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 37: HT SIGNAL FIELD (HTSIG1 and HTSIG2) bit assignment [2005 802.11n TGn Sync Specification at 100-101] 11.2.1.7.2.10 SIGNALTAIL The bits 18-23 constitute the SIGNALTAIL field, and all 6 bits shall be set to zero. [2005 802.11n TGn Sync Specification at 104] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would have been obvious in view of the combination with PHY Updates to TGn Sync Proposal, Document No. IEEE 802.11-05/418r0 (May 16, 2005) (“2005 TGn Sync PHY Updates”). One of ordinary skill in the art would have been motivated to combine the 2005 802.11n TGn Sync Specification with the 2005 TGn Sync PHY Updates because the

Claim Elements	Disclosure in the TGn Sync Proposal
	documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync PHY Updates disclosed, for example: May 2005 doc.: IEEE 802.11-05/0418r0 HT-LTF Submission Slide 11 Syed Aon Mujtaba, Agere Systems, et. al.

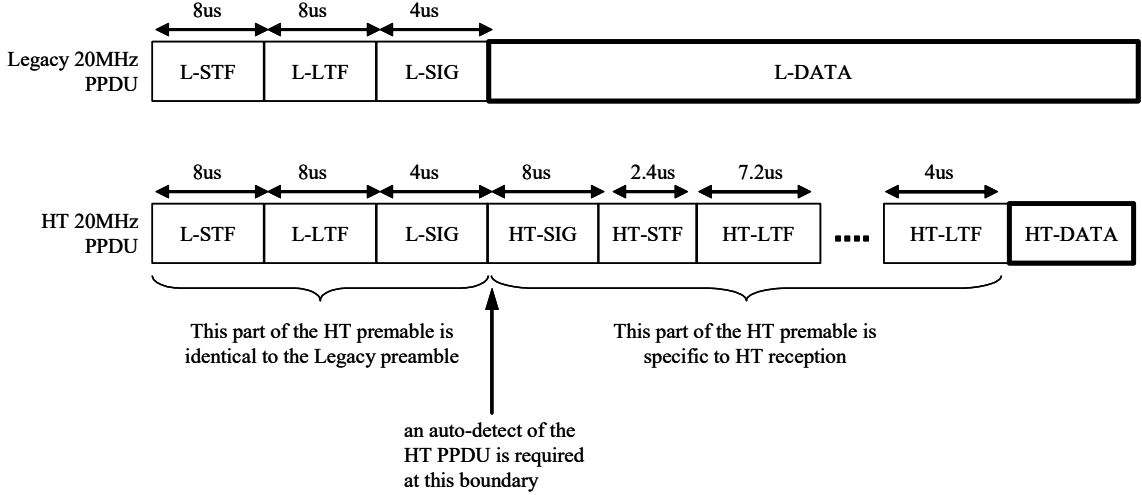
Claim Elements	Disclosure in the TGn Sync Proposal
	<u>May 2005</u> <u>doc.: IEEE 802.11-05/0418r0</u> HT-LTF ➔ The first HT-LTF field contains a repeated symbol: ■ further refinement of frequency offset estimation – helpful especially when frequency transients are present ■ accurate noise power estimation after the AGC ➔ Subsequent HT-LTF fields contain only one OFDM symbol ■ simulation results show minimal degradation in channel estimation accuracy and PER Submission Slide 12 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync PHY Updates, at Slide 11-12] To the extent that the 2005 TGn Sync Specification did not disclose the limitation, the limitation would also have been obvious in view of the combination with TGn Sync Complete Proposal, Document No. IEEE.11-04/888r9 (March 4, 2005)(“2005 TGn Sync Proposal Presentation”). One of ordinary skill in the art would have been motivated to combine the 2005 802.11n TGn Sync Specification and/or 2005 TGn Sync PHY Updates with the 2005

Claim Elements	Disclosure in the TGn Sync Proposal
	TGn Sync Proposal Presentation because the documents were disclosed by the same group at about the same time, discussing the same subject matter, for the purpose of being considered together to understand the same proposed amendments to the IEEE 802.11 standard. 2005 TGn Sync Proposal Presentation disclosed, for example: March 2005 doc.: IEEE 802.11-04/888r9 HT-PPDU Format in 40MHz  Submission Slide 50 Syed Aon Mujtaba, Agere Systems, et. al. [2005 TGn Sync Proposal Presentation, Slide 50] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:

Claim Elements	Disclosure in the TGN Sync Proposal
	The diagram shows a sequence of fields in a PPDU: L-STF, L-LTF, L-SIG, HT-SIG, HT-STF, HT-LTF, followed by an ellipsis, then HT-LTF, HT-Data, HT-Data, and another ellipsis. Figure 19: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active. The figure illustrates the frequency allocation for a 40MHz channel. The top part shows the 40MHz scale with indices from -64 to +63. The lower sub-channel (indices -64 to -1) and upper sub-channel (indices 0 to +63) each contain 64 tones. The bottom part shows a 20MHz scale with indices from -32 to +31, centered around the 0 index of the 40MHz scale. Figure 20: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

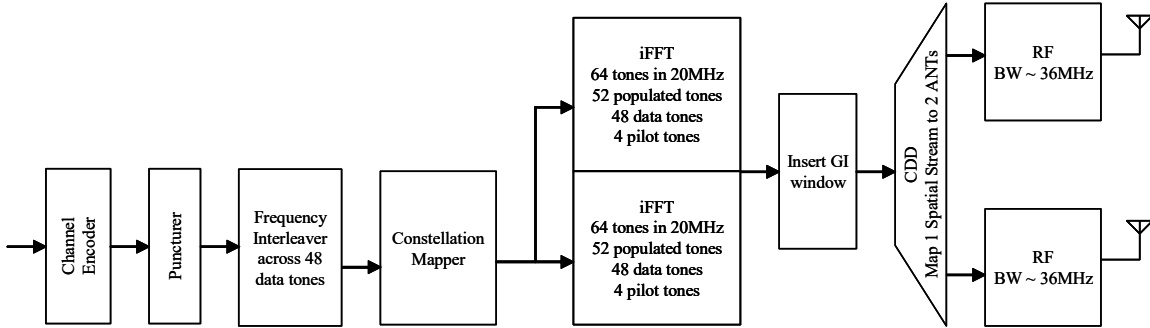
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 21: PPDU Format for 2x40 Basic MIMO Transmission⁹ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found.. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

⁹ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

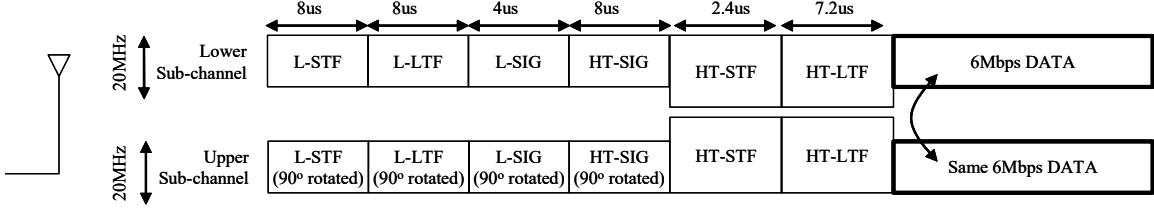
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 22: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGn Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 23: Transmitter configuration for 6Mbps in 40MHz¹⁰ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

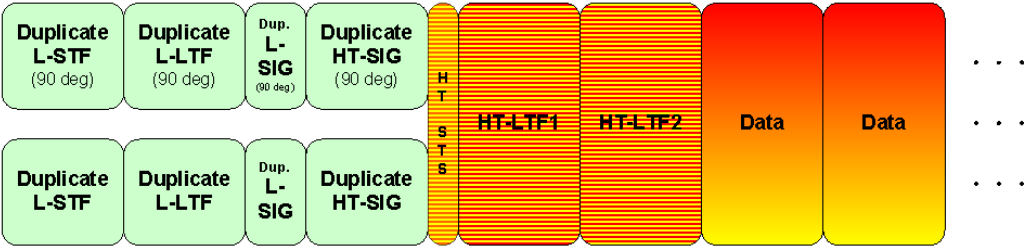
¹⁰ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

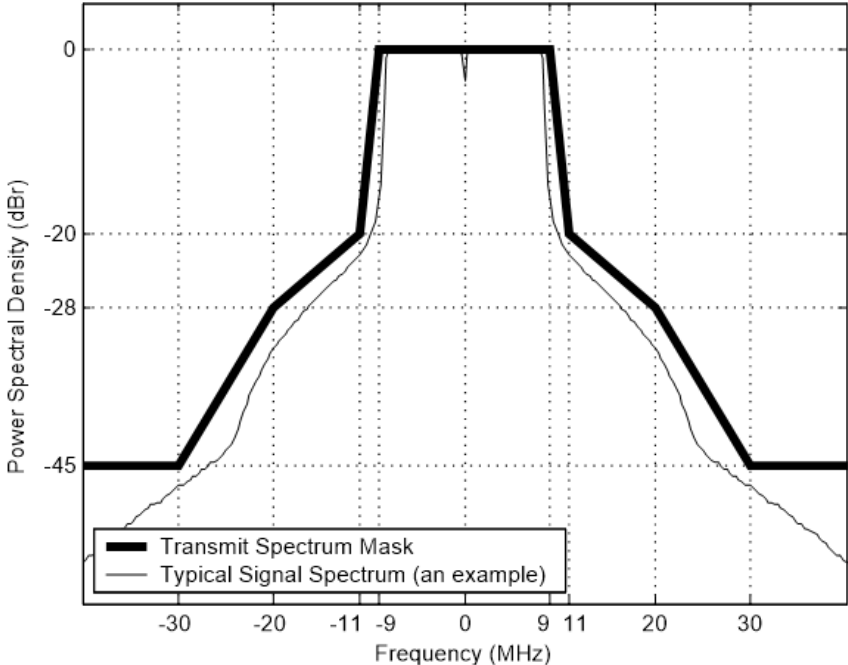
Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 24: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data Legacy Compatible Preamble HT Part Legend L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field Legacy Compatible Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna  The diagrams show three antennas (1, 2, 3) over time. Each antenna's signal is represented by a sequence of colored blocks: green for STF, L LTF, L SIG; yellow for HT SIG, HT STF, HT LTF; and red for Data. The sequence is identical for all three antennas. Below the diagrams, the field names are listed: STF, L LTF, L SIG, HT SIG, HT STF, HT LTF, and Data. These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna L-STF L-LTF L-SIG HT-SIG or single antenna Antenna L-STF L-LTF L-SIG HT-SIG The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	The TGn Sync Proposal disclosed that the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference disclosed:

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.10.1 Transmit spectral mask 11.2.1.10.1.1 20MHz channel spacing In the 20 MHz bandwidth mode the HT PHY shall follow 17.3.9.2 in ref [1]. The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18MHz, -20dBr at 11 MHz frequency offset, -28dBr at 20MHz frequency offset and -45dBr at 30MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 1. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. 20 MHz 802.11n Transmit Spectrum Mask  Figure 43: Transmit Spectrum Mask for 20MHz channelization

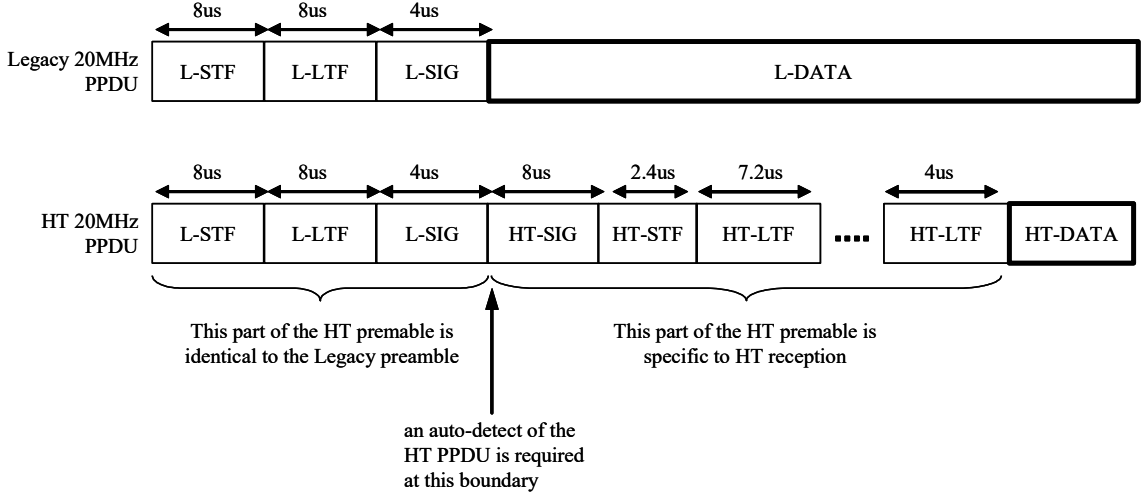
Claim Elements	Disclosure in the TGn Sync Proposal
	11.2.1.10.1.2 40MHz channel spacing The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 38MHz, -20dBr at 21 MHz frequency offset, and -45dBr at 60MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 2. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth.

Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 44: Transmit spectrum mask for 40MHz channelization A HT device transmitting a 20MHz signal in a 40MHz BSS shall conform to the spectral mask shown in Figure 44. [2005 802.11n TGn Sync Specification at 114-116] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:

Claim Elements	Disclosure in the TGN Sync Proposal
	The diagram shows a sequence of fields in a PPDU: L-STF, L-LTF, L-SIG, HT-SIG, HT-STF, HT-LTF, followed by an ellipsis, then HT-LTF, HT-Data, HT-Data, and another ellipsis. Figure 25: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active. The figure consists of two horizontal axes. The top axis is labeled 'Indices at 40MHz' and shows two sub-channels. The 'Lower sub-channel' is on the left, spanning from index -64 to -1, with a bracket indicating '64 tones in 20MHz'. The 'Upper sub-channel' is on the right, spanning from index 0 to +63, also with a bracket indicating '64 tones in 20MHz'. Arrows point to specific indices: -64, -63, -1, 0, +1, +62, +63. The bottom axis is labeled 'Indices at 20MHz' and shows a continuous scale with markers at -32, -31, +31, -32, -31, +30, +31. Vertical dashed lines align the 20MHz indices with the 40MHz sub-channel boundaries. Figure 26: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

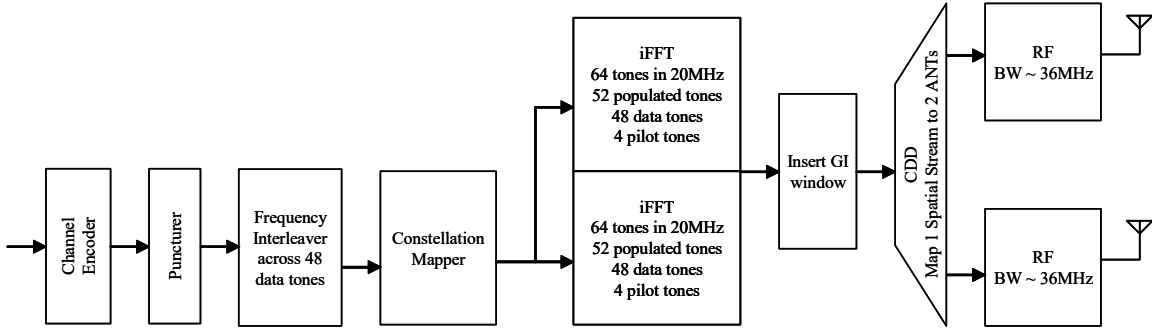
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 27: PPDU Format for 2x40 Basic MIMO Transmission¹¹ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found.. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

¹¹ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

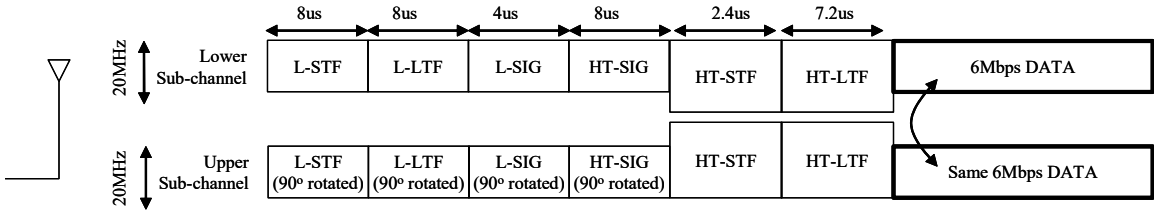
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 28: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGN Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 29: Transmitter configuration for 6Mbps in 40MHz¹² Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

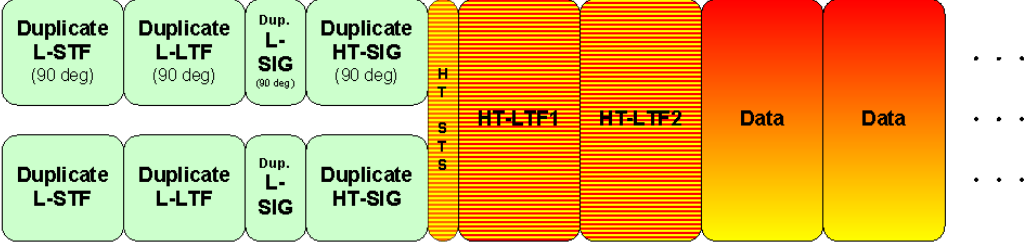
¹² 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

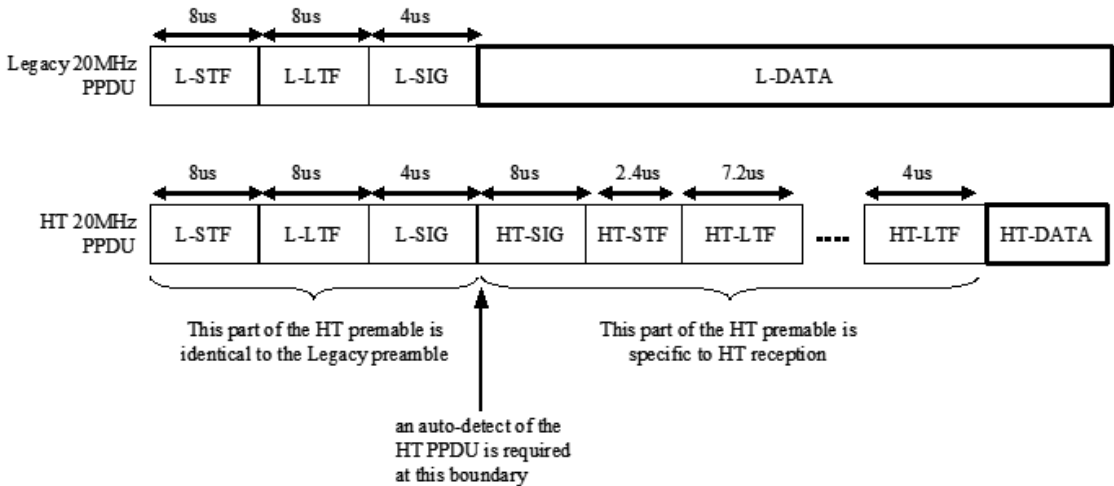
Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 30: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data Legacy Compatible Preamble HT Part Legend L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field Legacy Compatible Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna The diagrams show three antennas (1, 2, 3) each with a sequence of training fields. The fields are: STF (Short Training Field), L LTF (Long LTF), L SIG (Long SIG), HT SIG (HT SIG), HT STF (HT STF), HT LTF (HT LTF), and Data. The fields are color-coded: STF is green, L LTF is light green, L SIG is light green, HT SIG is light green, HT STF is orange, HT LTF is orange, and Data is red. The sequence of fields is: STF, L LTF, L SIG, HT SIG, HT STF, HT LTF, and Data. The diagrams are labeled 1, 2, and 3 for Antenna 1, 2, and 3 respectively. These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna L-STF L-LTF L-SIG HT-SIG or single antenna Antenna L-STF L-LTF L-SIG HT-SIG The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

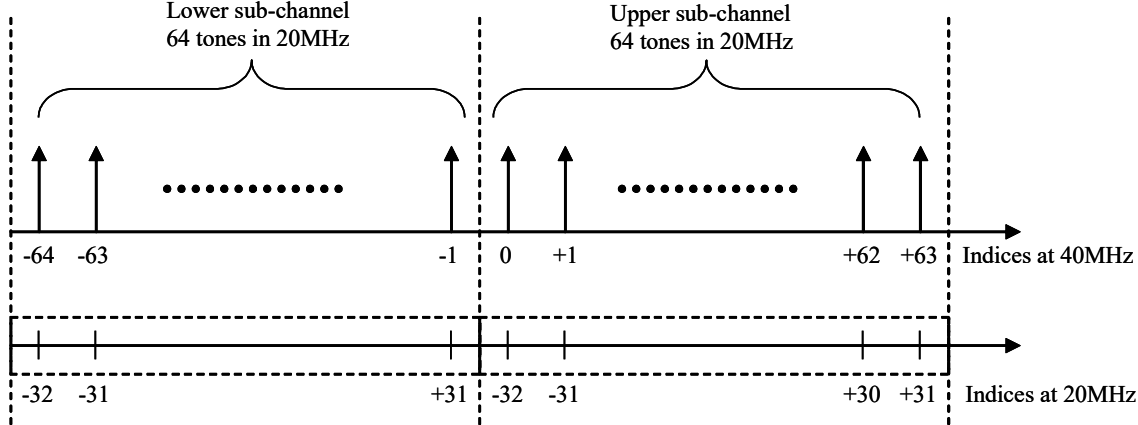
Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[2.] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	The TGn Sync Proposal disclosed the wireless transceiver, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference disclosed:

Claim Elements	Disclosure in the TGN Sync Proposal
	The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 27:  Figure 27: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG.

Claim Elements	Disclosure in the TGn Sync Proposal
	The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. [2005 802.11 TGn Sync Specification at 75] 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode:

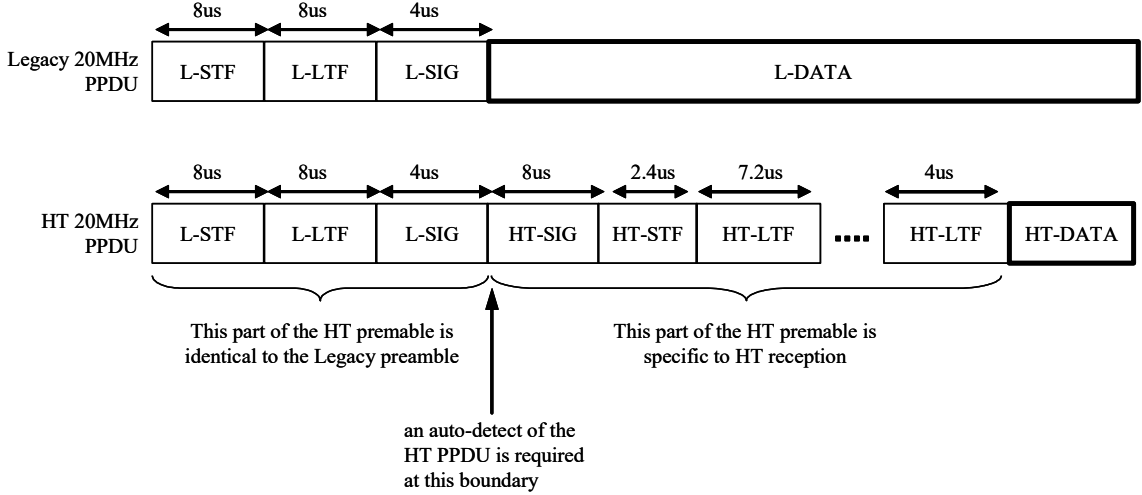
Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 30: PPDU Format for N_{TX} antennas L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2.

Claim Elements	Disclosure in the TGN Sync Proposal
	The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31: Figure 31: PPDU format leveraging CDD transmission [2005 802.11 TGN Sync Specification at 83-84] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1: L-STF L-LTF L-SIG HT-SIG HT-STF HT-LTF ... HT-LTF HT-Data HT-Data ...

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 31: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.  Figure 32: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

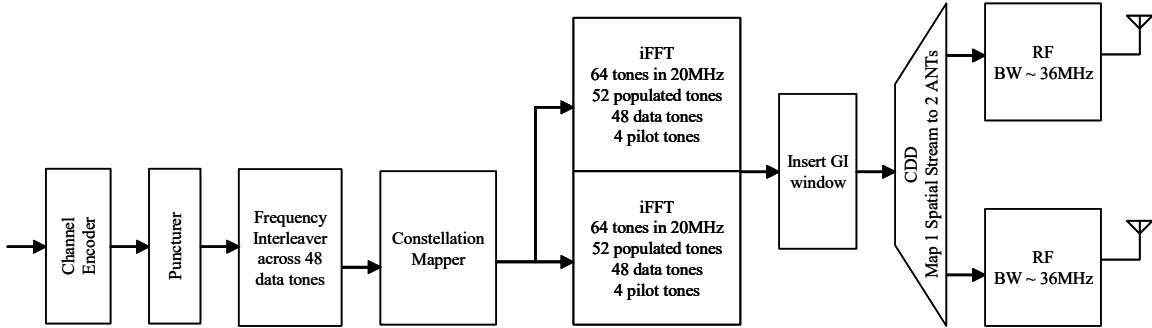
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 33: PPDU Format for 2x40 Basic MIMO Transmission¹³ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found.. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

¹³ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

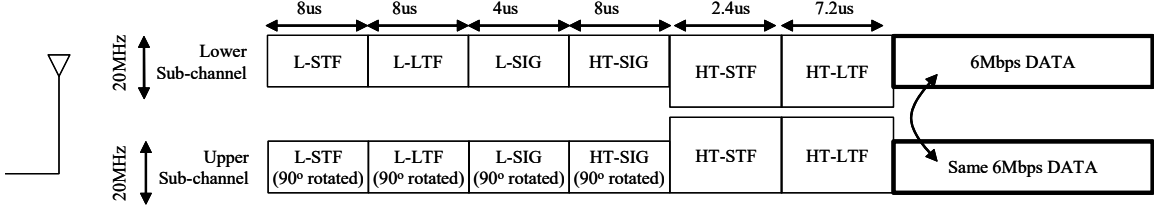
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 34: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGN Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGn Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 35: Transmitter configuration for 6Mbps in 40MHz¹⁴ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

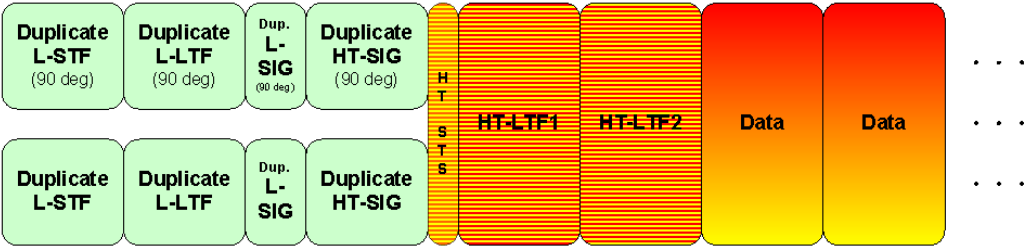
¹⁴ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

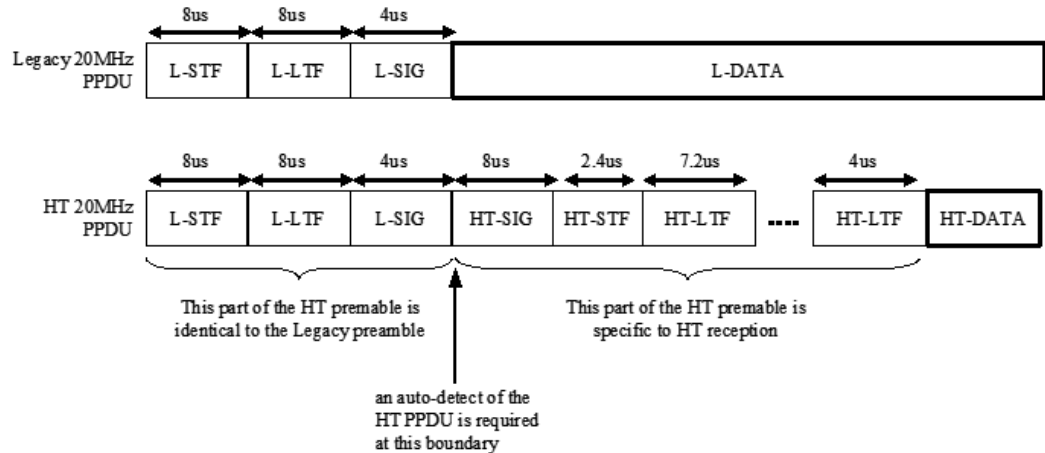
Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 36: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data Legacy Compatible Preamble HT Part Legend L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field Legacy Compatible Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna  The diagrams show three antennas (1, 2, 3) over time. Each antenna's transmission is divided into seven segments: STF (Space-Time Field), L LTF (Long Labeled Training Field), L SIG (Long Labeled Signal), HT SIG (High Throughput Signal), HT STF (High Throughput Space-Time Field), HT LTF (High Throughput Long Labeled Training Field), and Data. The segments are color-coded: STF is green, L LTF is light green, L SIG is light green, HT SIG is light green, HT STF is orange, HT LTF is orange, and Data is red. The segments are arranged in a grid where each row represents an antenna and each column represents a time slot. The segments are labeled with their respective names and some with subscripts (e.g., L TS1, L TS2, HT SIG 1, HT SIG 2, HT STF, HT LTF, DATA). These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The diagram shows three antennas (1, 2, 3) transmitting a Legacy Compatible Preamble. Each antenna has a sequence of fields: L-STF (green), L-LTF (green), L-SIG (green), HT-SIG 1 (green), HT-SIG 2 (green), and HT-STTS (orange). The fields are aligned across the three antennas, indicating they are transmitted as a single spatial stream. or single antenna Antenna The diagram shows three antennas (1, 2, 3) transmitting a Legacy Compatible Preamble. Antenna 1 has a sequence of fields: L-STF (green), L-LTF (green), L-SIG (green), HT-SIG 1 (green), HT-SIG 2 (green), and HT-STTS (orange). Antennas 2 and 3 have only HT-STTS (orange) fields, indicating they are transmitted in an omnidirectional mode that can be demodulated by legacy receivers. The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

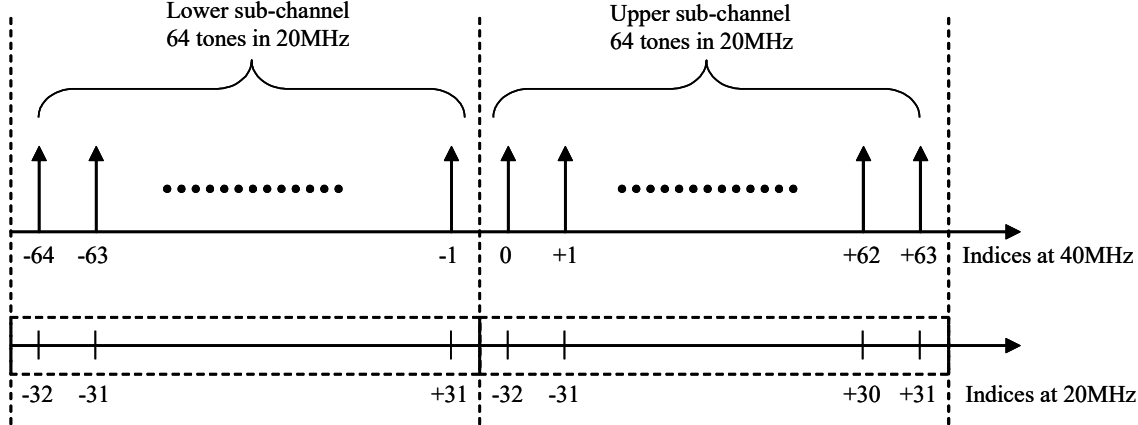
Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[3.] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first	The 2005 802.11 TGn Sync Specification disclosed a wireless transceiver, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference disclosed:

Claim Elements	Disclosure in the TGN Sync Proposal
packet in the first narrower frequency band.	The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 27:  Figure 27: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG.

Claim Elements	Disclosure in the TGn Sync Proposal
	The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. [2005 802.11 TGn Sync Specification at 75] 11.2.1.1 Basic MIMO PPDU format The HT Physical layer defines a PPDU format that provides interoperability and coexistence with 802.11a stations and with ERP-OFDM stations of 802.11g at the link level without protection mechanisms. Figure 30 shows the PPDU format for the basic MIMO mode:

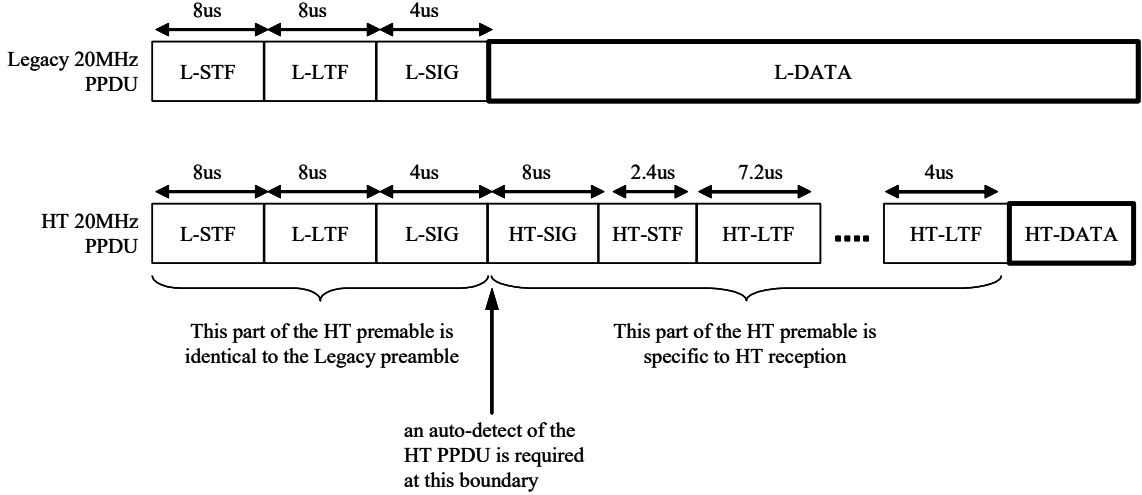
Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 30: PPDU Format for N_{TX} antennas L-STF is the Legacy Short Training Field. Details of the L-STF symbols can be found in clause 11.2.1.6.1. The HT-STF is specific for HT. Details can be found in 11.2.1.6.3 L-LTF stands for Legacy Long Training Field. Details of the L-LTF symbols can be found in clause 11.2.1.6.2. The HT-LTFs are specific for HT and the details can be found in clause 11.2.1.6.4 L-SIG is based on the Legacy SIGNAL field as defined in clause 17.3.4 in [1]. The modulation and coding procedure also follows the steps of 17.3.4 in [1]. The RATE and LENGTH fields in L-SIG are defined in accordance with “spoofing” procedures described in 11.2.1.7.1. The HT-SIG field is the signal field dedicated to the HT mode. The structure of this field is the same as the L-SIG. Since our proposal supports interoperability between HT devices and legacy OFDM devices at the PHY layer, a HT receiver will not know <i>a priori</i> whether a legacy packet or an HT packet is being received. That determination can only be made after the L-SIG. Our proposal supports two mechanisms for signaling a HT transmission: (a) send the HT-SIG as a BPSK signal on the quadrature axis, instead of on the in-phase axis, and (b) invert the polarity of the pilots in the HT-SIG with respect to the pilots in the L-SIG. These two mechanism allow an auto-detect of a HT transmission. Note that the pilots in the HT-SIG are not transmitted on the Quadrature axis. The definition of the contents of HT-SIG is specified in 11.2.1.7.2.

Claim Elements	Disclosure in the TGN Sync Proposal
	The L-STF, L-LTF, L-SIG, and HT-SIG should be transmitted from the antenna array such that an omni-directional beam pattern is created in the far field. This reduces the probability of creating hidden nodes in the BSS. One way to create an omni-beam is to transmit these fields from strictly one antenna. However, if the transmitter is power-amplifier limited, array gain can be derived by transmitting on multiple antennas. Since transmitting the same signal from multiple antennas invariably creates beamforming, one way to mitigate beamforming is to phase shift (i.e. time delay) the signal across the transmit antenna array. For an OFDM symbol, the delay can be introduced cyclically. Since delaying the same signal introduces frequency selectivity at the receiver, such a transmission is commonly referred to as “cyclical delay diversity” or CDD. This transmission format is shown in Figure 31: Figure 31: PPDU format leveraging CDD transmission [2005 802.11 TGN Sync Specification at 83-84] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1: L-STF L-LTF L-SIG HT-SIG HT-STF HT-LTF ... HT-LTF HT-Data HT-Data ...

Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 37: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active.  Figure 38: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3.

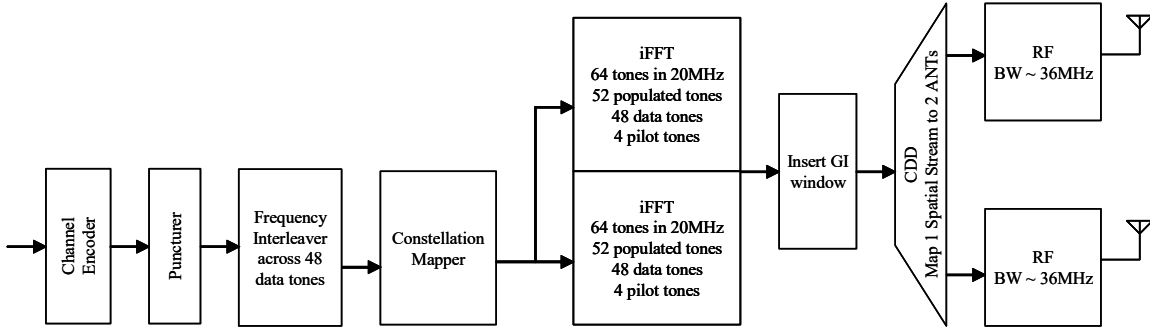
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 39: PPDU Format for 2x40 Basic MIMO Transmission¹⁵ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found.. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection 2. AGC 3. Coarse Frequency Offset Estimation

¹⁵ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

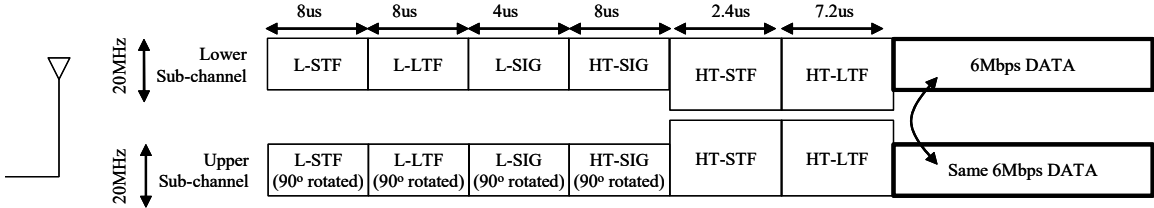
Claim Elements	Disclosure in the TGN Sync Proposal
	4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 40: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems. A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to

Claim Elements	Disclosure in the TGn Sync Proposal
	whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time. The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next.

Claim Elements	Disclosure in the TGn Sync Proposal
	Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones

Claim Elements	Disclosure in the TGN Sync Proposal
	in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  Figure 41: Transmitter configuration for 6Mbps in 40MHz¹⁶ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6:

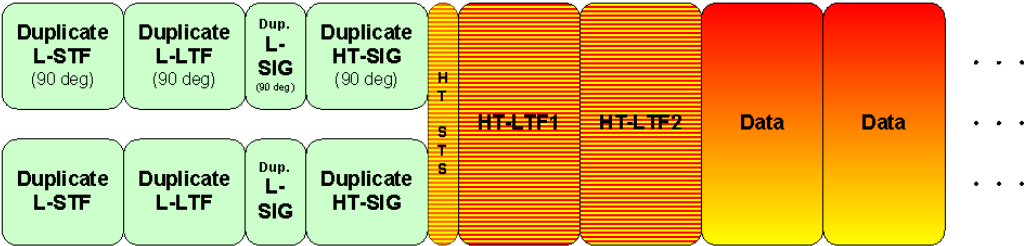
¹⁶ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

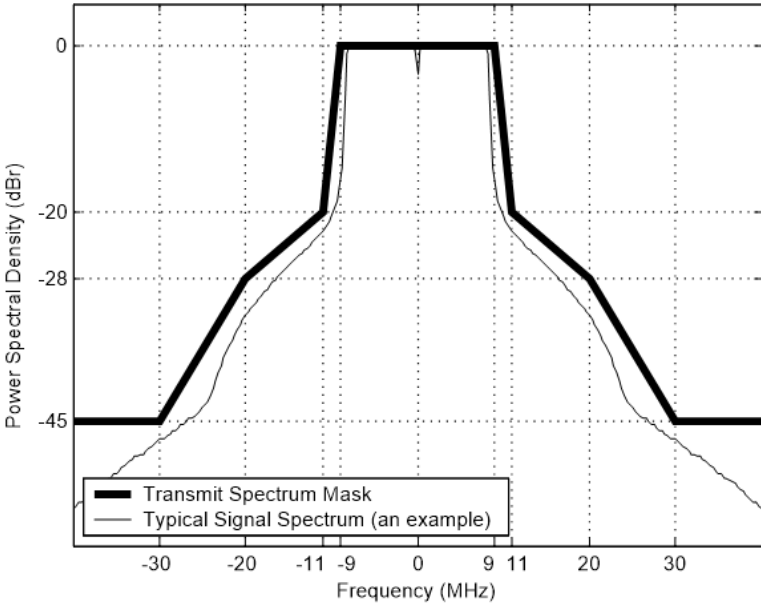
Claim Elements	Disclosure in the TGn Sync Proposal
	 Figure 42: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77]

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data Legacy Compatible Preamble HT Part Legend L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field Legacy Compatible Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

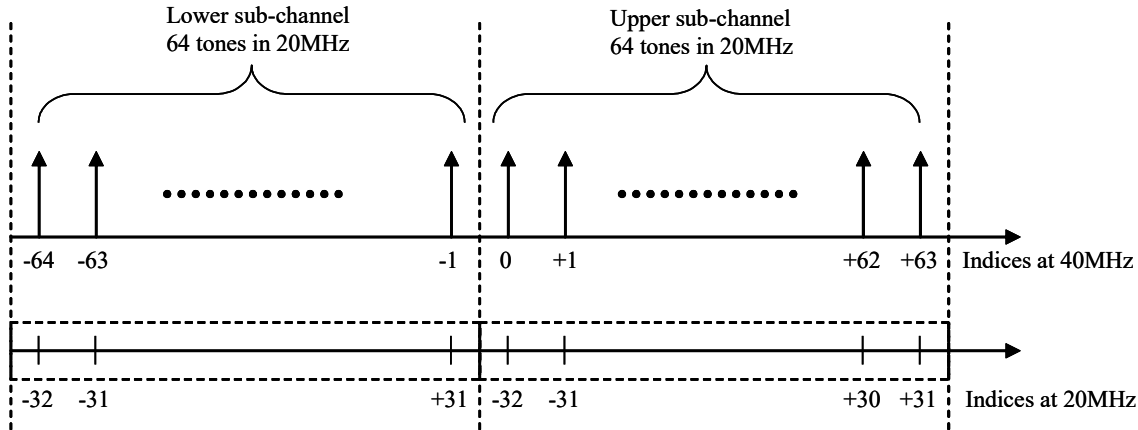
Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna  The diagrams show three antennas (1, 2, 3) each with a sequence of training fields. The fields are: STF (Space-Time Field), L LTF (Long LTF), L SIG (Long SIG), HT SIG (High Throughput SIG), HT STF (High Throughput STF), HT LTF (High Throughput LTF), and Data. The fields are color-coded: STF is green, L LTF is light green, L SIG is light green, HT SIG is light green, HT STF is orange, HT LTF is orange, and Data is red. The sequence of fields is: STF, L LTF, L SIG, HT SIG, HT STF, HT LTF, and Data. The diagrams are labeled with 'Antenna' and '1', '2', '3' respectively. These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna L-STF L-LTF L-SIG HT-SIG or single antenna Antenna L-STF L-LTF L-SIG HT-SIG The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[4.] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	The 2005 802.11 TGn Sync Specification disclosed a wireless transceiver, wherein the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference disclosed:

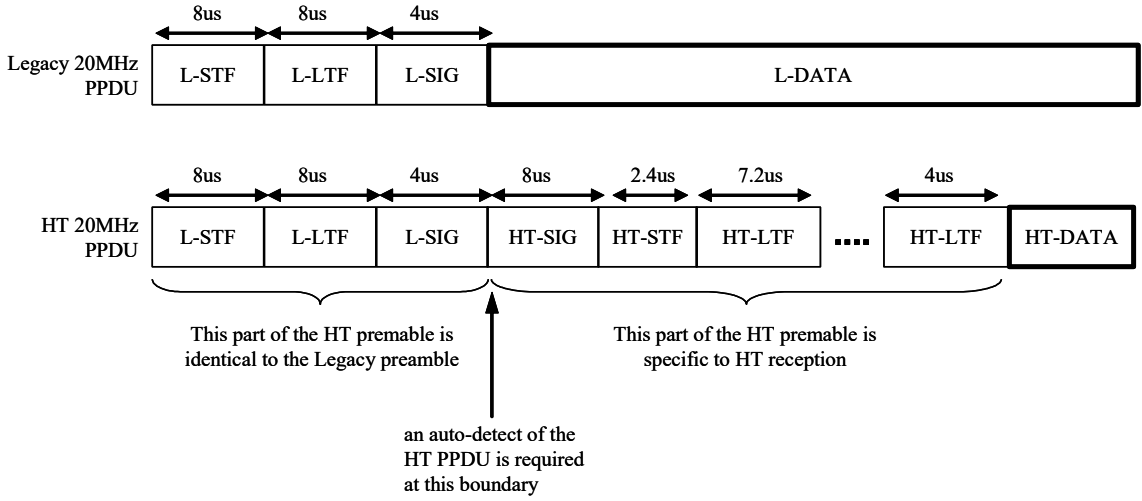
Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.10.1 Transmit spectral mask 11.2.1.10.1.1 20MHz channel spacing In the 20 MHz bandwidth mode the HT PHY shall follow 17.3.9.2 in ref [1]. The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18MHz, -20dBr at 11 MHz frequency offset, -28dBr at 20MHz frequency offset and -45dBr at 30MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 1. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. 20 MHz 802.11n Transmit Spectrum Mask  Figure 43: Transmit Spectrum Mask for 20MHz channelization

Claim Elements	Disclosure in the TGN Sync Proposal
	11.2.1.10.1.2 40MHz channel spacing The transmitted spectrum shall have a 0dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 38MHz, -20dBr at 21 MHz frequency offset, and -45dBr at 60MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 2. The measurements shall be made using a 100kHz resolution bandwidth and a 30kHz video bandwidth. 40 MHz 802.11n Transmit Spectrum Mask Power Spectral Density (dBr) Frequency (MHz) — Transmit Spectrum Mask — Typical Signal Spectrum (an example) Figure 44: Transmit spectrum mask for 40MHz channelization A HT device transmitting a 20MHz signal in a 40MHz BSS shall conform to the spectral mask shown in Figure 44.

Claim Elements	Disclosure in the TGn Sync Proposal
	[2005 802.11n TGn Sync Specification at 114-116] PPDU Format for Basic MIMO Transmission The generic PPDU format is shown in Figure 1:  Figure 43: PPDU Format The L-STF (Legacy Short Training Field), the L-LTF (Legacy Long Training Field), L-SIG (Legacy Signal Field) and HT-SIG (High Throughput Signal Field) comprise the legacy compatible part of the PPDU preamble. HT-STF, the HT-STFs and HT-Data symbols comprise the HT-Part of the PPDU. In the 40MHz bandwidth, there are two 20MHz wide sub-channels. The upper sub-channel spans from 0 to +63, and the lower sub-channel spans from -64 to -1, as shown in Figure 2. A 40MHz-HT device receiving a 20MHz-only transmission shall indicate to the MAC which sub-channel is currently active. 

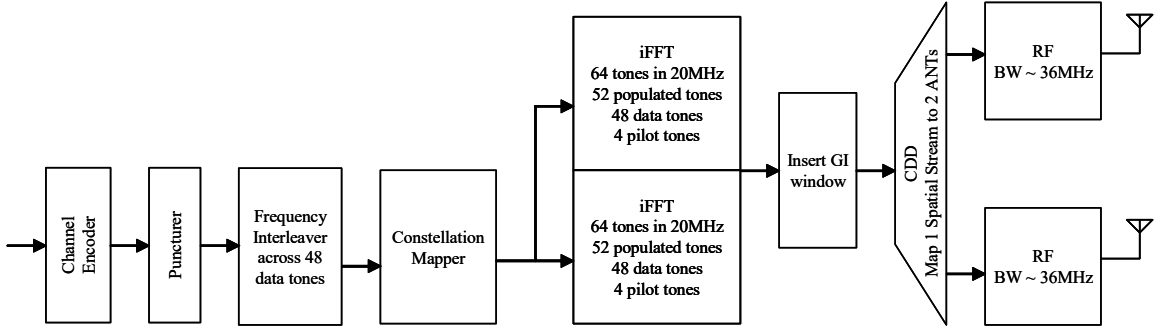
Claim Elements	Disclosure in the TGN Sync Proposal
	Figure 44: Upper and Lower sub-channel specification in 40MHz The PPDU format from two transmit antennas, each 40MHz wide, is shown in Figure 3. Figure 45: PPDU Format for 2x40 Basic MIMO Transmission¹⁷ The legacy part of the HT preamble (i.e. L-STF to L-SIG) and HT-SIG may either be transmitted from one antenna or both antennas. If transmitted from both antennas, the mapping of this single spatial stream to two antennas has to be such that beamforming in the far-field is mitigated. One method for achieving this is to use a cyclical delay diversity (CDD) mapping, as mentioned in Error! Reference source not found.. The optional part of the PPDU, corresponding to the CDD format, is shown in red color in Figure 3. HT PLCP Preamble for Synchronization and Legacy Interoperability The functions performed by the preamble include: 1. Start-of-Packet (SoP) detection

¹⁷ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosure in the TGN Sync Proposal
	2. AGC 3. Coarse Frequency Offset Estimation 4. Coarse Timing Offset Estimation 5. Fine Timing Offset Estimation 6. Fine Frequency Offset Estimation 7. Channel Estimation The High Throughput (HT) preamble in our proposal is a concatenation of the legacy preamble (identical to 802.11a/g) and a HT-specific preamble, as shown in Figure 4:  Figure 46: HT Preamble format Concatenation of the legacy preamble allows PHY layer interoperability with 802.11a and ERP-802.11g modems.

Claim Elements	Disclosure in the TGN Sync Proposal
	A HT receiver does not know <i>a priori</i> whether it is receiving a legacy PPDU or a HT PPDU. Hence, a HT receiver has to perform an auto-detect after the legacy signal field (L-SIG) as to whether a HT-SIG is being received or legacy data (L-DATA). Our preamble format includes two provisions for auto-detecting the HT-SIG: (a) transmitting the HT-SIG as a BPSK signal on the quadrature axis instead of the in-phase axis, and (b) inverting the pilot polarity in going from the L-SIG to the HT-SIG. The legacy part of the HT preamble allows a legacy receiver to properly decode the L-SIG. A HT receiver shall also perform functions 1 through 7 (SoP to Channel Estimation) to successfully decode the HT-SIG. It is anticipated that functions 1 through 4 (and perhaps function 5) are performed by the legacy short training field (L-STF), and functions 5 through 7 are performed by the legacy long training field (L-LTF). Since a HT device (in our proposal) shall support multiple transmit antennas, the legacy part of the preamble can either be transmitted from one antenna or from multiple antennas. If more than one antenna is used for transmission, it is recommended that the signal be shifted in a cyclical fashion across the transmit antenna array. This technique introduces cyclical delay diversity (CDD), and it tends to reduce the “effective” length of the guard interval, as seen by a legacy device. Hence, the total shift across the transmit antenna array should be limited to 50ns. In the 40MHz mode, the L-STF in the lower sub-channel is identical to legacy, whereas the L-STF in the upper sub-channel is a 90 degree phase rotation of the legacy STF. This rotation is performed to keep the PAPR of the STF low (see Figure 2 and Figure 3) Since a legacy OFDM RX is not expected to “understand” any transmission after the L-SIG, the RATE and LENGTH fields in the L-SIG are “spoofed” such that a legacy OFDM RX can defer for the correct period of time.

Claim Elements	Disclosure in the TGn Sync Proposal
	The HT-SIG contains information needed to correctly de-map and decode the HT data field (i.e. the MIMO-OFDM symbols). It also contains fields for supporting advanced techniques that are described next. Since the L-STF does not provide a sufficiently accurate power measurement for MIMO AGC purposes, a HT-STF has been introduced after the HT-SIG. The HT-STF is tone-interleaved symbol across the transmit antenna array. The HT short training symbol uses 24 tones in 20MHz (L-STF uses 12 tones in a 20 MHz channel). The choice of 24 tones permits accurate AGC measurements across 4 transmit antennas. In the 40 MHz channel, 48 tones are used in the HT-STF. The 24 (48) tones are interleaved across the antennas, i.e., 6 (12) tones are used per antenna if there are 4 transmitter antennas, and likewise 12 (24) are used per antenna if there are 2 transmitter antennas. The length of the HT-STF is 1.6μs. Since, the purpose of HT-STF is purely for AGC purposes, only one STS is needed. Together with the 0.8μs guard interval, the total length of the HT-STF is 2.4μs. The GI of the HT-STF, i.e. the first 0.8μs, would contain echoes from the previous symbol. Hence, a clean measurement of power is made in the 1.6μs portion of the HT-STF. It is anticipated that the RF transient settling after the AGC switch would occur in the GI of the HT-LTF that follows the HT-STF. After the AGC has been “fine-tuned” for HT reception, channel estimation and fine frequency offset estimation are performed using the HT Long Training Symbols. In the basic MIMO modes, as in beamforming mode, the number of HT-LTFs sent must be at least equal to the number of streams sent, and at most equal to the number of transmit antennas. For example, when one spatial stream is transmitted using two transmit antennas, at least one HT-LTF must be sent, and under some conditions two HT-LTFs may be sent. However, if two spatial streams are sent using two transmit antennas, two HT-LTFs must be sent. When the number of HT-LTFs that are sent is greater than the number of data streams, the resulting set of HT-LTFs is referred to as a segmented HT-LTF, and the additional HT-LTFs are referred to as extension HT-LTFs. In this case the tone interleaving is arranged so that the first N_{ss} HT-LTFs sound the MIMO channel used by the N_{ss} data streams, and the extension

Claim Elements	Disclosure in the TGN Sync Proposal
	HT-LTFs sound the remaining dimensions of the MIMO channel. This is covered in more detail in Error! Reference source not found. The HT-LTF is also tone interleaved to minimize the power fluctuation with respect to the AGC setting (obtained via the HT-STF). Therefore, one HT-LTF would cover half of the tones in the two antenna case. Remaining tones are covered in the second HT-LTF. The first HT-LTF consists of two Long Training Symbols (LTS) as in 802.11a/g and a regular guard interval of 0.8 μs, giving a total length of 7.2μs. When present, the second, third and fourth HT-LTFs each consist of a single HT-LTS with a regular guard interval of 0.8 μs, giving a total length of 4μs. Duplicate 6Mbps mode The lowest data rate in the 40MHz mode would be 13.5Mbps (= 6Mbps x 2.25), if independent information bits are mapped to the upper and lower sub-channels. A 6Mbps mode in 40MHz is obtained by duplicating the data from the lower sub-channel to the upper sub-channel. For the 6Mbps mode in 40MHz, the MPDU is encoded, punctured, interleaved, and constellation-mapped as a 6Mbps transmission in 20MHz. The duplication is performed just prior to the iFFT sub-carrier mapping, as shown in Figure 5.  <pre> graph LR Input(()) --> CE[Channel Encoder] CE --> P[Puncturer] P --> FI[Frequency Interleaver
across 48 data tones] FI --> CM[Constellation Mapper] CM --> IFFT1[iFFT
64 tones in 20MHz
52 populated tones
48 data tones
4 pilot tones] CM --> IFFT2[iFFT
64 tones in 20MHz
52 populated tones
48 data tones
4 pilot tones] IFFT1 --> GI[Insert GI window] IFFT2 --> GI GI --> CDD[CDD
Map 1 Spatial Stream to 2 ANT's] CDD --> RF1[RF
BW ~ 36MHz] CDD --> RF2[RF
BW ~ 36MHz] RF1 --> Ant1(()) RF2 --> Ant2(()) </pre>

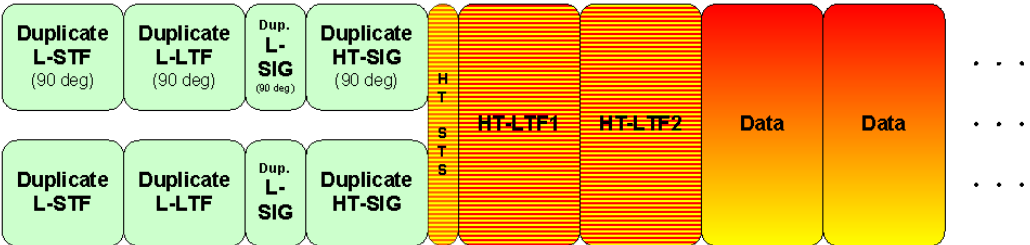
Claim Elements	Disclosure in the TGn Sync Proposal
	Figure 47: Transmitter configuration for 6Mbps in 40MHz¹⁸ Since the 6Mbps duplicate mode comprises of 1 spatial stream, only 1 HT-LTF is needed. Also note that there is no tone-fill past the HT-SIG, unlike the regular 40MHz PPDU format show in Figure 3. The PPDU format for the 6Mbps duplicate mode is shown in Figure 6: Figure 48: PPDU format for 6Mbps duplicate mode Pilot locations in the duplicate mode follow the pilot locations in the 20MHz mode. The duplicate 6Mbps mode (in 40MHz) is signaled as mode 32 in the MCS set (see Error! Reference source not found.). [TGn Sync Proposal 2005, 73-77]

¹⁸ 40MHz operation by an HT device shall only be permitted in those regulatory domain that allow it.

Claim Elements	Disclosure in the TGn Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 PPDU Format L-STF L-LTF L-SIG HT-SIG HT STF HT LTF ... HT LTF Data Legacy Compatible Preamble HT Part Legend L- Legacy, HT- High Throughput STF = Short Training Field LTF = Long Training Field SIG = Signal Field Legacy Compatible Can be decoded by <i>any</i> legacy 802.11a or g compliant device for interoperability Submission Slide 12 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 12]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Training Fields • Design priorities – Backward compatibility with 802.11a/g – Robust performance – Cost effective implementation – Low overhead Antenna The diagrams show three antennas (1, 2, 3) each with a sequence of training fields. The fields are: STF (Space-Time Field), L LTF (Long LTF), L SIG (Long SIG), HT SIG (High Throughput SIG), HT STF (High Throughput STF), HT LTF (High Throughput LTF), and Data. The sequence is: STF, L LTF, L SIG, HT SIG, HT STF, HT LTF, Data. The fields are color-coded: STF (green), L LTF (green), L SIG (green), HT SIG (green), HT STF (yellow), HT LTF (yellow), and Data (red). These space-time diagrams apply to both 20 and 40 MHz channels Submission Slide 16 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 16]

Claim Elements	Disclosure in the TGN Sync Proposal
	August 2004 doc.: IEEE 802.11-04/888r0 Legacy Compatible Preamble CDD Antenna The diagram illustrates the transmission of a Legacy Compatible Preamble across three antennas. Each antenna's signal is represented by a horizontal sequence of colored blocks. Antenna 1, 2, and 3 all show the same sequence of fields: L-STF (green), L-LTF (green), L-SIG (green), HT-SIG 1 (green), HT-SIG 2 (green), and HT-STX (orange). The fields are aligned vertically across the three antennas, indicating they are transmitted as a single spatial stream. Below the diagram, the fields are labeled: L-STF, L-LTF, L-SIG, and HT-SIG. or single antenna Antenna The diagram illustrates the transmission of a Legacy Compatible Preamble across three antennas. Antenna 1 transmits the full sequence of fields: L-STF (green), L-LTF (green), L-SIG (green), HT-SIG 1 (green), HT-SIG 2 (green), and HT-STX (orange). Antennas 2 and 3 only transmit the HT-STX field (orange). This indicates that the fields are transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Below the diagram, the fields are labeled: L-STF, L-LTF, L-SIG, and HT-SIG. The L-STF, L-LTF, L-SIG and HT-SIG are transmitted as a single spatial stream. This may be either transmitted on all Tx antennas via a method such as Cyclic Delay Diversity (CDD), or on a single antenna. These are implementation options. Requirement: These fields must be transmitted in an omnidirectional mode that can be demodulated by legacy receivers. Submission Slide 17 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 17]

Claim Elements	Disclosure in the TGN Sync Proposal
	<u>August 2004</u> <u>doc.: IEEE 802.11-04/888r0</u> 40 MHz PPDU Format  • Duplicate format preamble – Provides interoperability with 20 MHz legacy STAs – Data, pilot and training tones in each 20 MHz subchannel are identical to corresponding 20 MHz format – 90 deg phase shift on upper sub-channel controls PAPR • HT part – 108 data tones + 6 pilots – 3 center nulls (not shown) Submission Slide 24 Aon Mujtaba, Agere Systems, et al [TGnSync 2004, slide 24]
[8.] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	The TGn Sync Proposal disclosed a wireless transceiver wherein the wireless transceiver supports one or more wireless standards. For example, the reference disclosed:

Claim Elements	Disclosure in the TGn Sync Proposal										
	IEEE P802.11 Wireless LANs TGn Sync Proposal Technical Specification Date: 2005-05-18 Author: <table><tr><th>Name</th><th>Company</th><th>Address</th><th>Phone</th><th>email</th></tr><tr><td>Syed Aon Mujtaba</td><td>Agere Systems Inc.</td><td>555 Union Blvd., Allentown, PA 18109, U.S.A.</td><td>+1 610 712 6616</td><td>mujtaba@agere.com</td></tr></table> Abstract This document presents the technical specification for the MAC and the PHY layer of the TGn Sync proposal to IEEE 802.11 TGn [2005 802.11n TGn Sync Specification at 1] The TGn Sync proposal also offers seamless interoperability with 802.11 legacy devices. This interoperability is achieved with an enhanced 802.11 preamble design and efficient PHY and MAC level mechanisms, which also provide robustness and cost-effectiveness. [2005 802.11n TGn Sync Specification at 3]	Name	Company	Address	Phone	email	Syed Aon Mujtaba	Agere Systems Inc.	555 Union Blvd., Allentown, PA 18109, U.S.A.	+1 610 712 6616	mujtaba@agere.com
Name	Company	Address	Phone	email							
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Claim Elements	Disclosure in the TGn Sync Proposal
	2 <u>References</u> [1] IEEE Std 802.11®-1999 (Reaff 2003) Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications [2] IEEE P802.11e/D8.0, February 2004 (Draft Amendment to IEEE Std 802.11, 1999 Edition (Reaff 2003)) Medium Access Control (MAC) Enhancements for Quality of Service (QoS) [3] Project Authorization Request for IEEE 802.11n. 11-02-798r7-HT-SG-Draft-PAR.doc [4] IEEE 802.11-04/887, "TGnSync Proposal Summary" [5] IEEE 802.11-04/888, "TGnSync Proposal" [6] IEEE 802.11-04/890, "TGnSync Proposal FRCC Compliance" [7] IEEE 802.11-04/891, "TGnSync Proposal PHY Results" [8] IEEE 802.11-04/892, "TGnSync Proposal MAC Results" [9] IEEE 802.11-04/893, "TGnSync Proposal MAC1 Simulation Results" [10] IEEE 802.11-04/894, "TGnSync Proposal MAC2 Simulation Results" [11] IEEE 802.11-04/895, "TGnSync Proposal MAC Simulation Methodology" [2005 802.11n TGn Sync Specification at 11]
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim 1, preamble.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency	See, e.g., claim 1, limitation 1.A above.

Claim Elements	Disclosure in the TGn Sync Proposal
band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim 1, limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[9.D] the demodulator further operable to demodulate the	<i>See, e.g.</i> , claim 1, limitation 1.D above.

Claim Elements	Disclosure in the TGn Sync Proposal
second number of OFDM symbols to determine the second header portion,	
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10.] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[11.] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[12.] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[16.] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Claim Elements	Disclosure in the TGn Sync Proposal
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1 preamble.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[17.B] demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim 1, limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of	<i>See, e.g.</i> , claim 1, limitation 1.C above.

Claim Elements	Disclosure in the TGn Sync Proposal
header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[21.] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.
[22.] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[23.] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[24.] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosure in the TGn Sync Proposal
of correctly decoding header information of the first packet in the first narrower frequency band	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g., claim 1, preamble.</i>
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g., claim 1, limitation 1.A above.</i>
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g., claim 1, limitation 1.B above.</i>
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a	<i>See, e.g., claim 1, limitation 1.C above.</i>

Claim Elements	Disclosure in the TGn Sync Proposal
second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[26.] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27.] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 3 above.
[28.] The method of claim 25, wherein the second wider	<i>See, e.g.</i> , claim 4 above.

Claim Elements	Disclosure in the TGn Sync Proposal
frequency band is two times wider than the first narrower frequency band.	
[32.] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A8

**Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262
to The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond ("Van Nee")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under pre-AIA 35 U.S.C. § 102 as anticipated by Van Nee; (2) under pre-AIA 35 U.S.C. § 103 as obvious in view of Van Nee standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Van Nee in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.¹

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA ("Brown"), published and made publicly available at least as early as August 20, 2009;

¹ Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in Van Nee
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Van Nee discloses a wireless OFDM transceiver. For example, the reference discloses the following: <i>See e.g.</i>, Van Nee at Abstract: An overview is given of the new IEEE 802.11n standard. This is the first wireless LAN standard based on MIMO-OFDM, a technique pioneered by Airgo Networks to give a significant performance increase in both range and rate relative to conventional wireless LAN. Performance results show that net user throughputs over 100 Mbps are achievable, which is about four times larger than the maximum achievable throughput using IEEE 802.11a/g. For the same throughput, MIMO-OFDM achieves a range that is about 3 times larger than non-MIMO systems. This significant improvement in range-rate performance makes MIMO-

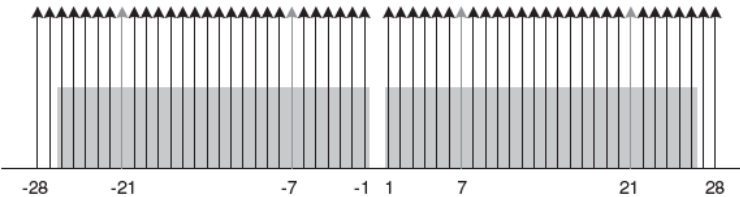
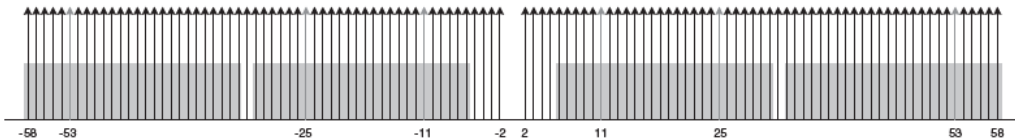
Claim Elements	Disclosure in Van Nee
	OFDM the ideal solution not only for wireless LAN, but also for home entertainment networks and 4G networks.
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Van Nee discloses a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference discloses the following: <i>See e.g.</i>, Van Nee at 445: The solution to obtain significant higher data rates and increase range performance at the same time is MIMO-OFDM (Multiple Input Multiple Output Orthogonal Frequency Division multiplexing) [2, 3]. MIMO-OFDM increases the link capacity by simultaneously transmitting multiple data streams using multiple transmit and receive antennas. It makes it possible to reach data rates that are several times larger than the current highest 802.11a/g rate of 54 Mbps without having to employ a larger bandwidth or a less robust QAM constellation [4]. <i>Id.</i> at 448: Figure 4 shows the packet structure of IEEE802.11a. One of the most important criteria for the choice of the new preambles for IEEE802.11n is compatibility with IEEE802.11a&g. To achieve this, a mixed-mode preamble is constructed as depicted in Figure 5. The mixed-mode preamble starts with an 802.11a preamble with the only difference that multiple transmitters transmit cyclically delayed copies of the preamble. A legacy 802.11a receiver is able to receive this preamble up to the legacy signal field, which guarantees a proper defer behavior of legacy devices for 802.11n packets. <i>Id.</i> at Fig. 5:

Claim Elements	Disclosure in Van Nee
	<i>The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond</i> 449 Figure 5. IEEE802.11n mixed-mode packet with two spatial streams. <i>Id.</i> at 449: The short training field (STF) of 802.11n is the same as for 802.11a&g, except that different transmitters use different cyclic delays. The latter is done to avoid undesired beamforming effects and to get accurate power estimates that can be used to set the receive gain. For a proper AGC setting, it is important that the received power during the short training field is the same as the power during the rest of the packet. To achieve this, the short training fields from different transmitters must have a low cross-correlation, also after being convolved with the wireless channel impulse response which has a typical rms delay spread in the order of 50 to 100 ns. It can be seen from the autocorrelation function in Figure 6 that applying a cyclic delay of -400 ns (or a cyclic advance of 400 ns) minimizes the correlation between two different transmitted short symbols, which is the reason that this value was selected for the greenfield short training field and for the second short training field in the mixed-mode preamble. The short training field of the mixed-mode preamble uses a cyclic delay of only -200 ns for the case of 2 transmitters, because of a fear that legacy 802.11a/g receivers might not be able to deal with larger cyclic delay values. Legacy receivers are also the reason that only negative cyclic delays are used. To a receiver the presence of a second transmit signal with a positive cyclic delay appears like a multipath signal that arrives later than the signal of the first transmitter. If the receiver uses a correlation approach to set its symbol timing [7], then it will set the symbol time too late, which can result in inter-symbol interference. When the second transmitter uses a negative cyclic delay, the receiver will set its symbol timing too early, which will eat into the OFDM guard time without causing inter-symbol interference. <i>Id.</i> at 450-51:

Claim Elements	Disclosure in Van Nee																																																																	
	It is mandatory for an 802.11n device to transmit or receive 2 spatial streams. In addition to this, optional modes are defined for 3 and 4 spatial streams. Figure 8 shows the structure of the optional mixed-mode preamble for the case of 4 spatial streams. This preamble has 4 high throughput long training symbols that are encoded with an orthogonal pattern such that the receiver is able to obtain channel estimates for all 4 spatial streams. Together with the optional short guard interval option and the use of a 40MHz channel, the 4 spatial stream mode gives a highest possible raw data rate of 600 Mbps. <i>Id.</i> at Fig. 8: <table><tr><td>STF 0 ns CD</td><td>LTF 0 ns CD</td><td>L-SIG 0 ns CD</td><td>HT-SIG1 0 ns CD</td><td>HT-SIG2 0 ns CD</td><td>HT-STF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>-HT-LTF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>Data 0 ns CD</td><td></td><td>Data 0 ns CD</td></tr><tr><td>STF -50 ns CD</td><td>LTF -150 ns CD</td><td>L-SIG -150 ns CD</td><td>HT-SIG1 -150 ns CD</td><td>HT-SIG2 -150 ns CD</td><td>HT-STF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>-HT-LTF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>Data -400 ns CD</td><td></td><td>Data -400 ns CD</td></tr><tr><td>STF -100 ns CD</td><td>LTF -100 ns CD</td><td>L-SIG -100 ns CD</td><td>HT-SIG1 -100 ns CD</td><td>HT-SIG2 -100 ns CD</td><td>HT-STF -200 ns CD</td><td>HT-LTF -200 ns CD</td><td>HT-LTF -200 ns CD</td><td>HT-LTF -200 ns CD</td><td>-HT-LTF -200 ns CD</td><td>Data -200 ns CD</td><td></td><td>Data -200 ns CD</td></tr><tr><td>STF -150 ns CD</td><td>LTF -150 ns CD</td><td>L-SIG -150 ns CD</td><td>HT-SIG1 -150 ns CD</td><td>HT-SIG2 -150 ns CD</td><td>HT-STF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>Data -600 ns CD</td><td></td><td>Data -600 ns CD</td></tr><tr><td>8 μs</td><td>8 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4</td><td>μs</td></tr></table> <i>Figure 8.</i> IEEE802.11n mixed-mode packet with four spatial streams.	STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	HT-LTF 0 ns CD	HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD	STF -50 ns CD	LTF -150 ns CD	L-SIG -150 ns CD	HT-SIG1 -150 ns CD	HT-SIG2 -150 ns CD	HT-STF -400 ns CD	HT-LTF -400 ns CD	HT-LTF -400 ns CD	-HT-LTF -400 ns CD	HT-LTF -400 ns CD	Data -400 ns CD		Data -400 ns CD	STF -100 ns CD	LTF -100 ns CD	L-SIG -100 ns CD	HT-SIG1 -100 ns CD	HT-SIG2 -100 ns CD	HT-STF -200 ns CD	HT-LTF -200 ns CD	HT-LTF -200 ns CD	HT-LTF -200 ns CD	-HT-LTF -200 ns CD	Data -200 ns CD		Data -200 ns CD	STF -150 ns CD	LTF -150 ns CD	L-SIG -150 ns CD	HT-SIG1 -150 ns CD	HT-SIG2 -150 ns CD	HT-STF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	Data -600 ns CD		Data -600 ns CD	8 μs	8 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4	μs
STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	HT-LTF 0 ns CD	HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD																																																						
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8 μs	8 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4	μs																																																						
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Van Nee discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. For example, the reference discloses the following: <i>See e.g.,</i> Van Nee at 445: On the other hand, wireless LAN, the technology initially expected to provide only limited range and bandwidth has come a long way. Since the first IEEE 802.11 standard in 1997, the maximum data rate has climbed from 2 to 54 Mbps [1]. Unfortunately, every increase in rate came at the expense of a loss in range. In the IEEE 802.11a/g standards, for instance, the highest data rate of 54 Mbps is achieved through the use of 64-QAM. The use of such highly spectral efficient higher order modulations requires a significant larger SNR than the simple BPSK modulation used for the lowest 1 Mbps rate, resulting in a significant loss in range. In																																																																	

Claim Elements	Disclosure in Van Nee
	addition, the link becomes more vulnerable to co-channel interference, which reduces the total system capacity. The solution to obtain significant higher data rates and increase range performance at the same time is MIMO-OFDM (Multiple Input Multiple Output Orthogonal Frequency Division multiplexing) [2, 3]. MIMO-OFDM increases the link capacity by simultaneously transmitting multiple data streams using multiple transmit and receive antennas. It makes it possible to reach data rates that are several times larger than the current highest 802.11a/g rate of 54 Mbps without having to employ a larger bandwidth or a less robust QAM constellation [4]. After almost a decade of research on MIMO-OFDM, this technique is now ready to succeed OFDM as the dominant transmission technique in wireless LAN. With the introduction of MIMO-OFDM wireless LAN products in 2004 by Airgo Networks and the advent of the MIMO-OFDM based 802.11n standard, the performance of wireless LAN in terms of throughput and range is brought to a significantly higher level, enabling new applications outside the traditional wireless LAN area. The one time vision to replace wires in home entertainment applications, like TV cable replacement, has become a reality. <i>Id.</i>, Table 1:

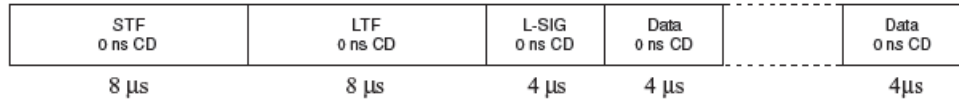
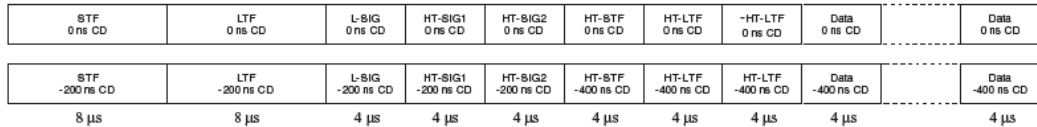
Claim Elements	Disclosure in Van Nee																																																																																																						
	Table 1. Mandatory modulation and coding schemes (MCS) <table><tr><th>MCS</th><th>Code rate</th><th>Modulation</th><th>Number of spatial streams</th><th>Data rate in 20 MHz</th><th>Data rate in 40 MHz</th></tr><tr><td>0</td><td>1/2</td><td>BPSK</td><td>1</td><td>6.5</td><td>13.5</td></tr><tr><td>1</td><td>1/2</td><td>QPSK</td><td>1</td><td>13</td><td>27</td></tr><tr><td>2</td><td>3/4</td><td>QPSK</td><td>1</td><td>19.5</td><td>40.5</td></tr><tr><td>3</td><td>1/2</td><td>16-QAM</td><td>1</td><td>26</td><td>54</td></tr><tr><td>4</td><td>3/4</td><td>16-QAM</td><td>1</td><td>39</td><td>81</td></tr><tr><td>5</td><td>2/3</td><td>64-QAM</td><td>1</td><td>52</td><td>108</td></tr><tr><td>6</td><td>3/4</td><td>64-QAM</td><td>1</td><td>58.5</td><td>121.5</td></tr><tr><td>7</td><td>5/6</td><td>64-QAM</td><td>1</td><td>65</td><td>135</td></tr><tr><td>8</td><td>1/2</td><td>BPSK</td><td>2</td><td>13</td><td>27</td></tr><tr><td>9</td><td>1/2</td><td>QPSK</td><td>2</td><td>26</td><td>54</td></tr><tr><td>10</td><td>3/4</td><td>QPSK</td><td>2</td><td>39</td><td>81</td></tr><tr><td>11</td><td>1/2</td><td>16-QAM</td><td>2</td><td>52</td><td>108</td></tr><tr><td>12</td><td>3/4</td><td>16-QAM</td><td>2</td><td>78</td><td>162</td></tr><tr><td>13</td><td>2/3</td><td>64-QAM</td><td>2</td><td>104</td><td>216</td></tr><tr><td>14</td><td>3/4</td><td>64-QAM</td><td>2</td><td>117</td><td>243</td></tr><tr><td>15</td><td>5/6</td><td>64-QAM</td><td>2</td><td>130</td><td>270</td></tr></table> <i>Id.</i> at 447: Figure 1 shows the block diagram of an IEEE802.11n transmitter. Input data is first scrambled using the same length-127 pseudo-noise scrambler that is used in IEEE802.11a. The convolutional encoder is also the same as IEEE802.11a, with the only difference that for 3 and 4 spatial streams, odd and even bits are separately encoded by two different encoders which is done to limit the maximum decoding rate at the receive side. After encoding, a parser sends consecutive blocks of $s = \max(N_{\text{bpsc}}/2,1)$ bits to different spatial streams, with N_{bpsc} being the number of bits per subcarrier. The bits are then interleaved by a block interleaver with a block size equal to the number of bits in a single OFDM symbol of the nth spatial stream, $N_{\text{CBPS},n}$. By interleaving the bits across both spatial	MCS	Code rate	Modulation	Number of spatial streams	Data rate in 20 MHz	Data rate in 40 MHz	0	1/2	BPSK	1	6.5	13.5	1	1/2	QPSK	1	13	27	2	3/4	QPSK	1	19.5	40.5	3	1/2	16-QAM	1	26	54	4	3/4	16-QAM	1	39	81	5	2/3	64-QAM	1	52	108	6	3/4	64-QAM	1	58.5	121.5	7	5/6	64-QAM	1	65	135	8	1/2	BPSK	2	13	27	9	1/2	QPSK	2	26	54	10	3/4	QPSK	2	39	81	11	1/2	16-QAM	2	52	108	12	3/4	16-QAM	2	78	162	13	2/3	64-QAM	2	104	216	14	3/4	64-QAM	2	117	243	15	5/6	64-QAM	2	130	270
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	streams and subcarriers, the link performance benefits from both spatial diversity and frequency diversity. The interleaver for spatial stream n within its block of $N_{CBPS,n}$ bits is defined by the following relations, where k_n is the input bit index for spatial stream n and j_n is the output bit index. $k_n = 0, 1 \dots N_{CBPS,n}-1$ $s_n = \max(N_{BPSC,n}/2, 1)$ $i = (N_{CBPS,n}/I_{DEPTH})(k_n \bmod I_{DEPTH}) + \text{floor}(k_n/I_{DEPTH})$ $j = s_n \times \text{floor}(i/s_n) + (i + N_{CBPS,n} - \text{floor}(I_{DEPTH} \times i/N_{CBPS,n})) \bmod s_n$ $j_n = (j + N_{CBPS,n} - N_{BPSC,n} D_n) \bmod (N_{CBPS,n})$ <i>Id.</i> at Figs. 2-3:  <i>Figure 2.</i> Subcarrier allocations for a 20 MHz channel. Data tones are black. Pilots are dark grey. Light grey blocks are the subcarriers used for 802.11a, for the legacy part of the mixed-mode preamble, and for the HT-SIG field.  <i>Figure 3.</i> Subcarrier allocations for a 40 MHz channel. Pilots are dark grey. Light grey blocks are the subcarriers used for 802.11a, for the legacy part of the mixed-mode preamble, and for the HT-SIG field. <i>Id.</i> at 448: The subcarrier mapping for 20MHz and 40MHz channels is depicted in Figures 2 and 3, respectively. The 20MHz mode uses 56 subcarriers for the high throughput data symbols, which is 4 more than the number used by 802.11a. The legacy part of the mixed-mode

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	preamble (see Section 2.2.) and the high throughput signal field use the same subcarriers as 802.11a, which are shown as grey blocks in the figures. The 20MHz 11n modes use 4 pilots just like 802.11a, while the 40MHz 11n mode uses 6 pilots. A difference with 802.11a is that 802.11n uses a space time mapping for the pilots when transmitting from multiple antennas. In this way some extra transmit diversity is obtained on the pilots, and undesired beamforming effects are prevented. 2.2. PREAMBLES Figure 4 shows the packet structure of IEEE802.11a. One of the most important criteria for the choice of the new preambles for IEEE802.11n is compatibility with IEEE802.11a&g. To achieve this, a mixed-mode preamble is constructed as depicted in Figure 5. The mixed-mode preamble starts with an 802.11a preamble with the only difference that multiple transmitters transmit cyclically delayed copies of the preamble. A legacy 802.11a receiver is able to receive this preamble up to the legacy signal field, which guarantees a proper defer behavior of legacy devices for 802.11n packets. <i>Id.</i> at Fig. 5: <i>The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond 449</i> <table><tr><td>STF 0 ns CD</td><td>LTF 0 ns CD</td><td>L-SIG 0 ns CD</td><td>HT-SIG1 0 ns CD</td><td>HT-SIG2 0 ns CD</td><td>HT-STF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>-HT-LTF 0 ns CD</td><td>Data 0 ns CD</td><td></td><td>Data 0 ns CD</td></tr><tr><td>STF -200 ns CD</td><td>LTF -200 ns CD</td><td>L-SIG -200 ns CD</td><td>HT-SIG1 -200 ns CD</td><td>HT-SIG2 -200 ns CD</td><td>HT-STF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>Data -400 ns CD</td><td></td><td>Data -400 ns CD</td></tr><tr><td>8 μs</td><td>8 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td></td><td>4 μs</td></tr></table> <i>Figure 5.</i> IEEE802.11n mixed-mode packet with two spatial streams. <i>Id.</i> at 449-50: The short training field (STF) of 802.11n is the same as for 802.11a&g, except that different transmitters use different cyclic delays. The latter is done to avoid undesired beamforming effects and to get accurate power estimates that can be used to set the receive gain. For a proper AGC setting, it is important that the received power during the short training field is the same as the power during the rest of the packet. To achieve this, the short training fields from	STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD	STF -200 ns CD	LTF -200 ns CD	L-SIG -200 ns CD	HT-SIG1 -200 ns CD	HT-SIG2 -200 ns CD	HT-STF -400 ns CD	HT-LTF -400 ns CD	HT-LTF -400 ns CD	Data -400 ns CD		Data -400 ns CD	8 μs	8 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs		4 μs
STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD																								
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8 μs	8 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs		4 μs																								

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	different transmitters must have a low cross-correlation, also after being convolved with the wireless channel impulse response which has a typical rms delay spread in the order of 50 to 100 ns. It can be seen from the autocorrelation function in Figure 6 that applying a cyclic delay of -400 ns (or a cyclic advance of 400 ns) minimizes the correlation between two different transmitted short symbols, which is the reason that this value was selected for the greenfield short training field and for the second short training field in the mixed-mode preamble. The short training field of the mixed-mode preamble uses a cyclic delay of only -200 ns for the case of 2 transmitters, because of a fear that legacy 802.11a/g receivers might not be able to deal with larger cyclic delay values. Legacy receivers are also the reason that only negative cyclic delays are used. To a receiver the presence of a second transmit signal with a positive cyclic delay appears like a multipath signal that arrives later than the signal of the first transmitter. If the receiver uses a correlation approach to set its symbol timing [7], then it will set the symbol time too late, which can result in inter-symbol interference. When the second transmitter uses a negative cyclic delay, the receiver will set its symbol timing too early, which will eat into the OFDM guard time without causing inter-symbol interference. After the legacy signal field (L-SIG), a new high throughput signal field (HT-SIG) is transmitted that contains 48 bits with information including a 16-bit length field, a 7-bit field for the modulation and coding scheme (MCS), bits to indicate various options like LDPC coding, and an 8-bits CRC. To enable detection of the presence of a high throughput signal field, it uses a BPSK constellation that is rotated by 90 degrees. After the high throughput signal field, a second short training field is transmitted. This high throughput short training field (HT-STF) can be used to retrain the AGC, which may be needed for 2 reasons; first, the transmitter may employ beamforming for the high throughput part of the packet only, such that there may be a large power difference between the received signal before and after the start of the high throughput short training field. Second, there may also be a power difference because of non-zero cross-correlations between the cyclically shifted short training fields of the legacy part of the mixed mode preamble. This effect is small when using a cyclic delay of -200 or -400 ns like explained earlier. For the case of 4 transmitters, however, cyclic delays as small as 50 ns are used, which can result in a few dB

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	difference between the received power before and after the high throughput short training field. The high throughput short training field is followed by one or more high throughput long training fields (HT-LTF) that are used for channel estimation. The number of HT-LTF symbols is equal to the number of spatial streams. For the case of 2 spatial streams, the second HT-LTF of the first spatial stream is inverted to create an orthogonal space-time pattern. The receiver can obtain channel estimates for both spatial streams by adding and subtracting the first and second HT-LTF, respectively. The channel estimates can then be used to process the MIMOOFDM data symbols that follow the HT-LTF. The only remaining training task after channel estimation is pilot processing. Every data symbol has a few pilot subcarriers – 4 in 20MHz modes, 6 for 40MHz modes – that can be used to track any residual carrier frequency offset. <i>Id.</i> at 450-51: It is mandatory for an 802.11n device to transmit or receive 2 spatial streams. In addition to this, optional modes are defined for 3 and 4 spatial streams. Figure 8 shows the structure of the optional mixed-mode preamble for the case of 4 spatial streams. This preamble has 4 high throughput long training symbols that are encoded with an orthogonal pattern such that the receiver is able to obtain channel estimates for all 4 spatial streams. Together with the optional short guard interval option and the use of a 40MHz channel, the 4 spatial stream mode gives a highest possible raw data rate of 600 Mbps. <i>Id.</i> at Fig. 8: <table><tr><td>STF 0 ns CD</td><td>LTF 0 ns CD</td><td>L-SIG 0 ns CD</td><td>HT-SIG1 0 ns CD</td><td>HT-SIG2 0 ns CD</td><td>HT-STF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>-HT-LTF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>HT-LTF 0 ns CD</td><td>Data 0 ns CD</td><td></td><td>Data 0 ns CD</td></tr><tr><td>STF -50 ns CD</td><td>LTF -150 ns CD</td><td>L-SIG -150 ns CD</td><td>HT-SIG1 -150 ns CD</td><td>HT-SIG2 -150 ns CD</td><td>HT-STF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>-HT-LTF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>HT-LTF -400 ns CD</td><td>Data -400 ns CD</td><td></td><td>Data -400 ns CD</td></tr><tr><td>STF -100 ns CD</td><td>LTF -100 ns CD</td><td>L-SIG -100 ns CD</td><td>HT-SIG1 -100 ns CD</td><td>HT-SIG2 -100 ns CD</td><td>HT-STF -200 ns CD</td><td>HT-LTF -200 ns CD</td><td>-HT-LTF -200 ns CD</td><td>HT-LTF -200 ns CD</td><td>HT-LTF -200 ns CD</td><td>Data -200 ns CD</td><td></td><td>Data -200 ns CD</td></tr><tr><td>STF -150 ns CD</td><td>LTF -150 ns CD</td><td>L-SIG -150 ns CD</td><td>HT-SIG1 -150 ns CD</td><td>HT-SIG2 -150 ns CD</td><td>HT-STF -600 ns CD</td><td>-HT-LTF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>HT-LTF -600 ns CD</td><td>Data -600 ns CD</td><td></td><td>Data -600 ns CD</td></tr><tr><td>8 μs</td><td>8 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td><td>4 μs</td></tr></table> <i>Figure 8.</i> IEEE802.11n mixed-mode packet with four spatial streams.	STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	HT-LTF 0 ns CD	HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD	STF -50 ns CD	LTF -150 ns CD	L-SIG -150 ns CD	HT-SIG1 -150 ns CD	HT-SIG2 -150 ns CD	HT-STF -400 ns CD	HT-LTF -400 ns CD	-HT-LTF -400 ns CD	HT-LTF -400 ns CD	HT-LTF -400 ns CD	Data -400 ns CD		Data -400 ns CD	STF -100 ns CD	LTF -100 ns CD	L-SIG -100 ns CD	HT-SIG1 -100 ns CD	HT-SIG2 -100 ns CD	HT-STF -200 ns CD	HT-LTF -200 ns CD	-HT-LTF -200 ns CD	HT-LTF -200 ns CD	HT-LTF -200 ns CD	Data -200 ns CD		Data -200 ns CD	STF -150 ns CD	LTF -150 ns CD	L-SIG -150 ns CD	HT-SIG1 -150 ns CD	HT-SIG2 -150 ns CD	HT-STF -600 ns CD	-HT-LTF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	Data -600 ns CD		Data -600 ns CD	8 μ s	8 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s	4 μ s
STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	HT-LTF 0 ns CD	HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD																																																						
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[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	Van Nee discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following: See <i>e.g.</i>, Van Nee at 448: Figure 4 shows the packet structure of IEEE802.11a. One of the most important criteria for the choice of the new preambles for IEEE802.11n is compatibility with IEEE802.11a&g. To achieve this, a mixed-mode preamble is constructed as depicted in Figure 5. The mixed-mode preamble starts with an 802.11a preamble with the only difference that multiple transmitters transmit cyclically delayed copies of the preamble. A legacy 802.11a receiver is able to receive this preamble up to the legacy signal field, which guarantees a proper defer behavior of legacy devices for 802.11n packets. <i>Id.</i> at Fig. 4:  <i>Figure 4. IEEE802.11a/g packet structure.</i> <i>Id.</i> at Fig. 5: <i>The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond 449</i>  <i>Figure 5. IEEE802.11n mixed-mode packet with two spatial streams.</i> <i>Id.</i> at 450-51:

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STF 0 ns CD	LTF 0 ns CD	L-SIG 0 ns CD	HT-SIG1 0 ns CD	HT-SIG2 0 ns CD	HT-STF 0 ns CD	HT-LTF 0 ns CD	-HT-LTF 0 ns CD	HT-LTF 0 ns CD	HT-LTF 0 ns CD	Data 0 ns CD		Data 0 ns CD																																																						
STF -50 ns CD	LTF -150 ns CD	L-SIG -150 ns CD	HT-SIG1 -150 ns CD	HT-SIG2 -150 ns CD	HT-STF -400 ns CD	HT-LTF -400 ns CD	HT-LTF -400 ns CD	-HT-LTF -400 ns CD	HT-LTF -400 ns CD	Data -400 ns CD		Data -400 ns CD																																																						
STF -100 ns CD	LTF -100 ns CD	L-SIG -100 ns CD	HT-SIG1 -100 ns CD	HT-SIG2 -100 ns CD	HT-STF -200 ns CD	HT-LTF -200 ns CD	HT-LTF -200 ns CD	HT-LTF -200 ns CD	-HT-LTF -200 ns CD	Data -200 ns CD		Data -200 ns CD																																																						
STF -150 ns CD	LTF -150 ns CD	L-SIG -150 ns CD	HT-SIG1 -150 ns CD	HT-SIG2 -150 ns CD	HT-STF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	HT-LTF -600 ns CD	-HT-LTF -600 ns CD	Data -600 ns CD		Data -600 ns CD																																																						
8 μs	8 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4 μs	4	μs																																																						
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Van Nee discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference discloses the following: <i>See, e.g.,</i> Van Nee at 445: On the other hand, wireless LAN, the technology initially expected to provide only limited range and bandwidth has come a long way. Since the first IEEE 802.11 standard in 1997, the maximum data rate has climbed from 2 to 54 Mbps [1]. Unfortunately, every increase in rate came at the expense of a loss in range. In the IEEE 802.11a/g standards, for instance, the highest data rate of 54 Mbps is achieved through the use of 64-QAM. The use of such highly spectral efficient higher order modulations requires a significant larger SNR than the simple BPSK modulation used for the lowest 1 Mbps rate, resulting in a significant loss in range. In addition, the link becomes more vulnerable to co-channel interference, which reduces the total system capacity.																																																																	

Claim Elements	Disclosure in Van Nee
	The solution to obtain significant higher data rates and increase range performance at the same time is MIMO-OFDM (Multiple Input Multiple Output Orthogonal Frequency Division multiplexing) [2, 3]. MIMO-OFDM increases the link capacity by simultaneously transmitting multiple data streams using multiple transmit and receive antennas. It makes it possible to reach data rates that are several times larger than the current highest 802.11a/g rate of 54 Mbps without having to employ a larger bandwidth or a less robust QAM constellation [4]. After almost a decade of research on MIMO-OFDM, this technique is now ready to succeed OFDM as the dominant transmission technique in wireless LAN. With the introduction of MIMO-OFDM wireless LAN products in 2004 by Airgo Networks and the advent of the MIMO-OFDM based 802.11n standard, the performance of wireless LAN in terms of throughput and range is brought to a significantly higher level, enabling new applications outside the traditional wireless LAN area. The one time vision to replace wires in home entertainment applications, like TV cable replacement, has become a reality. <i>Id.</i>, Table 1:

Claim Elements	Disclosure in Van Nee																																																																																																						
	Table 1. Mandatory modulation and coding schemes (MCS) <table><tr><th>MCS</th><th>Code rate</th><th>Modulation</th><th>Number of spatial streams</th><th>Data rate in 20 MHz</th><th>Data rate in 40MHz</th></tr><tr><td>0</td><td>1/2</td><td>BPSK</td><td>1</td><td>6.5</td><td>13.5</td></tr><tr><td>1</td><td>1/2</td><td>QPSK</td><td>1</td><td>13</td><td>27</td></tr><tr><td>2</td><td>3/4</td><td>QPSK</td><td>1</td><td>19.5</td><td>40.5</td></tr><tr><td>3</td><td>1/2</td><td>16-QAM</td><td>1</td><td>26</td><td>54</td></tr><tr><td>4</td><td>3/4</td><td>16-QAM</td><td>1</td><td>39</td><td>81</td></tr><tr><td>5</td><td>2/3</td><td>64-QAM</td><td>1</td><td>52</td><td>108</td></tr><tr><td>6</td><td>3/4</td><td>64-QAM</td><td>1</td><td>58.5</td><td>121.5</td></tr><tr><td>7</td><td>5/6</td><td>64-QAM</td><td>1</td><td>65</td><td>135</td></tr><tr><td>8</td><td>1/2</td><td>BPSK</td><td>2</td><td>13</td><td>27</td></tr><tr><td>9</td><td>1/2</td><td>QPSK</td><td>2</td><td>26</td><td>54</td></tr><tr><td>10</td><td>3/4</td><td>QPSK</td><td>2</td><td>39</td><td>81</td></tr><tr><td>11</td><td>1/2</td><td>16-QAM</td><td>2</td><td>52</td><td>108</td></tr><tr><td>12</td><td>3/4</td><td>16-QAM</td><td>2</td><td>78</td><td>162</td></tr><tr><td>13</td><td>2/3</td><td>64-QAM</td><td>2</td><td>104</td><td>216</td></tr><tr><td>14</td><td>3/4</td><td>64-QAM</td><td>2</td><td>117</td><td>243</td></tr><tr><td>15</td><td>5/6</td><td>64-QAM</td><td>2</td><td>130</td><td>270</td></tr></table> Id. at 447: Figure 1 shows the block diagram of an IEEE802.11n transmitter. Input data is first scrambled using the same length-127 pseudo-noise scrambler that is used in IEEE802.11a. The convolutional encoder is also the same as IEEE802.11a, with the only difference that for 3 and 4 spatial streams, odd and even bits are separately encoded by two different encoders which is done to limit the maximum decoding rate at the receive side. After encoding, a parser sends consecutive blocks of $s = \max(N_{\text{bpsc}}/2,1)$ bits to different spatial streams, with N_{bpsc} being the number of bits per subcarrier. The bits are then interleaved by a block interleaver with a block size equal to the number of bits in a single OFDM symbol of the nth spatial stream, $NCBPS_n$. By interleaving the bits across both spatial	MCS	Code rate	Modulation	Number of spatial streams	Data rate in 20 MHz	Data rate in 40MHz	0	1/2	BPSK	1	6.5	13.5	1	1/2	QPSK	1	13	27	2	3/4	QPSK	1	19.5	40.5	3	1/2	16-QAM	1	26	54	4	3/4	16-QAM	1	39	81	5	2/3	64-QAM	1	52	108	6	3/4	64-QAM	1	58.5	121.5	7	5/6	64-QAM	1	65	135	8	1/2	BPSK	2	13	27	9	1/2	QPSK	2	26	54	10	3/4	QPSK	2	39	81	11	1/2	16-QAM	2	52	108	12	3/4	16-QAM	2	78	162	13	2/3	64-QAM	2	104	216	14	3/4	64-QAM	2	117	243	15	5/6	64-QAM	2	130	270
MCS	Code rate	Modulation	Number of spatial streams	Data rate in 20 MHz	Data rate in 40MHz																																																																																																		
0	1/2	BPSK	1	6.5	13.5																																																																																																		
1	1/2	QPSK	1	13	27																																																																																																		
2	3/4	QPSK	1	19.5	40.5																																																																																																		
3	1/2	16-QAM	1	26	54																																																																																																		
4	3/4	16-QAM	1	39	81																																																																																																		
5	2/3	64-QAM	1	52	108																																																																																																		
6	3/4	64-QAM	1	58.5	121.5																																																																																																		
7	5/6	64-QAM	1	65	135																																																																																																		
8	1/2	BPSK	2	13	27																																																																																																		
9	1/2	QPSK	2	26	54																																																																																																		
10	3/4	QPSK	2	39	81																																																																																																		
11	1/2	16-QAM	2	52	108																																																																																																		
12	3/4	16-QAM	2	78	162																																																																																																		
13	2/3	64-QAM	2	104	216																																																																																																		
14	3/4	64-QAM	2	117	243																																																																																																		
15	5/6	64-QAM	2	130	270																																																																																																		

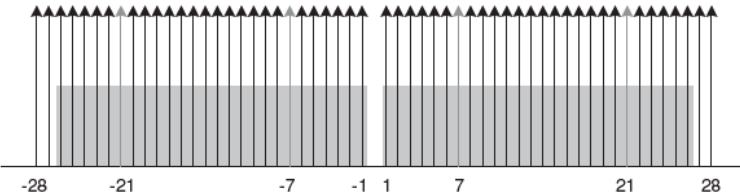
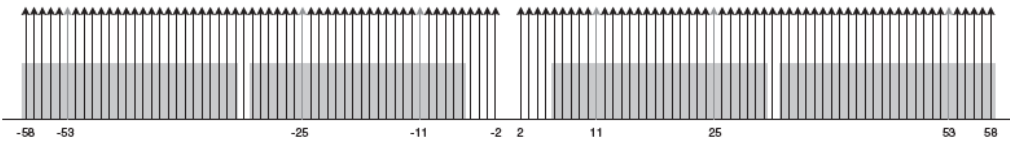
Claim Elements	Disclosure in Van Nee
	streams and subcarriers, the link performance benefits from both spatial diversity and frequency diversity. The interleaver for spatial stream n within its block of NCBPS, n bits is defined by the following relations, where k_n is the input bit index for spatial stream n and j_n is the output bit index.
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Van Nee discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following: <i>See, e.g.,</i> Van Nee at 448: The subcarrier mapping for 20MHz and 40MHz channels is depicted in Figures 2 and 3, respectively. The 20MHz mode uses 56 subcarriers for the high throughput data symbols, which is 4 more than the number used by 802.11a. The legacy part of the mixed-mode preamble (see Section 2.2.) and the high throughput signal field use the same subcarriers as 802.11a, which are shown as grey blocks in the figures. The 20MHz 11n modes use 4 pilots just like 802.11a, while the 40MHz 11n mode uses 6 pilots. A difference with 802.11a is that 802.11n uses a space time mapping for the pilots when transmitting from multiple antennas. In this way some extra transmit diversity is obtained on the pilots, and undesired beamforming effects are prevented. <i>Id.</i> at Figs. 2-3:

Claim Elements	Disclosure in Van Nee
	<i>Figure 2.</i> Subcarrier allocations for a 20 MHz channel. Data tones are black. Pilots are dark grey. Light grey blocks are the subcarriers used for 802.11a, for the legacy part of the mixed-mode preamble, and for the HT-SIG field. <i>Figure 3.</i> Subcarrier allocations for a 40MHz channel. Pilots are dark grey. Light grey blocks are the subcarriers used for 802.11a, for the legacy part of the mixed-mode preamble, and for the HT-SIG field. <i>Id.</i> at 451: In 2004, Airgo Networks launched the first wirelessLANchipset based onMIMO-OFDM.This first generation MIMO-OFDM system uses a 20MHz channel to transmit at either standard 802.11a/g data rates with a large range increase compared to conventional wireless LAN, or at significantly higher data rates up to 108 Mbps. In 2005, a second generation MIMO-OFDM product was introduced that uses Adaptive Channel Expansion to transmit either in a 20 or 40MHz channel, increasing the top data rate to 240 Mbps. Figure 9 demonstrates the performance impact of a wireless LAN using MIMO-OFDM versus a conventional wireless LAN in a 20MHz channel. The plot shows the cumulative distribution function of the measured TCP/IP throughput, where the client device has been put on a slowly rotating turntable to get throughput results for all possible orientations. From Figure 9 it can be seen that in 10% of all possible orientations, the MIMO wireless LAN has a throughput less than about 33 Mbps, so for 90% of all orientations the throughput exceeds 33 Mbps. For the non-MIMO wireless LAN, this 10% number is only 4 Mbps. Hence, for a 10% outage

Claim Elements	Disclosure in Van Nee
	probability, the MIMO throughput is more than 8 times better in this particular case. For the 1% outage probability, the performance difference is even more pronounced. Figure 10 shows measured TCP/IP throughput results for both 20 and 40MHz channel width. Each throughput curve consists of 8 points that correspond to different locations of the client inside a house, with an increased range towards the access point, but also with an increasing number of walls between the client and the access point. For the first test point, the client device is in the same room as the access point at a distance of 17 feet, while at the last test point the distance is 102 feet including 5 walls in between client and access point. The results show that for any range, the MIMO-OFDM throughput is 2.5 to 5 times that of other products. Notice that several of these other products use channel bonding to provide a proprietary maximum raw data rate of 108 Mbps in a 40MHz channel. This explains why these products are able to achieve maximum TCP/IP throughputs over 40 Mbps, while conventional 802.11a/g products have a maximum TCP/IP throughput of about 25 Mbps. The maximum throughput of Airgo ACE exceeds 100 Mbps, which meets the throughput goal set by 802.11n [6].
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Van Nee discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See e.g., Van Nee at 447:</i> After encoding, a parser sends consecutive blocks of $s = \max(N_{\text{bpsc}}/2, 1)$ bits to different spatial streams, with N_{bpsc} being the number of bits per subcarrier. The bits are then interleaved by a block interleaver with a block size equal to the number of bits in a single OFDM symbol of the nth spatial stream, $NCBPS_n$. By interleaving the bits across both spatial streams and subcarriers, the link performance benefits from both spatial diversity and frequency diversity. The interleaver for spatial stream n within its block of $NCBPS_n$ bits is defined by the following relations, where k_n is the input bit index for spatial stream n and j_n is the output bit index. <i>Id.</i> at 453: The performance of wireless LAN in terms of range and throughput is increased significantly by the use of MIMO-OFDM which is the basis of the new IEEE 802.11n standard.

Claim Elements	Disclosure in Van Nee
	Performance results show that net user throughputs over 100 Mbps are achievable with just 2 spatial streams, which is about four times larger than the maximum achievable throughput using IEEE 802.11a/g. For the same throughput, MIMO-OFDM achieves a range increase of about a factor of 3 compared to conventional wireless LAN. This performance boost makes MIMO-OFDM the ideal successor to the current OFDM-only wireless LAN. Also, it enables new throughput-demanding applications such as wireless video distribution. Seeing the effectiveness and superior capability of MIMO-OFDM in enhancing data rate and extending range, other standards organizations have realized that it can do wonders for other technologies, both fixed, mobile and cellular.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Van Nee discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Van Nee at 447:</i> After encoding, a parser sends consecutive blocks of $s = \max(N_{\text{bpsc}}/2, 1)$ bits to different spatial streams, with N_{bpsc} being the number of bits per subcarrier. The bits are then interleaved by a block interleaver with a block size equal to the number of bits in a single OFDM symbol of the nth spatial stream, $NCBPS_n$. By interleaving the bits across both spatial streams and subcarriers, the link performance benefits from both spatial diversity and frequency diversity. The interleaver for spatial stream n within its block of $NCBPS_n$ bits is defined by the following relations, where k_n is the input bit index for spatial stream n and j_n is the output bit index. <i>Id.</i> at 448: The subcarrier mapping for 20MHz and 40MHz channels is depicted in Figures 2 and 3, respectively. The 20MHz mode uses 56 subcarriers for the high throughput data symbols, which is 4 more than the number used by 802.11a. The legacy part of the mixed-mode preamble (see Section 2.2.) and the high throughput signal field use the same subcarriers as 802.11a, which are shown as grey blocks in the figures. The 20MHz 11n modes use 4 pilots just like 802.11a, while the 40MHz 11n mode uses 6 pilots. A difference with 802.11a is that 802.11n uses a space time mapping for the pilots when transmitting from multiple antennas. In

Claim Elements	Disclosure in Van Nee
	this way some extra transmit diversity is obtained on the pilots, and undesired beamforming effects are prevented. <i>Id.</i> at 453: The performance of wireless LAN in terms of range and throughput is increased significantly by the use of MIMO-OFDM which is the basis of the new IEEE 802.11n standard. Performance results show that net user throughputs over 100 Mbps are achievable with just 2 spatial streams, which is about four times larger than the maximum achievable throughput using IEEE 802.11a/g. For the same throughput, MIMO-OFDM achieves a range increase of about a factor of 3 compared to conventional wireless LAN. This performance boost makes MIMOOFDM the ideal successor to the current OFDM-only wireless LAN. Also, it enables new throughput-demanding applications such as wireless video distribution. Seeing the effectiveness and superior capability of MIMO-OFDM in enhancing data rate and extending range, other standards organizations have realized that it can do wonders for other technologies, both fixed, mobile and cellular.
[4] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	Van Nee discloses that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g.,</i> Van Nee at 448: The subcarrier mapping for 20MHz and 40MHz channels is depicted in Figures 2 and 3, respectively. The 20MHz mode uses 56 subcarriers for the high throughput data symbols, which is 4 more than the number used by 802.11a. The legacy part of the mixed-mode preamble (see Section 2.2.) and the high throughput signal field use the same subcarriers as 802.11a, which are shown as grey blocks in the figures. The 20MHz 11n modes use 4 pilots just like 802.11a, while the 40MHz 11n mode uses 6 pilots. A difference with 802.11a is that 802.11n uses a space time mapping for the pilots when transmitting from multiple antennas. In this way some extra transmit diversity is obtained on the pilots, and undesired beamforming effects are prevented. <i>Id.</i> at Figs. 2-3:

Claim Elements	Disclosure in Van Nee
	 <i>Figure 2.</i> Subcarrier allocations for a 20 MHz channel. Data tones are black. Pilots are dark grey. Light grey blocks are the subcarriers used for 802.11a, for the legacy part of the mixed-mode preamble, and for the HT-SIG field.  <i>Figure 3.</i> Subcarrier allocations for a 40 MHz channel. Pilots are dark grey. Light grey blocks are the subcarriers used for 802.11a, for the legacy part of the mixed-mode preamble, and for the HT-SIG field.
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Van Nee discloses that the wireless transceiver supports one or more wireless standards. For example, the reference discloses the following: <i>See e.g., Van Nee at Abstract:</i> An overview is given of the new IEEE 802.11n standard. This is the first wireless LAN standard based on MIMO-OFDM, a technique pioneered by Airgo Networks to give a significant performance increase in both range and rate relative to conventional wireless LAN. Performance results show that net user throughputs over 100 Mbps are achievable, which is about four times larger than the maximum achievable throughput using IEEE 802.11a/g. For the same throughput, MIMO-OFDM achieves a range that is about 3 times larger than non-MIMO systems. This significant improvement in range-rate performance makes MIMO-OFDM the ideal solution not only for wireless LAN, but also for home entertainment networks and 4G networks.
[9.PRE] A wireless OFDM (Orthogonal Frequency	<i>See, e.g., claim 1, preamble above.</i>

Claim Elements	Disclosure in Van Nee
Division Multiplexing) transceiver comprising:	
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim 1, limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet	<i>See, e.g.</i> , claim 1, limitation 1.C above.

Claim Elements	Disclosure in Van Nee
comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[11] The wireless transceiver of claim 9, wherein the at least one	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in Van Nee
repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first	<i>See, e.g.</i> , claim 1, limitation 1.B above.

Claim Elements	Disclosure in Van Nee
packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	<i>See, e.g.</i> , claim 1, limitation 1.D above.

Claim Elements	Disclosure in Van Nee
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[24] The method of claim 17, wherein the at least one	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in Van Nee
repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim 1, limitation 1.B above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM	<i>See, e.g.</i> , claim 1, limitation 1.C above.

Claim Elements	Disclosure in Van Nee
symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[25.E] wherein the first narrower and second wider	<i>See, e.g.</i> , claim 1, limitation 1.A above.

Claim Elements	Disclosure in Van Nee
frequency bands have one or more overlapping frequency regions.	
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[27] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[32] The method of claim 25, wherein the wireless	<i>See, e.g.</i> , Claim 8 above.

Claim Elements	Disclosure in Van Nee
transceiver supports one or more wireless standards.	

Exhibit A9

**Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent Application Publication No. 2005/0169261 ("Williams") Alone or in Combination with U.S. Patent No. 8,018,975
("Ma") and/or U.S. Patent No. 9,313,067 ("Soliman")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under pre-AIA 35 U.S.C. § 102 as anticipated by Williams¹; (2) under pre-AIA 35 U.S.C. § 103 as obvious in view of Williams standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Williams in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ Williams was filed on August 5, 2004.

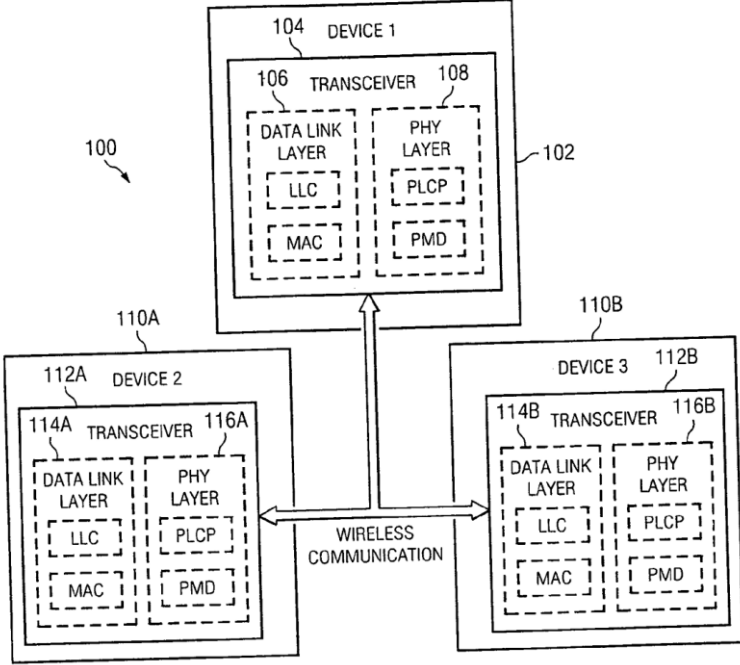
² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Williams alone or in combination with Ma and/or Soliman discloses a wireless OFDM transceiver. For example, the reference discloses the following: <i>See, e.g., Williams ¶ [0020]:</i> As shown in FIG. 1, the wireless system may comprise the devices 102, 110A, and 110B. The device 102 may comprise a transceiver 104 having a data link layer 106 and a physical (PHY) layer 108. In at least some embodiments, the device 102 may implement a first wireless protocol (e.g., 802.11a, 802.11g). Similarly, each of the devices 110A and 110B also may comprise a transceiver 112A, 112B having a data

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	link layer 114A, 114B and a PHY layer 116A, 116B. In at least some embodiments, the devices 110A and 110B may be implement a second wireless protocol (e.g., 802.11n). <i>Id.</i> at Fig. 1: FIG. 1  <i>Id.</i> ¶¶ [0029]-[0030]: The header 302 may comprise a single OFDM (Orthogonal Frequency Division Multiplexing) symbol 312 denoted as “SIGNAL1”. In at least some embodiments, the header 302 may define fictitious information for interpretation by devices that are not compatible with the header extension 304 or other parameters of a protocol. The purpose of the fictitious information will later be described. The SIGNAL1 symbol 312 described above may be transmitted at a rate of 6 megabits per second (Mbps) using binary phase shift keying (BPSK) and a coding rate of ½. As shown in FIG. 3, the SIGNAL1 symbol 312 may

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	comprise data from a “RATE” field, a “SIG2 IND” field, a “LENGTH” field, a “PARITY” field, and a “TAIL” field. The RATE field may comprise 4 bits of data that identify a data rate having a fixed type of modulation (e.g., BPSK, QPSK, 16-QAM, 64-QAM) and/or a convolutional coding rate (e.g., $\frac{1}{2}$, $\frac{3}{4}$, $\frac{2}{3}$). In at least some embodiments, the RATE field also may contain information that defines a transmission antenna configuration. The SIG2 IND field may comprise 1 bit of data that identifies whether the header extension 304 will be used (i.e., the SIG2 IND field may be used as a flag that indicates when the header extension 304 is used). Alternatively, other methods may be used to determine whether the header extension 304 is used. For example, a “stealth” signal may be transmitted with the header frame 302 using the quadrature component of the signal subcarrier. The stealth signal may be detectable by devices (e.g., devices 110A and 110B) that can interpret the header extension 304 and undetectable to devices (e.g., device 102) that cannot interpret the header extension 304. Alternatively, the stealth signal may be detectable by devices (e.g., device 102) other than those that use the second protocol, in which case the stealth signal, preferably, does not interfere with the normal operation of the non-second protocol device. The LENGTH field may comprise 12 bits of data that identify a number of octets used for the data 306. The PARITY field may comprise 1 bit that identifies a positive parity bit for bits (0-16) of the header 302. The TAIL field may comprise 6 bits used to bring a convolutional encoder to a zero state. The header extension 304 may be used when the SIG2 IND field bit of the header 302 is asserted (i.e., equal to a logical “1”). As shown, the header extension 304 may comprise a single OFDM symbol 314 denoted as “SIGNAL2”. In at least some embodiments, the header extension 304 may define information regarding parameters used by the second protocol. The SIGNAL2 symbol 314 described above may be transmitted at a rate of 6 Mbps using BPSK and a coding rate of $\frac{1}{2}$. The header extension 304 may comprise a “RATE2” field, a “LENGTH2” field, a “PARITY” field, and a “TAIL” field. The RATE2 field may comprise 8 bits that define a data transfer rate of a second protocol and a corresponding modulation type, coding rate and/or antenna configuration.
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications,	Williams alone or in combination with Ma and/or Soliman discloses a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Williams ¶¶ [0026]-[0030]:</i> FIG. 2 illustrates an exemplary data packet 200 used for wireless data transmission. As shown in FIG. 2, the data packet 200 may comprise a preamble 202, a header field 204, a MAC address field 206, a data

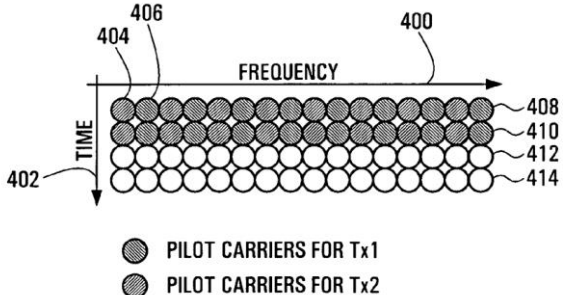
Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	field 208, and a CRC field 210. The preamble 202 may be used for synchronization and channel estimation. The header field 204 may provide modulation information, convolution coding rate information, and data length (i.e., number of octets) information. The MAC address field 206 may comprise a hardware address that identifies a node of a network. The data field 208 may comprise a variable amount of scrambled data. The CRC field 210 may comprise information for detecting data transmission errors. In accordance with at least some embodiments of the invention, one or more fields of a data packet 200 may be added and/or modified in order to permit the devices 110A, 110B to transmit data to each other according to the second protocol, and permit the devices 110A, 110B to transmit data to the device 102 using the first protocol and vice versa as previously described. Additionally, adding and/or modifying fields of a data packet 200 may permit the devices 102, 110A, and 110B to estimate the duration of data transfers (used for CCA) according to data rates supported by either the first protocol or the second protocol. FIG. 3 illustrates a data frame 300 in accordance with embodiments of the invention. In some embodiments, the data frame 300 may comprise a modified PPDU (PLCP Protocol Data Unit) frame. As shown in FIG. 3, the data frame 300 may comprise a header 302 (e.g., a PLCP header), a header extension 304, and data 306 (e.g. PSDU (PLCP Service Data Unit) data). A MAC address frame (not shown) also may be included before or in the data 306. The header 302 may comprise a single OFDM (Orthogonal Frequency Division Multiplexing) symbol 312 denoted as “SIGNAL1”. In at least some embodiments, the header 302 may define fictitious information for interpretation by devices that are not compatible with the header extension 304 or other parameters of a protocol. The purpose of the fictitious information will later be described. The SIGNAL1 symbol 312 described above may be transmitted at a rate of 6 megabits per second (Mbps) using binary phase shift keying (BPSK) and a coding rate of $\frac{1}{2}$. As shown in FIG. 3, the SIGNAL1 symbol 312 may comprise data from a “RATE” field, a “SIG2 IND” field, a “LENGTH” field, a “PARITY” field, and a “TAIL” field. The RATE field may comprise 4 bits of data that identify a data rate having a fixed type of modulation (e.g., BPSK, QPSK, 16-QAM, 64-QAM) and/or a convolutional coding rate (e.g., $\frac{1}{2}$, $\frac{3}{4}$, $\frac{2}{3}$). In at least some embodiments, the RATE field also may contain information that defines a transmission antenna configuration. The SIG2 IND field may comprise 1 bit of data that identifies whether the header extension 304 will be used (i.e., the SIG2 IND field may be used as a flag that indicates when the header

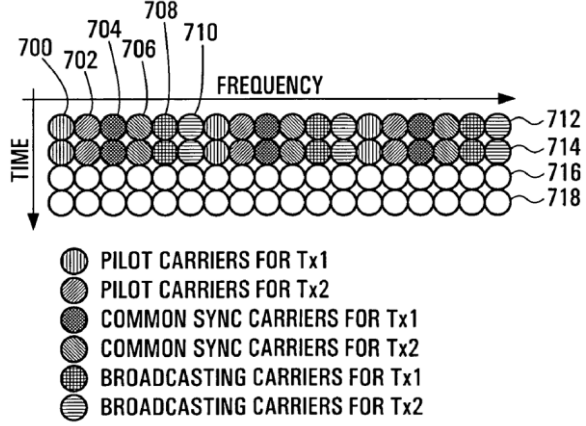
Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	extension 304 is used). Alternatively, other methods may be used to determine whether the header extension 304 is used. For example, a “stealth” signal may be transmitted with the header frame 302 using the quadrature component of the signal subcarrier. The stealth signal may be detectable by devices (e.g., devices 110A and 110B) that can interpret the header extension 304 and undetectable to devices (e.g., device 102) that cannot interpret the header extension 304. Alternatively, the stealth signal may be detectable by devices (e.g., device 102) other than those that use the second protocol, in which case the stealth signal, preferably, does not interfere with the normal operation of the non-second protocol device. The LENGTH field may comprise 12 bits of data that identify a number of octets used for the data 306. The PARITY field may comprise 1 bit that identifies a positive parity bit for bits (0-16) of the header 302. The TAIL field may comprise 6 bits used to bring a convolutional encoder to a zero state. The header extension 304 may be used when the SIG2 IND field bit of the header 302 is asserted (i.e., equal to a logical “1”). As shown, the header extension 304 may comprise a single OFDM symbol 314 denoted as “SIGNAL2”. In at least some embodiments, the header extension 304 may define information regarding parameters used by the second protocol. The SIGNAL2 symbol 314 described above may be transmitted at a rate of 6 Mbps using BPSK and a coding rate of ½. The header extension 304 may comprise a “RATE2” field, a “LENGTH2” field, a “PARITY” field, and a “TAIL” field. The RATE2 field may comprise 8 bits that define a data transfer rate of a second protocol and a corresponding modulation type, coding rate and/or antenna configuration. <i>Id.</i> at Fig. 3: FIG. 3 300 302 304 306 308 4 BITS 1 BIT 12 BITS 1 BIT 6 BITS 8 BITS 8 BITS 1 BIT 6 BITS 16 BITS 6 BITS RATE SIG2 IND LENGTH PARITY TAIL RATE2 O/E LENGTH2 PARITY TAIL SERVICE PSDU TAIL PAD BITS SIGNAL EXTENSION 202 CODED OFDM (BSPK, R=1/2) CODED OFDM (BSPK, R=1/2) CODED OFDM (SELECT RATE, SELECT LENGTH) 318 PREAMBLE SIGNAL1 SIGNAL2 DATA SILENT 12 SYMBOLS 312 1 OFDM SYMBOL 314 1 OFDM SYMBOL VARIABLE NUMBER OF OFDM SYMBOLS 316 0 VOLTS

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Williams alone or in combination with Ma and/or Soliman discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. For example, the reference discloses the following: <i>See, e.g., Williams ¶ [0017]:</i> Electronic devices that communicate wirelessly may use a variety of techniques to prepare, send, receive, and recover data. For example, data preparation techniques may comprise data scrambling, error correction coding, interleaving, data packet formatting, modulation, and/or other techniques. To send the data, one or more carrier frequencies may be selected and one or more antennas may propagate a wireless signal at the selected carrier frequency(s). To receive the data, one or more antennas may “pick up” the wireless signal, after which the data may be recovered using techniques such as signal amplification, digitization, down-sampling, equalization, demodulation, de-interleaving, de-coding, and/or de-scrambling. <i>Id. ¶ [0024]:</i> In order for the devices 102, 110A, and 110B to communicate wirelessly, the PHY layers 108, 116A, 116B and the data link layers 106, 114A, 114B may perform several functions. For example, the PHY layers 108, 116A, 116B may each implement a physical layer convergence procedure (PLCP) sub-layer and a physical medium dependent (PMD) sub-layer. The PLCP sub-layer may provide an interface whereby carrier sense and clear channel assessment (CCA) signals are provided to the data link layer 106, 114A, 114B indicating whether the PHY layer 108, 116A, 116B is in use. The PMD sub-layer may provide encoding, decoding, modulation, and/or demodulation of data. The PMD sub-layers also may provide analog-to-digital and/or digital-to-analog data conversion. <i>Id. ¶ [0036]:</i> As shown in FIGS. 2 and 3, the data frame 300 may also comprise a preamble 202 and a signal extension 308, 318. The preamble 202 may comprise a number of symbols (e.g., 12 symbols) that are used for synchronization and channel estimation. The signal extension 308 may comprise a time period of silence (i.e., no data is transmitted) that provides a receiving system with additional time to decode the data 306

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	before receiving another data frame 300. For example, the signal extension time period may comprise approximately 4 μs. Ma at 2:13-24: OFDM technology has been adopted by DAB, DVB-T and IEEE 802.11 standards. DAB and DVB-T are used for audio and video territorial broadcasting. In these systems, the signal is transmitted in a continuous data stream. A preamble is not needed because fast packet access is not critical. DAB and DVB-T are also applied in single frequency networks. In this case, every transmitter transmits the same signal as a simulcast. The interference from the neighbouring transmitters can be treated as an active echo, which can be handled by the proper design of the prefix. IEEE 802.11 is the wireless LAN standard. It is a packet based OFDM transmission system. A preamble header is introduced in this standard. <i>Id.</i> at 4:6-18: In some embodiments, the sub-carriers of the preamble OFDM symbols are organized as a repeating sequence of {dedicated pilot channel for each of N transmit antennas, common synchronization channel sub-carrier for each of N transmit antennas} arranged in a predetermined order. In some embodiments, the sub-carriers of the preamble OFDM symbols are organized as a repeating sequence of {at least one dedicated pilot channel sub-carrier for each of N transmit antennas, at least one common synchronization channel sub-carrier for each of N transmit antennas, at least one broadcast channel sub-carrier} arranged in a predetermined order. <i>Id.</i> at 7:54-67: In some embodiments, the method is applied to a MIMO-OFDM frame format having a header symbol format in which subcarriers of a header symbol are divided into a non-contiguous set of subcarriers for each of a plurality of antennas, with each antenna transmitting header symbols only on the respective set of sub-carriers, and wherein the header symbols contain multiplexed pilot channel sub-carriers and common synchronization channel sub-carriers for each of the plurality of antennas, the frame beginning with two identical header OFDM symbols during which contents of the pilot channel sub-carriers are repeated and contents of the synchronization channel sub-carriers are repeated, the common synchronization channel sub-carriers carrying a complex sequence which is different for respective

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	antenna of one base station and being common across multiple base stations, and contents of the dedicated pilot channel sub-carriers being at least locally unique to a particular base station. <i>Id.</i> at 10:5-36: OFDM is a parallel transmission technology. The whole useful bandwidth is divided into many sub-carriers, and each sub-carrier is modulated independently. According to an embodiment of the invention, to separate different antenna with multiple antennas transmission, during the header not all sub-carriers are used on all transmit antennas. Rather, the sub-carriers are divided between antennas. An example of this will now be described with reference to FIG. 3. The sub-carrier frequencies contained within an OFDM symbol are each represented by circles. In this example it is assumed that there are two transmitting antennas in the MIMO system. FIG. 3 shows OFDM symbols with the various sub-carriers spaced along the frequency axis 400, and with the contents of all the sub-carriers at a given instant representing one symbol in time, as indicated along the time axis 402. In this case, the first two OFDM symbols 408, 410 are used for dedicated pilot channel information while the remaining symbols (only two shown, 412, 414) are used for regular OFDM symbols. The dedicated pilot channel information transmitted on the first two OFDM symbols 408, 410 alternates by sub-carrier between being transmitted by the first antenna and the second antenna. This is indicated for the first sub-carrier 404 which is transmitting dedicated pilot channel information for the first transmitter and sub-carrier 406 which is transmitting dedicated pilot channel information for the second sub-carrier, and this pattern then repeats for the remainder of the sub-carriers. The other OFDM symbols 412, 414 contain information transmitted by both antennas. It is to be understood that other spacings could alternatively be used. Furthermore, if there are more than two transmit antennas, the pilot channel information would then alternate by sub-carrier in some predetermined pattern between all of the transmit antennas. <i>Id.</i> at Fig. 3:

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	 FIG. 3 <i>Id.</i> at 11:37-54: An example of the mapping of the different channels in the MIMO-OFDM system with two-transmitter diversity is shown in FIG. 5. In this example, there are shown four OFDM symbols 712, 714, 716, 718 two of which 712, 714 are header symbols. During the header symbols 712, 714 every second sub-carrier is used for the first antenna with the remaining sub-carriers used for the second antenna. This is easily generalized to higher numbers of antennas. For this example, it is assumed that there are two transmit antennas in the MIMO system. Every sixth sub-carrier starting at the first sub-carrier 700 is for the first transmitter dedicated pilot channel sub-carriers. Every sixth sub-carrier starting at the second sub-carrier 702 is for the second transmitter dedicated pilot channel sub-carrier. Every sixth sub-carrier starting at the third sub-carrier 704 is for the first transmitter common synchronization channel sub-carrier. Every sixth sub-carrier starting at the fourth sub-carrier 706 is for the second transmitter common synchronization channel sub-carrier. Every sixth sub-carrier starting at the fifth sub-carrier is for broadcasting channel sub-carriers for the first antenna, and every sixth sub-carrier starting at the sixth sub-carrier 710 is for broadcasting channel sub-carriers for the second antenna. <i>Id.</i> at Fig. 5:

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	 FIG. 5 <i>Id.</i> at 13:34-66: Referring to FIG. 7A, a block diagram of MIMO-OFDM receiver functionality is shown which is adapted to perform coarse synchronization based on the two repeated OFDM header symbols transmitted by each transmit antenna as detailed above. The OFDM receiver includes a first receiving antenna 734 and a second receiving antenna 735 (although more generally there will be a plurality of N receiving antennae). The first receiving antenna 734 receives a first received signal at RF receiver 736. The first received signal is a combination of the two signals transmitted by the two transmitting antennae 21 and 23 of FIG. 6, although each of the two signals will have been altered by a respective channel between the respective transmitting antenna and the first receiving antenna 734. The second receiving antenna 735 receives a second received signal at RF receiver 739. The second received signal is a combination of the two signals transmitted by the two transmitting antennae 21 and 23, although each of the two signals will have been altered by a respective channel between the respective transmitting antenna and the second receiving antenna 735. The four channels (between each of the two transmitting antennae and each of the two receiving antennae) may vary with time and with frequency, and will in general be different from each other.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	Coarse synchronization is performed for the first receive antenna 734 by a coarse synchronizer 737 on discrete time samples of a received signal to determine an approximate range of a location of the starting position of the first header symbol. A similar process is performed by coarse synchronizer 741 for the second antenna 735. Coarse synchronization is facilitated by the use of repeated header symbols at the OFDM transmitter. <i>Id.</i> at 14:47-64: Referring to FIG. 7B, a block diagram is shown of an MIMO-OFDM fine synchronization functionality is shown. In one embodiment, the fine synchronization functionality is adapted to perform fine synchronization based on the two-repeated OFDM header symbols transmitted by each transmit antenna as detailed above using the common synchronization channel and/or the dedicated pilot channel. More generally, the fine synchronization functionality can perform fine synchronization for OFDM frames within which some known training sequence has been embedded. Also, an input to the fine synchronization process is a coarse synchronization position. This coarse synchronization position may be determined using the above discussed method, or using any other suitable method. The components which are identical to those of FIG. 7A are similarly numbered and in an actual implementation would be shared if the common synchronizers of FIG. 7A are to be used. The functionality of FIG. 7B is replicated for each of the one or more receive antenna.
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first	Williams alone or in combination with Ma and/or Soliman discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Williams ¶ [0017]:</i> Electronic devices that communicate wirelessly may use a variety of techniques to prepare, send, receive, and recover data. For example, data preparation techniques may comprise data scrambling, error correction coding, interleaving, data packet formatting, modulation, and/or other techniques. To send the data, one or more carrier frequencies may be selected and one or more antennas may propagate a wireless signal at the selected carrier frequency(s). To receive the data, one or more antennas may “pick up” the wireless signal, after which the data may be recovered using techniques such as signal amplification,

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	digitization, down-sampling, equalization, demodulation, de-interleaving, de-coding, and/or de-scrambling. <i>Id.</i> ¶¶ [0026]-[0030]: FIG. 2 illustrates an exemplary data packet 200 used for wireless data transmission. As shown in FIG. 2, the data packet 200 may comprise a preamble 202, a header field 204, a MAC address field 206, a data field 208, and a CRC field 210. The preamble 202 may be used for synchronization and channel estimation. The header field 204 may provide modulation information, convolution coding rate information, and data length (i.e., number of octets) information. The MAC address field 206 may comprise a hardware address that identifies a node of a network. The data field 208 may comprise a variable amount of scrambled data. The CRC field 210 may comprise information for detecting data transmission errors. In accordance with at least some embodiments of the invention, one or more fields of a data packet 200 may be added and/or modified in order to permit the devices 110A, 110B to transmit data to each other according to the second protocol, and permit the devices 110A, 110B to transmit data to the device 102 using the first protocol and vice versa as previously described. Additionally, adding and/or modifying fields of a data packet 200 may permit the devices 102, 110A, and 110B to estimate the duration of data transfers (used for CCA) according to data rates supported by either the first protocol or the second protocol. FIG. 3 illustrates a data frame 300 in accordance with embodiments of the invention. In some embodiments, the data frame 300 may comprise a modified PPDU (PLCP Protocol Data Unit) frame. As shown in FIG. 3, the data frame 300 may comprise a header 302 (e.g., a PLCP header), a header extension 304, and data 306 (e.g. PSDU (PLCP Service Data Unit) data). A MAC address frame (not shown) also may be included before or in the data 306. The header 302 may comprise a single OFDM (Orthogonal Frequency Division Multiplexing) symbol 312 denoted as “SIGNAL1”. In at least some embodiments, the header 302 may define fictitious information for interpretation by devices that are not compatible with the header extension 304 or other parameters of a protocol. The purpose of the fictitious information will later be described. The SIGNAL1 symbol 312 described above may be transmitted at a rate of 6 megabits per second (Mbps) using binary phase shift keying (BPSK) and a coding rate of ½. As shown in FIG. 3, the SIGNAL1 symbol 312 may

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	comprise data from a “RATE” field, a “SIG2 IND” field, a “LENGTH” field, a “PARITY” field, and a “TAIL” field. The RATE field may comprise 4 bits of data that identify a data rate having a fixed type of modulation (e.g., BPSK, QPSK, 16-QAM, 64-QAM) and/or a convolutional coding rate (e.g., $\frac{1}{2}$, $\frac{3}{4}$, $\frac{2}{3}$). In at least some embodiments, the RATE field also may contain information that defines a transmission antenna configuration. The SIG2 IND field may comprise 1 bit of data that identifies whether the header extension 304 will be used (i.e., the SIG2 IND field may be used as a flag that indicates when the header extension 304 is used). Alternatively, other methods may be used to determine whether the header extension 304 is used. For example, a “stealth” signal may be transmitted with the header frame 302 using the quadrature component of the signal subcarrier. The stealth signal may be detectable by devices (e.g., devices 110A and 110B) that can interpret the header extension 304 and undetectable to devices (e.g., device 102) that cannot interpret the header extension 304. Alternatively, the stealth signal may be detectable by devices (e.g., device 102) other than those that use the second protocol, in which case the stealth signal, preferably, does not interfere with the normal operation of the non-second protocol device. The LENGTH field may comprise 12 bits of data that identify a number of octets used for the data 306. The PARITY field may comprise 1 bit that identifies a positive parity bit for bits (0-16) of the header 302. The TAIL field may comprise 6 bits used to bring a convolutional encoder to a zero state. The header extension 304 may be used when the SIG2 IND field bit of the header 302 is asserted (i.e., equal to a logical “1”). As shown, the header extension 304 may comprise a single OFDM symbol 314 denoted as “SIGNAL2”. In at least some embodiments, the header extension 304 may define information regarding parameters used by the second protocol. The SIGNAL2 symbol 314 described above may be transmitted at a rate of 6 Mbps using BPSK and a coding rate of $\frac{1}{2}$. The header extension 304 may comprise a “RATE2” field, a “LENGTH2” field, a “PARITY” field, and a “TAIL” field. The RATE2 field may comprise 8 bits that define a data transfer rate of a second protocol and a corresponding modulation type, coding rate and/or antenna configuration. <i>Id.</i> at Fig. 3:

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	FIG. 3 300 302 304 306 308 202 312 314 316 318 4 BITS 1 BIT 12 BITS 1 BIT 6 BITS 8 BITS 8 BITS 1 BIT 6 BITS 16 BITS 6 BITS RATE SIG2 IND LENGTH PARITY TAIL RATE2 O/E LENGTH2 PARITY TAIL SERVICE PSDU TAIL PAD BITS SIGNAL EXTENSION CODED OFDM (BSPK, R=1/2) CODED OFDM (BSPK, R=1/2) CODED OFDM (SELECT RATE, SELECT LENGTH) PREAMBLE SIGNAL1 SIGNAL2 DATA SILENT 12 SYMBOLS 1 OFDM SYMBOL 1 OFDM SYMBOL VARIABLE NUMBER OF OFDM SYMBOLS 0 VOLTS
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Williams alone or in combination with Ma and/or Soliman discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference discloses the following: See, e.g., Williams ¶ [0024]: In order for the devices 102, 110A, and 110B to communicate wirelessly, the PHY layers 108, 116A, 116B and the data link layers 106, 114A, 114B may perform several functions. For example, the PHY layers 108, 116A, 116B may each implement a physical layer convergence procedure (PLCP) sub-layer and a physical medium dependent (PMD) sub-layer. The PLCP sub-layer may provide an interface whereby carrier sense and clear channel assessment (CCA) signals are provided to the data link layer 106, 114A, 114B indicating whether the PHY layer 108, 116A, 116B is in use. The PMD sub-layer may provide encoding, decoding, modulation, and/or demodulation of data. The PMD sub-layers also may provide analog-to-digital and/or digital-to-analog data conversion. <i>Id.</i> ¶ [0036]: As shown in FIGS. 2 and 3, the data frame 300 may also comprise a preamble 202 and a signal extension 308, 318. The preamble 202 may comprise a number of symbols (e.g., 12 symbols) that are used for synchronization and channel estimation. The signal extension 308 may comprise a time period of silence (i.e., no data is transmitted) that provides a receiving system with additional time to decode the data 306 before receiving another data frame 300. For example, the signal extension time period may comprise approximately 4 μs.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Williams alone or in combination with Ma and/or Soliman discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following: <i>See, e.g., Williams ¶ [0017]:</i> To send the data, one or more carrier frequencies may be selected and one or more antennas may propagate a wireless signal at the selected carrier frequency(s). To receive the data, one or more antennas may “pick up” the wireless signal, after which the data may be recovered using techniques such as signal amplification, digitization, down-sampling, equalization, demodulation, de-interleaving, de-coding, and/or de-scrambling. <i>Soliman at 2:1-9:</i> 802.11n, when using the 2.4 GHz band North American channelization scheme, divides the 2.4 GHz spectrum into 11 overlapping, staggered channels whose center frequencies are 5 megahertz (MHz) apart. A 20 MHz channel is divided into 56 subcarriers, with a subcarrier spacing of 0.3125 MHz, or 40 MHz channels with 112 subcarriers. Note: some subcarriers are used as pilot subcarriers. Like the above-described UWB system, 802.11n uses OFDM to transmit subcarriers. <i>Id. at 2:39-55:</i> More explicitly, a first baseband signal is generated having a first data rate in response to selecting the first clock frequency. A second baseband signal may be generated having a second data rate greater than the first data rate, in response to selecting the second clock frequency. Then, a first RF signal with a data rate in a range of about 13.5 to 135 megabits per second (Mbps) is generated in response to the first baseband signal. For example, the first RF signal may be associated with an 802.11n mode of operation using 40 MHz channels. In another aspect, the first RF signal data rate may be in the range of 6.5 to 65 Mbps, corresponding to 20 MHz channels in the 802.11n mode. A second RF signal with a data rate in a range of about 53.3 to 480 Mbps may be generated in response to the second baseband signal, corresponding to UWB operation. However, in other aspects, the second RF signal may operate in the UWB mode at data rates up to 1 GHz. <i>Id. at 4:40-56:</i>

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	FIG. 1 is a schematic block depicting a system 102 for transmitting information via alternate bandwidths using a shared baseband processor. The system 102 is embedded in communications device 100 and comprises a clock or clocking means 104 having an input on line 106 to accept a frequency selection signal, and an output on line 108 to supply a clock sampling frequency. The selected clock frequency supplied includes a first clock frequency ($1 \times F1$), and a second clock frequency ($k \times F1$), where $k > 1$. In one aspect, first clock sampling frequency ($1 \times F1$) defines l as either 1 or 2, with $F1$ being either about 20 MHz or about 40 MHz. The second frequency is then k times the first frequency. That is, the first clock frequency is either 20 or 40 MHz. These frequencies would support the operation of 802.11a/g and 802.11n communications. Further, k is selected so that the second clock sampling frequency supports the operation of UWB communications. <i>Id.</i> at 7:59-8:12: FIG. 4 is a schematic block diagram depicting a system 702 for receiving information via alternate bandwidths using a shared baseband processor. The system 702 is embedded in a communications device 700 and includes an RF module or RF means 704 having an input on line 706 to accept a radiated RF signal (as shown), or an RF signal from a hard-wired medium (not shown). The RF signal has a data rate responsive to a selected clock frequency. The RF module 704 has an output to supply a baseband signal on line 708, converted from the RF signal. A clock or clocking means 710 has an input on line 712 to accept a frequency selection signal and an output on line 714 to supply a clock sampling frequency. The selectable frequencies include a first clock frequency ($1 \times F1$) and a second clock frequency ($k \times F1$), where $k > 1$. In one aspect, first clock sampling frequency ($1 \times F1$) defines l as either 1 or 2, with $F1$ being either about 20 MHz or about 40 MHz. That is, the first clock frequency is either 20 or 40 MHz. The second frequency is k times the first frequency. These frequencies would support the operation of 802.11n, 802.11a, 802.11g, and UWB communications. <i>Id.</i> at Tables 2-3:

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman								
	TABLE 2								
	802.11n System (20 MHz channels)								
	Data Rates (calculated)								
		6.50	13.00	19.50	26.00	39.00	52.00	58.50	65.00
	Modulation/Constellation	Units	1 (BPSK)	2 (QPSK)	2 (OFDM/QPSK)	4 (16 QAM)	4 (16 QAM)	6 (64 QAM)	6 (64 QAM)
	FFT Size		64	64	64	64	64	64	64
	Coding Rate (K = 7)		$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
	Spreading Rate		1	1	1	1	1	1	1
	Information Tones		52	52	52	52	52	52	52
	Pilot tones		4	4	4	4	4	4	4
	Null Tones		8	8	8	8	8	8	8
	Data Tones		52	52	52	52	52	52	52
	Info. Length (FFT Integration Time)	μ s	3.20	3.20	3.20	3.20	3.20	3.20	3.20
	Cyclic Prefix	μ s	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	Guard Interval	μ s	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Symbol Length	μ s	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Channel Bit Rate	Mbps	13.00	26.00	26.00	52.00	52.00	78.00	78.00
	Tolerable RMS delay spread	μ s	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	Subcarrier spacing	MHz	0.31	0.31	0.31	0.31	0.31	0.31	0.31
	Occupied bandwidth	MHz	17.50	17.50	17.50	17.50	17.50	17.50	17.50
	No. of samples per symbol		80	80	80	80	80	80	80
	Sampling rate	MHz	20	20	20	20	20	20	20

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman									
	TABLE 3									
	802.11n System (40 MHz channels)									
	Data Rates (calculated)									
		13.50	27.00	40.50	54.00	81.00	108.00	121.50	135.00	
	Modulation/Constellation	Units	1 (BPSK)	2 (QPSK)	2 (OFDM/QPSK)	4 (16 QAM)	4 (16 QAM)	6 (64 QAM)	6 (64 QAM)	6 (64 QAM)
	FFT Size		128	128	128	128	128	128	128	128
	Coding Rate (K = 7)		1/2	1/2	3/4	1/2	3/4	3/4	3/4	5/6
	Spreading Rate		1	1	1	1	1	1	1	1
	Information Tones		108	108	108	108	108	108	108	108
	Pilot tones		6	6	6	6	6	6	6	6
	Null Tones		14	14	14	14	14	14	14	14
	Data Tones		108	108	108	108	108	108	108	108
	Info. Length (FFT Integration Time)	μs	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
	Cyclic Prefix	μs	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	Guard Interval	μs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Symbol Length	μs	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
Channel Bit Rate	Mbps	27.00	54.00	54.00	108.00	108.00	162.00	162.00	162.00	
Tolerable RMS delay spread	μs	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Subcarrier spacing	MHz	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	
Occupied bandwidth	MHz	35.63	35.63	35.63	35.63	35.63	35.63	35.63	35.63	
No. of samples per symbol		160	160	160	160	160	160	160	160	
Sampling rate	MHz	40	40	40	40	40	40	40	40	
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Williams alone or in combination with Ma and/or Soliman discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference discloses the following: See, e.g., William ¶ [0049]: For example, if a 6 Mbps encoding rate is indicated in the RATE field and a length of 31 octets is indicated in the LENGTH field, the duration, based on an approximately 4 μS symbol period, is approximately 44 μS. In this case there are 11 symbol periods, and the last symbol contains one octet and two silent or empty octets. The duration is also approximately 44 μS for a length of 32 octets, and 33 octets. In the case of a length of 32 octets, there are 11 symbol periods, and the last symbol contains two octets and one silent or empty octet. In the case of a length of 33 octets, there are 11 symbol periods, and the last symbol contains three octets and zero silent or empty octets. As the rate indicated in the RATE field increases, and the possible number of octets contained in the last symbol period increases, the									

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	number of bits which can be reclaimed in the LENGTH field increases. The number of bits which can be reclaimed may be calculated as: $\text{Reclaimed bits} = \text{floor}(\log_2(b/8)) \quad (7)$ Ma at 9:51-10:4: Referring again to FIG. 2B, it is noted that for non-header OFDM symbols, i.e. for the regular OFDM symbols 510, every OFDM symbol preferably also has a prefix. In “1K” mode, there are 32 prefix samples, and 1024 actual samples representing the FFT size, for a total of 1056 samples per symbol. In 1/2K mode, there is a 16 sample prefix, and then 512 samples per symbol (representing the FFT size) for a total of 528 samples/symbol. Advantageously, using the frame structure of FIG. 2B these different modes can be supported without changing the sampling frequency. When in 1/2K mode, there are twice as many OFDM symbols 510 per slot 506. The particular mode chosen at a given instant should be such that the prefix size is greater than the maximum channel delay in 1/K mode, more OFDM symbols are sent with fewer sub-carriers. This is more robust to high Doppler, because the symbol duration is shorter. Also, the spacing between the sub-carriers is larger further enhancing tolerance to Doppler. Thus, there is a unified frame structure which accommodates different FFT sizes, but with the same sampling rate a the receiver. Preferably the same preamble is used even for the different modes. <i>Id.</i> at 19:5-22: Finally, for access, the FFT is computed and fine synchronization is applied to the dedicated pilot channel of the BTS with the largest C/I ratio as per step 614. BTS initial synchronization performed on the common synchronization channel. A BTS specific sequence is embedded in the frequency domain and BTS identification processing is performed in the frequency domain allowing the elimination of MIMO-OFDM inter-channel interference. BTS power estimation is performed based on the pilot channel for each MIMO-OFDM BTS. BTS selection is performed based on C/I ratio measurements. The result is improvement of the synchronization and identification of the serving BTS in a severe multi-path channel and high interference environment by joint BTS synchronization and cell selection. Channel estimation may be performed on a combined common synchronization channel and dedicated pilot channel. Criteria are provided for cell switching and soft handoff by C/I estimation.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	Soliman at 5:30-40: Although only a single antenna is shown, it should be understood that antenna 120 a may represent a system of switchable antennas or a plurality of antennas arranged for diversity. A second RF device 116 b is a means for generating a second RF signal with a data rate in a range of about 53.3 to 480 Mbps in response to the second baseband signal. The second RF signal is transmitted on antenna 120 b. Again, only a single antenna is shown, but it should be understood that antenna 120 b may represent a system of antennas. These data rates are compatible with 802.11n and UWB standards. <i>Id.</i> at 6:23-53: FIG. 2 is a schematic block diagram depicting the baseband processor of FIG. 1 in greater detail. In one variation, the baseband processor 110 includes an encoder or means for encoding 300 having an input on line 112 to accept digital information, an output on line 302 to supply encoded digital information in the frequency domain, and an input on line 108 to accept a selected clock frequency. An interleaver or means for interleaving 304 has an input on line 302 to accept the encoded digital information, an output on line 306 to supply interleaved information in the frequency domain, and an input on line 108 to accept a selected clock frequency. The interleaver 304 is the device that provides a form of time diversity to guard against localized corruption or bursts of errors. The interleaving parameters are usually carefully selected to match the error correcting capabilities of the codes involved. An inverse fast Fourier transform (IFFT) block or IFFT means 308 has an input on line 306 onto accept information in the frequency domain and an input on line 108 to accept a selected clock frequency. The IFFT block 308 performs an IFFT operation on the input information and supplies a digital time domain signal. A digital-to-analog converter 310 converts the digital signal on line 312 to an analog baseband signal on line 114, responsive to the selected clock frequency on line 108.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to	Williams alone or in combination with Ma and/or Soliman discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g.,</i> Soliman at 5:30-40: Although only a single antenna is shown, it should be understood that antenna 120 a may represent a system of switchable antennas or a plurality of antennas arranged for diversity. A second RF device 116 b is a means for generating a second RF signal with a data rate in a range of about 53.3 to 480 Mbps in

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	response to the second baseband signal. The second RF signal is transmitted on antenna 120 b. Again, only a single antenna is shown, but it should be understood that antenna 120 b may represent a system of antennas. These data rates are compatible with 802.11n and UWB standards. <i>Id.</i> at 6:23-53: FIG. 2 is a schematic block diagram depicting the baseband processor of FIG. 1 in greater detail. In one variation, the baseband processor 110 includes an encoder or means for encoding 300 having an input on line 112 to accept digital information, an output on line 302 to supply encoded digital information in the frequency domain, and an input on line 108 to accept a selected clock frequency. An interleaver or means for interleaving 304 has an input on line 302 to accept the encoded digital information, an output on line 306 to supply interleaved information in the frequency domain, and an input on line 108 to accept a selected clock frequency. The interleaver 304 is the device that provides a form of time diversity to guard against localized corruption or bursts of errors. The interleaving parameters are usually carefully selected to match the error correcting capabilities of the codes involved. An inverse fast Fourier transform (IFFT) block or IFFT means 308 has an input on line 306 onto accept information in the frequency domain and an input on line 108 to accept a selected clock frequency. The IFFT block 308 performs an IFFT operation on the input information and supplies a digital time domain signal. A digital-to-analog converter 310 converts the digital signal on line 312 to an analog baseband signal on line 114, responsive to the selected clock frequency on line 108.
[4] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	Williams alone or in combination with Ma and/or Soliman discloses that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g.,</i> Soliman at 2:1-9: 802.11n, when using the 2.4 GHz band North American channelization scheme, divides the 2.4 GHz spectrum into 11 overlapping, staggered channels whose center frequencies are 5 megahertz (MHz) apart. A 20 MHz channel is divided into 56 subcarriers, with a subcarrier spacing of 0.3125 MHz, or 40 MHz channels with 112 subcarriers. Note: some subcarriers are used as pilot subcarriers. Like the above-described UWB system, 802.11n uses OFDM to transmit subcarriers. <i>Id.</i> at 2:39-55:

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	More explicitly, a first baseband signal is generated having a first data rate in response to selecting the first clock frequency. A second baseband signal may be generated having a second data rate greater than the first data rate, in response to selecting the second clock frequency. Then, a first RF signal with a data rate in a range of about 13.5 to 135 megabits per second (Mbps) is generated in response to the first baseband signal. For example, the first RF signal may be associated with an 802.11n mode of operation using 40 MHz channels. In another aspect, the first RF signal data rate may be in the range of 6.5 to 65 Mbps, corresponding to 20 MHz channels in the 802.11n mode. A second RF signal with a data rate in a range of about 53.3 to 480 Mbps may be generated in response to the second baseband signal, corresponding to UWB operation. However, in other aspects, the second RF signal may operate in the UWB mode at data rates up to 1 GHz. <i>Id.</i> at 4:40-56: FIG. 1 is a schematic block depicting a system 102 for transmitting information via alternate bandwidths using a shared baseband processor. The system 102 is embedded in communications device 100 and comprises a clock or clocking means 104 having an input on line 106 to accept a frequency selection signal, and an output on line 108 to supply a clock sampling frequency. The selected clock frequency supplied includes a first clock frequency ($1 \times F1$), and a second clock frequency ($k \times F1$), where $k > 1$. In one aspect, first clock sampling frequency ($1 \times F1$) defines 1 as either 1 or 2, with $F1$ being either about 20 MHz or about 40 MHz. The second frequency is then k times the first frequency. That is, the first clock frequency is either 20 or 40 MHz. These frequencies would support the operation of $802.11a/g$ and $802.11n$ communications. Further, k is selected so that the second clock sampling frequency supports the operation of UWB communications. <i>Id.</i> at 7:59-8:12: FIG. 4 is a schematic block diagram depicting a system 702 for receiving information via alternate bandwidths using a shared baseband processor. The system 702 is embedded in a communications device 700 and includes an RF module or RF means 704 having an input on line 706 to accept a radiated RF signal (as shown), or an RF signal from a hard-wired medium (not shown). The RF signal has a data rate responsive to a selected clock frequency. The RF module 704 has an output to supply a baseband signal on line 708, converted from the RF signal. A clock or clocking means 710 has an input on line 712 to accept a frequency selection signal and an output on line 714 to supply a clock sampling frequency. The selectable frequencies include a first clock frequency ($1 \times F1$) and a second clock frequency ($k \times F1$), where

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	k>1. In one aspect, first clock sampling frequency ($l \times F1$) defines l as either 1 or 2, with $F1$ being either about 20 MHz or about 40 MHz. That is, the first clock frequency is either 20 or 40 MHz. The second frequency is k times the first frequency. These frequencies would support the operation of 802.11n, 802.11a, 802.11g, and UWB communications. <i>Id.</i> at Tables 2-3.
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Williams alone or in combination with Ma and/or Soliman discloses that the wireless transceiver supports one or more wireless standards. For example, the reference discloses the following: <i>See, e.g., Williams ¶ [0020]:</i> As shown in FIG. 1, the wireless system may comprise the devices 102, 110A, and 110B. The device 102 may comprise a transceiver 104 having a data link layer 106 and a physical (PHY) layer 108. In at least some embodiments, the device 102 may implement a first wireless protocol (e.g., 802.11a, 802.11g). Similarly, each of the devices 110A and 110B also may comprise a transceiver 112A, 112B having a data link layer 114A, 114B and a PHY layer 116A, 116B. In at least some embodiments, the devices 110A and 110B may be implement a second wireless protocol (e.g., 802.11n). <i>Ma at 2:13-24:</i> OFDM technology has been adopted by DAB, DVB-T and IEEE 802.11 standards. DAB and DVB-T are used for audio and video territorial broadcasting. In these systems, the signal is transmitted in a continuous data stream. A preamble is not needed because fast packet access is not critical. DAB and DVB-T are also applied in single frequency networks. In this case, every transmitter transmits the same signal as a simulcast. The interference from the neighbouring transmitters can be treated as an active echo, which can be handled by the proper design of the prefix. IEEE 802.11 is the wireless LAN standard. It is a packet based OFDM transmission system. A preamble header is introduced in this standard. <i>Soliman at 2:1-9:</i> 802.11n, when using the 2.4 GHz band North American channelization scheme, divides the 2.4 GHz spectrum into 11 overlapping, staggered channels whose center frequencies are 5 megahertz (MHz) apart. A 20 MHz channel is divided into 56 subcarriers, with a subcarrier spacing of 0.3125 MHz, or 40 MHz

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
	channels with 112 subcarriers. Note: some subcarriers are used as pilot subcarriers. Like the above-described UWB system, 802.11n uses OFDM to transmit subcarriers.
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, preamble above.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[9.B] a demodulator, connected to the	<i>See, e.g.</i> , claim 1, limitation 1.B above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a	See, e.g., claim 1, limitation 1.C above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or	<i>See, e.g.</i> , claim 1, limitation 1.E above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
more overlapping frequency regions.	
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
the first packet in the first narrower frequency band.	
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division	<i>See, e.g.</i> , claim preamble 1.PRE above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
Multiplexing) transceiver comprising:	
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	See, e.g., claim limitation 1.A above.
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least	See, e.g., claim limitation 1.B above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	See, e.g., claim limitation 1.C above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless	<i>See, e.g.</i> , Claim 4 above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g., Claim 2 above.</i>
[24] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of	<i>See, e.g., Claim 3 above.</i>

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
correctly decoding header information of the first packet in the first narrower frequency band.	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a	<i>See, e.g.</i> , claim limitation 1.A above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
first number of OFDM symbols;	
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	See, e.g., claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency band, by the	See, e.g., claim limitation 1.C above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.,</i> claim limitation 1.D above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosures in Williams alone or in combination with Ma and/or Soliman
increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A10

Defendant's Invalidity Contentions Comparing the Asserted Claims of U.S. Patent No. 9,584,262 to WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by WWiSE 2005¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of WWiSE 2005 standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of the WWiSE 2005 in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA

¹ WWiSE 2005 was published and made publicly available at least as early as March 18, 2005.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
 - U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
 - U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
 - U.S. Patent No. 8,675,754 to Yonge, III et al. (“Yonge”);
 - U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
 - U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
 - U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
 - U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
 - U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
 - U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	WWiSE 2005 disclosed a wireless OFDM transceiver. See, e.g.: “MIMO-OFDM: Multiple input multiple output orthogonal frequency division multiplexing” [WWiSE 2005, p. 14] <u>20. High throughput PHY specification for the 2.4 and 5 GHz bands</u>

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	<u>20.1 Overview</u> This clause specifies the PHY entity for a multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system and the additions that have to be made to the base standard to accommodate the MIMO-OFDM PHY. The radio frequency LAN system is aimed for both the 2.4 GHz band and the 5 GHz bands, as specified in subclause 20.3.8.3 20.1.1 Introduction The MIMO-OFDM system provides a wireless LAN with mandatory data payload communication capabilities of up to 135 Mbit/s and with optional modes capable of supporting data rates up to 540 Mbit/s. The MIMO-OFDM PHY draws from the basic OFDM PHY defined in Clause 17, and builds its extensions to two, three, and four transmit antenna modes (hereafter known as 2TX, 3TX, and 4TX, respectively), operating in 20 MHz bandwidth. Additionally, 1TX, 2TX, 3TX, and 4TX modes are also defined for operation in 40 MHz bandwidth. 20.1.2 Operational Modes The radio portion of all Clause 20 compliant MIMO-OFDM PHY systems shall implement all mandatory and optional data rates defined in Clause 17, all mandatory data rates defined in Clause 19, and all optional data rates of the OFDM-based ERP defined in Clause 19, in their respective bands of operation. In addition, support for transmitting and receiving data using the MIMO-OFDM PHY defined in this Clause is mandatory for all rates specified for the 2TX, 20 MHz mode in subclause 20.3.2.2. Support for 3TX and 4TX modes in 20 MHz; 1TX, 2TX, 3TX, and 4TX modes in 40 MHz; and all modes defined in subclause 20.3.5.10 shall be optional. Furthermore, the amendment extends the optional ‘half-clocked’ operation with 10 MHz channel spacings described in Section 17 and Annex J to high throughput modes. For each mode offered at 20 MHz channel spacing, a

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	corresponding mode with half the data rate is offered with 10 MHz channel spacing. Support of the 27, 40.5, 54, 60.75, and 67.5 Mbps modes corresponding to the modes in Table 003 is mandatory when using 10 MHz channel spacing. [WWiSE 2005, p. 55]
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	WWiSE 2005 disclosed receiving, in a first narrower frequency band (e.g., using a 20MHz channel), by a receiver using wireless OFDM communication, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits (e.g., an extended range packet with two OFDM symbols carrying duplicate SIG-N header bits). See, for example: 20 MHz transmission: A frame transmission in which the modulation spans only one of the 20 MHz channels of a 40 MHz Channel Pair. 40 MHz channel pair: A pair of 20 MHz channels whose center frequencies are separated by 20 MHz and which can be treated as a single channel for 40 MHz transmissions by a BSS, and where one of the 20 MHz channels will also be used for (non-overlapping) 20 MHz transmissions by the BSS.” [WWiSE 2005, p. 13] <u>20. High throughput PHY specification for the 2.4 and 5 GHz bands</u> <u>20.1 Overview</u> This clause specifies the PHY entity for a multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system and the additions that have to be made to the base standard to accommodate the MIMO-OFDM PHY. The radio frequency LAN system is aimed for both the 2.4 GHz band and the 5 GHz bands, as specified in subclause 20.3.8.3 20.1.1 Introduction

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	The MIMO-OFDM system provides a wireless LAN with mandatory data payload communication capabilities of up to 135 Mbit/s and with optional modes capable of supporting data rates up to 540 Mbit/s. The MIMO-OFDM PHY draws from the basic OFDM PHY defined in Clause 17, and builds its extensions to two, three, and four transmit antenna modes (hereafter known as 2TX, 3TX, and 4TX, respectively), operating in 20 MHz bandwidth. Additionally, 1TX, 2TX, 3TX, and 4TX modes are also defined for operation in 40 MHz bandwidth. 20.1.2 Operational Modes The radio portion of all Clause 20 compliant MIMO-OFDM PHY systems shall implement all mandatory and optional data rates defined in Clause 17, all mandatory data rates defined in Clause 19, and all optional data rates of the OFDM-based ERP defined in Clause 19, in their respective bands of operation. In addition, support for transmitting and receiving data using the MIMO-OFDM PHY defined in this Clause is mandatory for all rates specified for the 2TX, 20 MHz mode in subclause 20.3.2.2. Support for 3TX and 4TX modes in 20 MHz; 1TX, 2TX, 3TX, and 4TX modes in 40 MHz; and all modes defined in subclause 20.3.5.10 shall be optional. Furthermore, the amendment extends the optional ‘half-clocked’ operation with 10 MHz channel spacings described in Section 17 and Annex J to high throughput modes. For each mode offered at 20 MHz channel spacing, a corresponding mode with half the data rate is offered with 10 MHz channel spacing. Support of the 27, 40.5, 54, 60.75, and 67.5 Mbps modes corresponding to the modes in Table 003 is mandatory when using 10 MHz channel spacing. [WWiSE 2005, p. 55] 20.3.2 PLCP frame format

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)																											
	Figure 001 shows the format of the PPDU used with greenfield access in the 1TX mode of operation in 40 MHz and the 2TX modes of operation in both 20 and 40 MHz. The PPDU consists of a MIMO-OFDM PLCP preamble, MIMO-OFDM PLCP header, PSDU, and may consist of appended tail bits and pad bits. The MIMO-OFDM PLCP preamble is composed of a sequence of short and long training symbols. The format of the PLCP preamble is defined in subclause 20.3.3 for each mode of operation in the MIMO-OFDM PHY. The MIMO-OFDM PLCP header is composed of the SIGNAL-N field and the SERVICE field. The SIGNAL-N field is defined in 20.3.4 and consists of 54 bits that specify all configuration and length-related parameters associated with PPDU transmission. The SERVICE field is composed of 16 bits and is defined in subclause 20.3.5.1. The SERVICE field of the PLCP header and the PSDU (with tail and pad bits appended, if necessary) are denoted as DATA and may constitute multiple MIMO-OFDM symbols. These symbols are transmitted according to the configuration parameters specified in the SIGNAL-N field. <table><tr><td colspan="4">MIMO-OFDM PLCP Preamble</td><td colspan="2">SIGNAL-N</td><td colspan="3">DATA</td></tr><tr><td colspan="4"></td><td colspan="2"></td><td colspan="3"></td></tr><tr><td>Reserved (6 bits)</td><td>Config (16 bits)</td><td>LENGTH (13 bits)</td><td>LPI (1 bit)</td><td>Reserved (8 bits)</td><td>CRC (4 bits)</td><td>Tail (6 bits)</td><td>SERVICE (16 bits)</td><td>PSDU (may be appended with tail bits and pad bits)</td></tr></table> MIMO-OFDM PLCP Header	MIMO-OFDM PLCP Preamble				SIGNAL-N		DATA												Reserved (6 bits)	Config (16 bits)	LENGTH (13 bits)	LPI (1 bit)	Reserved (8 bits)	CRC (4 bits)	Tail (6 bits)	SERVICE (16 bits)	PSDU (may be appended with tail bits and pad bits)
MIMO-OFDM PLCP Preamble				SIGNAL-N		DATA																						
Reserved (6 bits)	Config (16 bits)	LENGTH (13 bits)	LPI (1 bit)	Reserved (8 bits)	CRC (4 bits)	Tail (6 bits)	SERVICE (16 bits)	PSDU (may be appended with tail bits and pad bits)																				

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	Figure 001 – PPDU frame format: Greenfield access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes Figure 002 shows the format of the PPDU used with greenfield access in the 3TX and 4TX modes of operation in both 20 and 40 MHz. In these modes the MIMO-OFDM PLCP preamble field is extended according to subclause 20.3.3 in order to provide training from the additional transmit antennas. Figure 002 – PPDU frame format: Greenfield access in the 3TX and 4TX modes (20 and 40 MHz) Figure 003 shows the format of the PPDU used with mixed-mode access in the 1TX mode of operation in 40 MHz and the 2TX modes of operation in both 20 and 40 MHz. The PLCP header in these modes consists of an additional SIGNAL-MM field that conveys information about the MIMO-OFDM PPDU transmission to non-MIMO-OFDM stations, causing them to defer the medium for the duration of the MIMO-OFDM transmission. The SIGNAL-MM field is defined in subclause 20.3.4.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes Figures 004 and 005 shows the format of the PPDU used with mixed-mode access in the 3TX and 4TX modes, operating in 20 MHz and 40 MHz, respectively. Figure 004– PPDU frame format: Mixed-mode access in the 3TX and 4TX modes (20 MHz)

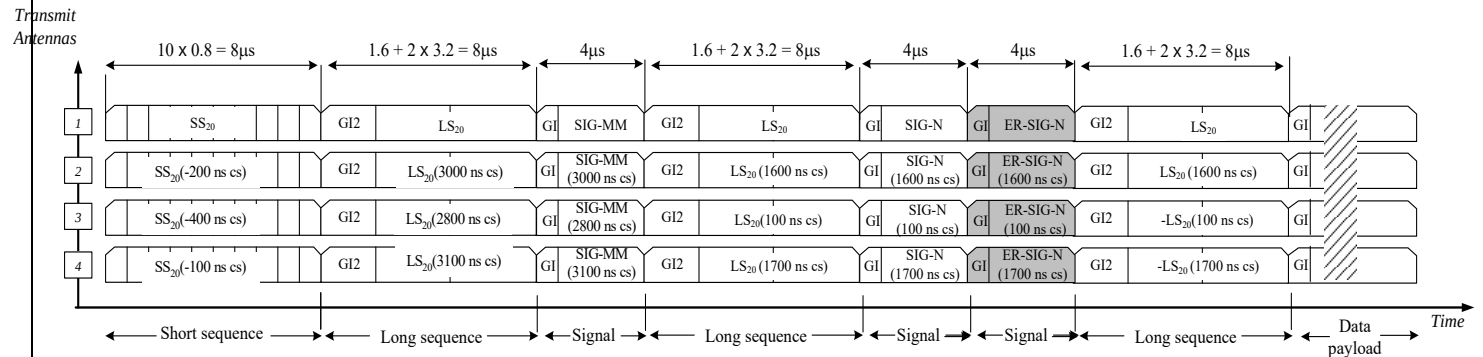
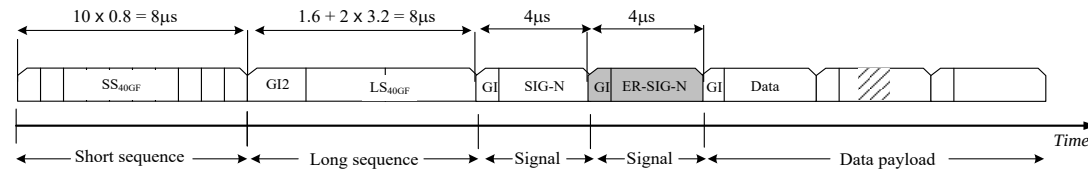
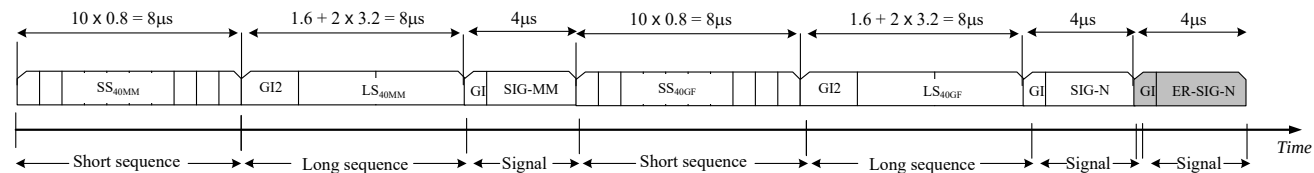
Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	Figure 005– PPDU frame format: Mixed-mode access in the 3TX and 4TX modes (40 MHz) [WWiSE 2005, pp. 58-60] 20.3.2.3 Timing related parameters Table 010 is a list of timing parameters associated with the MIMO-OFDM PLCP. Figure 004– PPDU frame format: Mixed-mode access in the 3TX and 4TX modes (20 MHz) Figure 005– PPDU frame format: Mixed-mode access in the 3TX and 4TX modes (40 MHz) [WWiSE 2005, pp. 58-60] 20.3.2.3 Timing related parameters Table 010 is a list of timing parameters associated with the MIMO-OFDM PLCP.

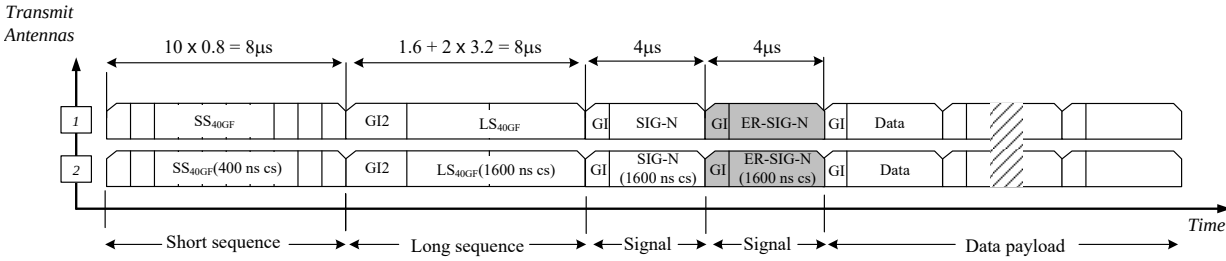
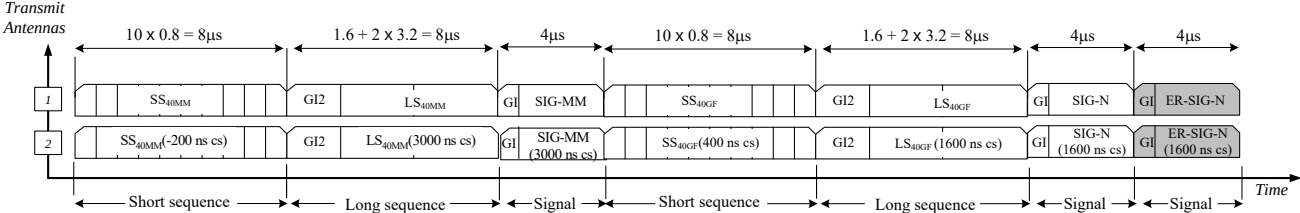
Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)																																												
	Table 010—Timing-related parameters <table><tr><th>Parameter</th><th>Value (20 MHz modes)</th><th>Value (40 MHz modes)</th><th>Remarks</th></tr><tr><td>N_{SD} : Number of data subcarriers</td><td>54</td><td>108</td><td></td></tr><tr><td>N_{SP} : Number of pilot subcarriers</td><td>2</td><td>4</td><td></td></tr><tr><td>N_{ST} : Number of subcarriers, total</td><td>56</td><td>112</td><td>N_{ST} = N_{SD} + N_{SP}</td></tr><tr><td>N_{OT}: Index of outermost populated subcarrier</td><td>28</td><td>58</td><td></td></tr><tr><td>N_{TX}: Number of transmit antennas</td><td>2,3,4</td><td>1,2,3,4</td><td></td></tr><tr><td>Δ_F: Subcarrier frequency spacing</td><td>0.3125 MHz</td><td>0.3125 MHz</td><td>Δ_F = 20/64 = 40/128 MHz</td></tr><tr><td>T_{FFT} : IFFT/FFT period</td><td>3.2 μs</td><td>3.2 μs</td><td>T_{FFT} = 1/Δ_F</td></tr><tr><td>T_{GI} : GI duration</td><td>0.8 μs</td><td>0.8 μs</td><td>(T_{FFT} /4)</td></tr><tr><td>T_{GI2} : Training symbol guard duration</td><td>1.6 μs</td><td>1.6 μs</td><td></td></tr><tr><td>T_{SYM} : Symbol interval</td><td>4 μs</td><td>4 μs</td><td>(T_{GI} + T_{FFT})</td></tr></table> [WWiSE 2005, pp. 64]	Parameter	Value (20 MHz modes)	Value (40 MHz modes)	Remarks	N _{SD} : Number of data subcarriers	54	108		N _{SP} : Number of pilot subcarriers	2	4		N _{ST} : Number of subcarriers, total	56	112	N _{ST} = N _{SD} + N _{SP}	N _{OT} : Index of outermost populated subcarrier	28	58		N _{TX} : Number of transmit antennas	2,3,4	1,2,3,4		Δ _F : Subcarrier frequency spacing	0.3125 MHz	0.3125 MHz	Δ _F = 20/64 = 40/128 MHz	T _{FFT} : IFFT/FFT period	3.2 μs	3.2 μs	T _{FFT} = 1/Δ _F	T _{GI} : GI duration	0.8 μs	0.8 μs	(T _{FFT} /4)	T _{GI2} : Training symbol guard duration	1.6 μs	1.6 μs		T _{SYM} : Symbol interval	4 μs	4 μs	(T _{GI} + T _{FFT})
Parameter	Value (20 MHz modes)	Value (40 MHz modes)	Remarks																																										
N _{SD} : Number of data subcarriers	54	108																																											
N _{SP} : Number of pilot subcarriers	2	4																																											
N _{ST} : Number of subcarriers, total	56	112	N _{ST} = N _{SD} + N _{SP}																																										
N _{OT} : Index of outermost populated subcarrier	28	58																																											
N _{TX} : Number of transmit antennas	2,3,4	1,2,3,4																																											
Δ _F : Subcarrier frequency spacing	0.3125 MHz	0.3125 MHz	Δ _F = 20/64 = 40/128 MHz																																										
T _{FFT} : IFFT/FFT period	3.2 μs	3.2 μs	T _{FFT} = 1/Δ _F																																										
T _{GI} : GI duration	0.8 μs	0.8 μs	(T _{FFT} /4)																																										
T _{GI2} : Training symbol guard duration	1.6 μs	1.6 μs																																											
T _{SYM} : Symbol interval	4 μs	4 μs	(T _{GI} + T _{FFT})																																										

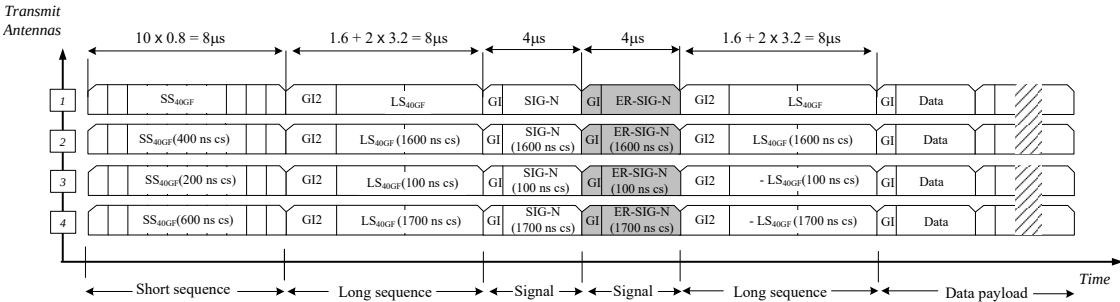
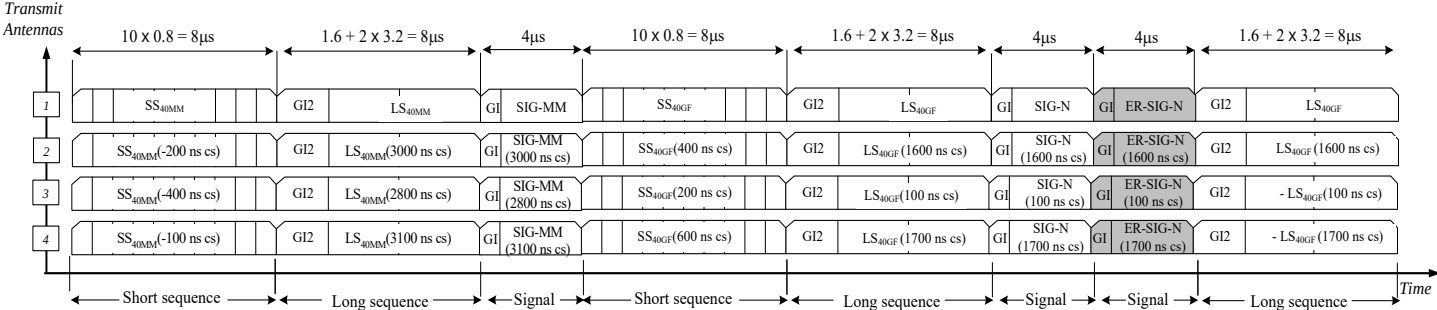
Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")
	<i>Transmit Antennas</i> Figure 007 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication. <i>Transmit Antennas</i> Figure 008 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication. <i>Transmit Antennas</i>

Claim Elements

Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")

Figure 009 – MIMO-OFDM Training structure for $N_{TX} = 3$ and 4, 20 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.**Figure 010 – MIMO-OFDM Training structure for $N_{TX} = 3, 4, 20$ MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.****Figure 011 – MIMO-OFDM Training structure for $N_{TX}=1$, 40 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.**

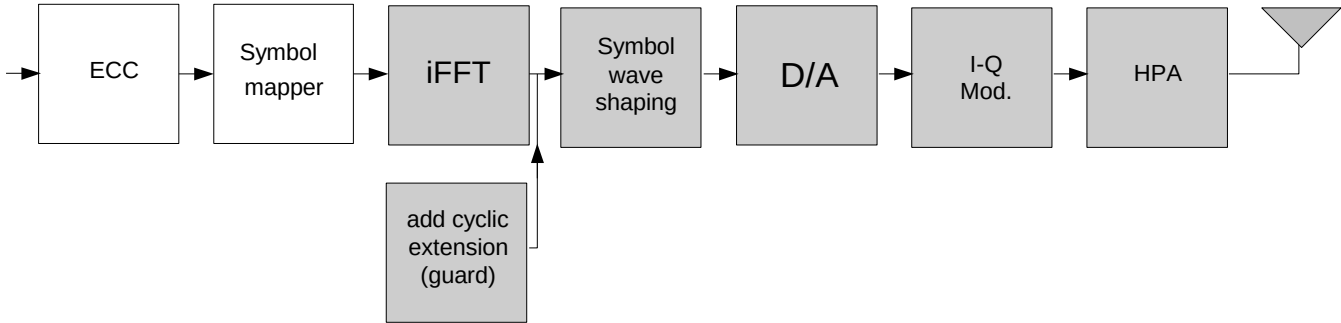
Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")
	Figure 012 – MIMO-OFDM Training structure for $N_{TX}=1$, 40 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.  Figure 013 – MIMO-OFDM Training structure for $N_{TX} = 2$, 40 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.  Figure 014 – MIMO-OFDM Training structure for $N_{TX} = 2$, 40 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")
	Figure 015 – MIMO-OFDM Training structure for $N_{TX} = 3$ and 4, 40 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.  Figure 016 – MIMO-OFDM Training structure for $N_{TX} = 3, 4$, 40 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication. 
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM	WWiSE 2005 Disclosed demodulation, by a demodulator connected to and in communication the receiver, the first number of OFDM symbols to determine the first plurality of header bits. See, e.g.: <u>20.3 MIMO-OFDM PLCP sublayer</u>

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
symbols to determine the first plurality of header bits,	20.3.1 Introduction This subclause provides a convergence procedure by which PSDUs are converted to and from PPDU at the transmitter and receiver. During transmission, the PSDU shall be appended with a PLCP preamble and header to create the PPDU. At the receiver, the PLCP preamble and header are processed to aid in the demodulation and delivery of the PSDU. Stations implementing the MIMO-OFDM PHY shall use one of two methods of access to the medium. The medium may be reserved solely via a MAC mechanism, as defined in subclause 9.13. Alternatively, a special PLCP frame format may be used to cause non-MIMO-OFDM stations to defer the medium to MIMO-OFDM traffic. Hereafter, these two methods of access shall be known as greenfield and mixed-mode, respectively. [WWiSE 2005, p. 58] 20.3.4 Signal fields (SIG-N and SIG-MM) The SIGNAL-N field (SIG-N) is separately defined for a mandatory standard configuration and an optional “extended communication range” configuration (ER) described below. In the mandatory standard configuration, SIG-N is composed of a single MIMO-OFDM symbol that provides all length and configuration parameters associated with a MIMO-OFDM PPDU. In the extended communication range configuration (ER), SIG-N is composed of two consecutive MIMO-OFDM symbols: The SIG-N MIMO-OFDM symbol is followed by a second MIMO-OFDM symbol, denoted as ER-SIG-N. The frequency domain MIMO-OFDM symbol ER-SIG-N is derived from MIMO-OFDM symbol SIG-N by

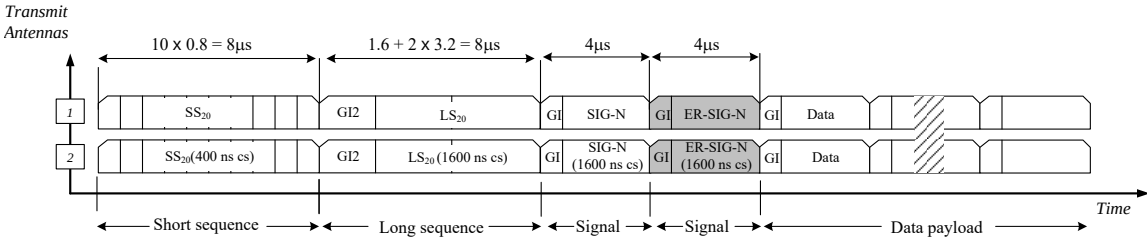
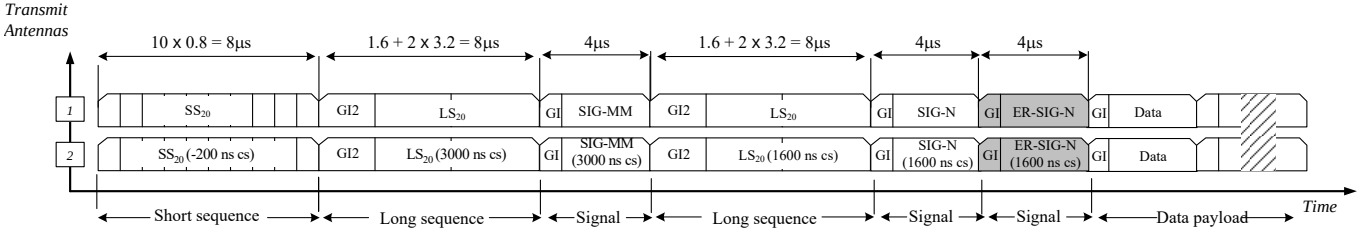
Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)																																													
	applying the following permutation on the subcarrier indices (as described in subclause 20.3.2.4) of the OFDM data symbols composing SIG-N: - For 20MHz data transmissions: With SIG-N=(0, s(1), s(2)..., s(28), 0, ..., 0, s(-28), s(-27), ..., s(-1)), ER-SIG-N is specified as ER-SIG-N =(0, s(-28), s(-27), ..., s(-1), 0, ..., 0, s(1), s(2)..., s(28)); - For 40MHz data transmissions: With SIG-N=(0, 0, 0, s(3), s(4)..., s(58), 0, ..., 0, s(-58), s(-57), ..., s(-3), 0, 0), ER-SIG-N is specified as ER-SIG-N=(0, 0, 0, s(-58), s(-57), ..., s(-3), 0, ..., 0, s(3), s(2)..., s(58), 0, 0). The extended communication range configuration is only used with the optional NTX-STBC modes (described in subclause 20.3.5.10) and only with rate-1/2 encoding using BPSK modulation. The SIGNAL-N field is composed of 54 bits, which shall be interpreted according to the bit assignment specified in Figure 017 and Table 011. The REXT bit, indicating extended range communication, can only be set in the optional NTX-STBC modes with rate-1/2 encoding and BPSK modulation. Table 011—SIG-N field bit assignment <table><tr><th>Bits</th><th>Field</th><th>Subfield</th><th>Parameter</th><th>Values</th></tr><tr><td>B0 : b5</td><td>RSVD</td><td></td><td>Reserved bits</td><td>111111, Bits shall be ignored at the receiver</td></tr><tr><td>B6 : b21</td><td>CONFIG</td><td></td><td>Configuration</td><td></td></tr><tr><td>B6 : b8</td><td></td><td>NSS</td><td>Number of spatial streams</td><td>000: 1, 001: 2, 010: 3, 011: 4</td></tr><tr><td>B9 : b11</td><td></td><td>NTX</td><td>Number of transmit antennas</td><td>000: 1, 001: 2, 010: 3, 011: 4</td></tr><tr><td>B12 : b13</td><td></td><td>BW</td><td>Bandwidth</td><td>00: 20 MHz, 01: 40 MHz</td></tr><tr><td>B14: b16</td><td></td><td>R</td><td>Code rate</td><td>000: 1/2, 001: 2/3, 010: 3/4, 011: 5/6</td></tr><tr><td>B17 : b18</td><td></td><td>CT</td><td>ECC type</td><td>00 : convolutional, 01 : LDPC</td></tr><tr><td>B19 : b21</td><td></td><td>CON</td><td>Constellation type</td><td>000: BPSK, 001: QPSK, 010: 16-QAM, 011: 64-QAM</td></tr></table>	Bits	Field	Subfield	Parameter	Values	B0 : b5	RSVD		Reserved bits	111111, Bits shall be ignored at the receiver	B6 : b21	CONFIG		Configuration		B6 : b8		NSS	Number of spatial streams	000: 1, 001: 2, 010: 3, 011: 4	B9 : b11		NTX	Number of transmit antennas	000: 1, 001: 2, 010: 3, 011: 4	B12 : b13		BW	Bandwidth	00: 20 MHz, 01: 40 MHz	B14: b16		R	Code rate	000: 1/2, 001: 2/3, 010: 3/4, 011: 5/6	B17 : b18		CT	ECC type	00 : convolutional, 01 : LDPC	B19 : b21		CON	Constellation type	000: BPSK, 001: QPSK, 010: 16-QAM, 011: 64-QAM
Bits	Field	Subfield	Parameter	Values																																										
B0 : b5	RSVD		Reserved bits	111111, Bits shall be ignored at the receiver																																										
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B6 : b8		NSS	Number of spatial streams	000: 1, 001: 2, 010: 3, 011: 4																																										
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B14: b16		R	Code rate	000: 1/2, 001: 2/3, 010: 3/4, 011: 5/6																																										
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Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)					
	B22 : b34	LEN		Length	Number of bytes in the payload. The value of 0 is allowed.	
	b35	LPI		Last PSDU indicator	1 indicates that this is the last PSDU to be aggregated into the current PPDU. LPI shall have the value of 1 when the value of the LEN field is 0.	
	b36	REXT		Standard or extended communication range configuration	0 indicates the standard configuration, 1 indicates the extended communication range configuration	
	b37 : b43	RSVD		Reserved	0000000, bits shall be ignored at the receiver	
	b44 : b47	CRC		Cyclic Redundancy Check	CRC calculated on bits 0-43 using generator polynomial x^4+x+1	
	b48 : b53	TAIL			000000	
	In all 20 MHz modes, the encoding of the single SIG-N MIMO-OFDM symbol shall be performed with QPSK modulation of the subcarriers of the first antenna and shall use convolutional coding at $R = 1/2$. In all 40 MHz modes, the encoding of the single SIG-N MIMO-OFDM symbol shall be performed with BPSK modulation of the subcarriers of the first antenna and shall use using convolutional coding at $R = 1/2$. The contents of the SIG-N field are not scrambled. [WWiSE 2005, pp. 69-70] 20.3.7 PLCP data modulation and modulation rate change The PLCP preamble shall be transmitted using a set of OFDM-modulated fixed waveforms, specified in subclause 20.3.3 for each transmit antenna for each mode of operation defined in the MIMO-OFDM PHY. The SIG-N field, composed of 54 bits, shall indicate the bandwidth, modulation, code rate, code type, number of TX antennas, and number of spatial streams that shall be used to transmit the MPDU. The transmitter (receiver) shall initiate the modulation constellation, code rate, code type, and other configuration parameters according to the CONFIG					

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	indicated in the SIG-N field. The MPDU transmission rate shall be set by the DATARATE parameter in the TXVECTOR, issued with the PHY-TXSTART.request primitive described in 20.2. 20.3.8 PMD operating specifications Subclauses 20.3.8.1 through 20.3.8.8 provide general specifications for the various modes and options defined in the MIMO-OFDM PMD sublayer. These specifications apply to both the receive and transmit functions and general operation of the MIMO-OFDM PHY. 20.3.8.1 TX Block diagram The general block diagram of the transmitter for the MIMO-OFDM PHY is shown in Figure 024. The blocks that are shaded in the figure may be replicated NTX times in a MIMO-OFDM system with NTX transmit antennas.  <pre> graph LR Input(()) --> ECC[ECC] ECC --> SM[Symbol mapper] SM --> iFFT[iFFT] iFFT --> SW[Symbol wave shaping] SW --> DA[D/A] DA --> IQ[I-Q Mod.] IQ --> HPA[HPA] HPA --> Antenna(()) iFFT --> CE[add cyclic extension (guard)] CE --> iFFT style ECC fill:#fff,stroke:#000 style SM fill:#fff,stroke:#000 style iFFT fill:#ccc,stroke:#000 style SW fill:#ccc,stroke:#000 style DA fill:#ccc,stroke:#000 style IQ fill:#ccc,stroke:#000 style HPA fill:#ccc,stroke:#000 style CE fill:#ccc,stroke:#000 style Antenna fill:#ccc,stroke:#000 </pre> Figure 024 – Transmitter block diagram for the MIMO-OFDM PHY [WWiSE 2005, p. 83]

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
[1.B.1] wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	WWiSE 2005 disclosed that at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers (e.g., the SIG-N header bits are repeated on all data subcarriers for extended range packets). See, for example: 20.3.4 Signal fields (SIG-N and SIG-MM) The SIGNAL-N field (SIG-N) is separately defined for a mandatory standard configuration and an optional “extended communication range” configuration (ER) described below. In the mandatory standard configuration, SIG-N is composed of a single MIMO-OFDM symbol that provides all length and configuration parameters associated with a MIMO-OFDM PPDU. In the extended communication range configuration (ER), SIG-N is composed of two consecutive MIMO-OFDM symbols: The SIG-N MIMO-OFDM symbol is followed by a second MIMO-OFDM symbol denoted as ER-SIG-N. The frequency domain MIMO-OFDM symbol ER-SIG-N is derived from MIMO-OFDM symbol SIG-N by applying the following permutation on the subcarrier indices (as described in subclause 20.3.2.4) of the OFDM data symbols composing SIG-N: • For 20MHz data transmissions: With SIG-N=(0, s(1), s(2)..., s(28), 0, ..., 0, s(-28), s(-27), ..., s(-1)), ER-SIG-N is specified as ER-SIG-N=(0, s(-28), s(-27), ..., s(-1), 0, ..., 0, s(1), s(2)..., s(28)); • For 40MHz data transmissions: With SIG-N=(0, 0, 0, s(3), s(4)..., s(58), 0, ..., 0, s(-58), s(-57), ..., s(-3), 0, 0), ER-SIG-N is specified as ER-SIG-N=(0, 0, 0, s(-58), s(-57), ..., s(-3), 0, ..., 0, s(3), s(2)..., s(58), 0, 0). The extended communication range configuration is only used with the optional NTX-STBC modes (described in subclause 20.3.5.10) and only with rate-1/2 encoding using BPSK modulation. The SIGNAL-N field is composed of 54 bits, which shall be interpreted according to the bit assignment specified in Figure 017 and Table 011. The REXT bit, indicating extended range communication, can only be set in the optional NTX-STBC modes with rate-1/2 encoding and BPSK modulation.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)																																												
	[WWiSE 2005, p 69]																																												
[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	WWiSE 2005 disclosed a wireless OFDM communications receiver receiving a second packet comprising a second number of OFDM symbols in a second wider frequency band, which is less than the first number of OFDM symbols, and which carries a second plurality of header bits that are different than the first plurality of header bits. Table 010—Timing-related parameters <table><tr><th></th><th>Value (20 MHz modes)</th><th>Value (40 MHz modes)</th><th>Remarks</th></tr><tr><td>N_{SD} : Number of data subcarriers</td><td>54</td><td>108</td><td></td></tr><tr><td>N_{SP} : Number of pilot subcarriers</td><td>2</td><td>4</td><td></td></tr><tr><td>N_{ST} : Number of subcarriers, total</td><td>56</td><td>112</td><td>N_{ST} = N_{SD} + N_{SP}</td></tr><tr><td>N_{OT}: Index of outermost populated subcarrier</td><td>28</td><td>58</td><td></td></tr><tr><td>N_{TX}: Number of transmit antennas</td><td>2,3,4</td><td>1,2,3,4</td><td></td></tr><tr><td>Δ_F: Subcarrier frequency spacing</td><td>0.3125 MHz</td><td>0.3125 MHz</td><td>Δ_F = 20/64 = 40/128 MHz</td></tr><tr><td>T_{FFT} : IFFT/FFT period</td><td>3.2 μs</td><td>3.2 μs</td><td>T_{FFT} = 1/Δ_F</td></tr><tr><td>T_{GI} : GI duration</td><td>0.8 μs</td><td>0.8 μs</td><td>(T_{FFT} /4)</td></tr><tr><td>T_{GI2} : Training symbol guard duration</td><td>1.6 μs</td><td>1.6 μs</td><td></td></tr><tr><td>T_{SYM} : Symbol interval</td><td>4 μs</td><td>4 μs</td><td>(T_{GI} + T_{FFT})</td></tr></table>		Value (20 MHz modes)	Value (40 MHz modes)	Remarks	N _{SD} : Number of data subcarriers	54	108		N _{SP} : Number of pilot subcarriers	2	4		N _{ST} : Number of subcarriers, total	56	112	N _{ST} = N _{SD} + N _{SP}	N _{OT} : Index of outermost populated subcarrier	28	58		N _{TX} : Number of transmit antennas	2,3,4	1,2,3,4		Δ _F : Subcarrier frequency spacing	0.3125 MHz	0.3125 MHz	Δ _F = 20/64 = 40/128 MHz	T _{FFT} : IFFT/FFT period	3.2 μs	3.2 μs	T _{FFT} = 1/Δ _F	T _{GI} : GI duration	0.8 μs	0.8 μs	(T _{FFT} /4)	T _{GI2} : Training symbol guard duration	1.6 μs	1.6 μs		T _{SYM} : Symbol interval	4 μs	4 μs	(T _{GI} + T _{FFT})
	Value (20 MHz modes)	Value (40 MHz modes)	Remarks																																										
N _{SD} : Number of data subcarriers	54	108																																											
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N _{ST} : Number of subcarriers, total	56	112	N _{ST} = N _{SD} + N _{SP}																																										
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T _{GI} : GI duration	0.8 μs	0.8 μs	(T _{FFT} /4)																																										
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T _{SYM} : Symbol interval	4 μs	4 μs	(T _{GI} + T _{FFT})																																										

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	[WWiSE 2005, p. 64]  Figure 007 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.  Figure 008 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

Claim Elements

Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")

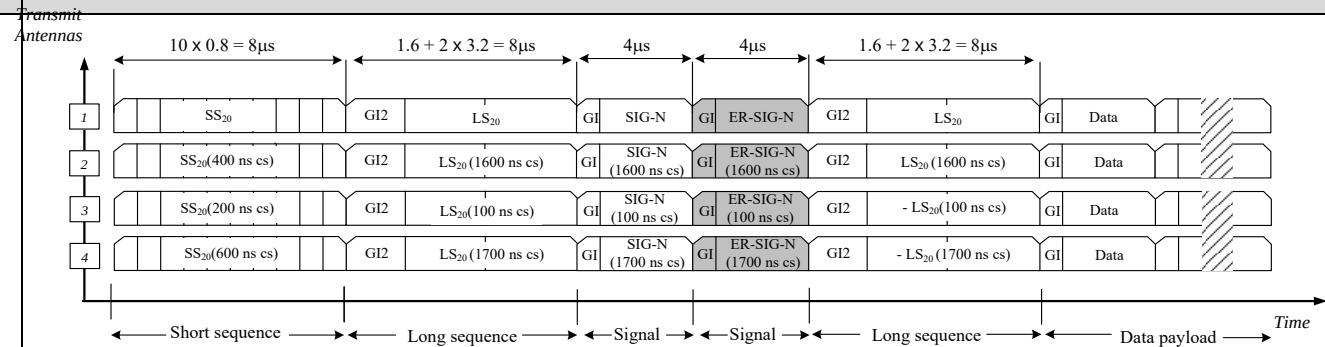


Figure 009 – MIMO-OFDM Training structure for $N_{TX} = 3$ and 4, 20 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

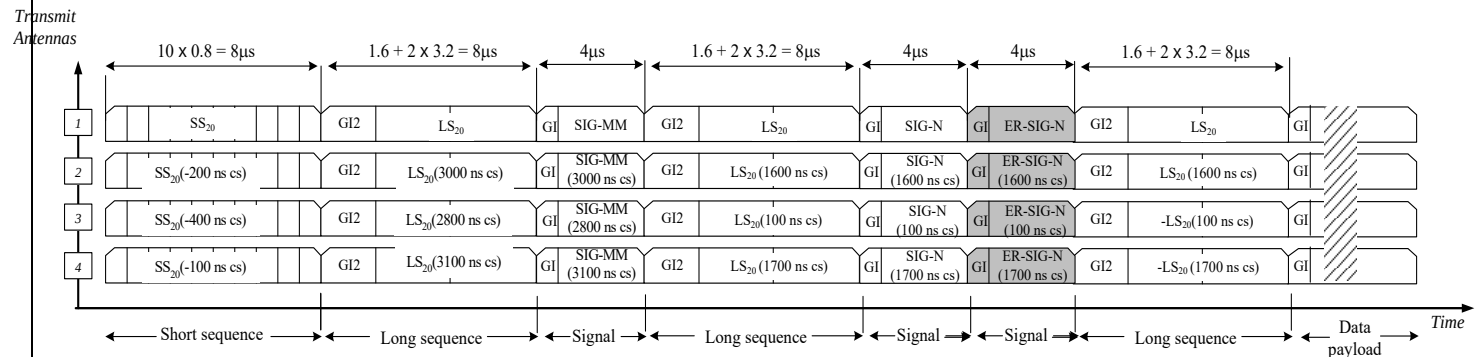
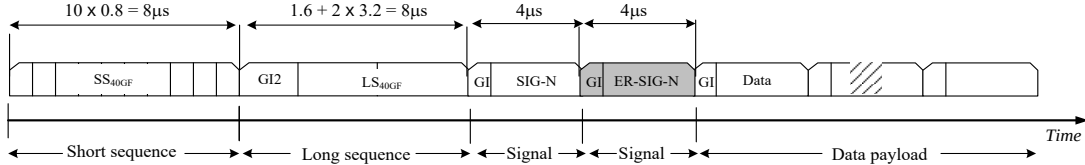
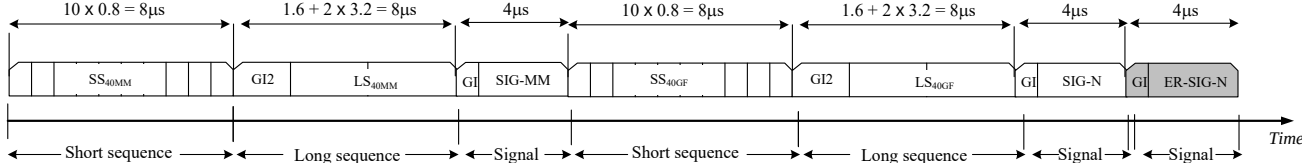
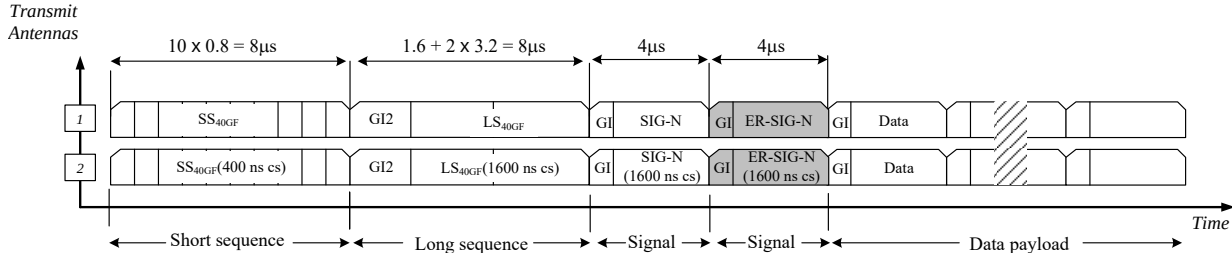


Figure 010 – MIMO-OFDM Training structure for $N_{TX} = 3, 4$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")
	 Figure 011 – MIMO-OFDM Training structure for $N_{TX}=1$, 40 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.  Figure 012 – MIMO-OFDM Training structure for $N_{TX}=1$, 40 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.  Figure 013 – MIMO-OFDM Training structure for $N_{TX} = 2$, 40 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

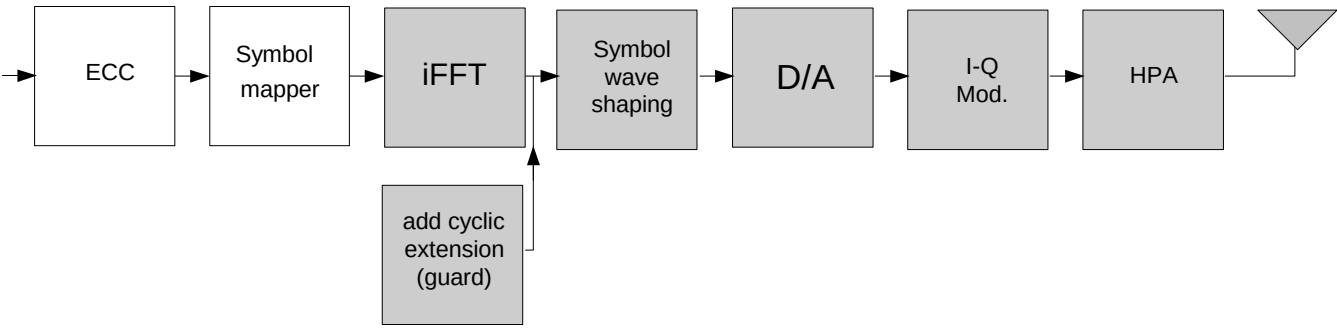
Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005")
	Figure 014 – MIMO-OFDM Training structure for $N_{TX} = 2$, 40 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication. Figure 015 – MIMO-OFDM Training structure for $N_{TX} = 3$ and 4, 40 MHz, greenfield operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	Figure 016 – MIMO-OFDM Training structure for $N_{TX} = 3, 4, 40$ MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication. [WWiSE 2005, pp. 67-69]
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	WWiSE 2005 disclosed demodulating (by a demodulator) the second number of OFDM symbols to determine the second plurality of header bits. See, e.g.: <u>20.3 MIMO-OFDM PLCP sublayer</u> 20.3.1 Introduction This subclause provides a convergence procedure by which PSDUs are converted to and from PPDU at the transmitter and receiver. During transmission, the PSDU shall be appended with a PLCP preamble and header to create the PPDU. At the receiver, the PLCP preamble and header are processed to aid in the demodulation and delivery of the PSDU. Stations implementing the MIMO-OFDM PHY shall use one of two methods of access to the medium. The medium may be reserved solely via a MAC mechanism, as defined in subclause 9.13. Alternatively, a special PLCP frame format may be used to cause non-MIMO-OFDM stations to defer the medium to MIMO-OFDM traffic. Hereafter, these two methods of access shall be known as greenfield and mixed-mode, respectively. [WWiSE 2005, p. 58] 20.3.4 Signal fields (SIG-N and SIG-MM) The SIGNAL-N field (SIG-N) is separately defined for a mandatory standard configuration and an optional “extended communication range” configuration (ER) described below.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)															
	In the mandatory standard configuration, SIG-N is composed of a single MIMO-OFDM symbol that provides all length and configuration parameters associated with a MIMO-OFDM PPDU. In the extended communication range configuration (ER), SIG-N is composed of two consecutive MIMO-OFDM symbols: The SIG-N MIMO-OFDM symbol is followed by a second MIMO-OFDM symbol, denoted as ER-SIG-N. The frequency domain MIMO-OFDM symbol ER-SIG-N is derived from MIMO-OFDM symbol SIG-N by applying the following permutation on the subcarrier indices (as described in subclause 20.3.2.4) of the OFDM data symbols composing SIG-N: - For 20MHz data transmissions: With SIG-N=(0, s(1), s(2)..., s(28), 0, ..., 0, s(-28), s(-27), ..., s(-1)), ER-SIG-N is specified as ER-SIG-N =(0, s(-28), s(-27), ..., s(-1), 0, ..., 0, s(1), s(2)..., s(28)); - For 40MHz data transmissions: With SIG-N=(0, 0, 0, s(3), s(4)..., s(58), 0, ..., 0, s(-58), s(-57), ..., s(-3), 0, 0), ER-SIG-N is specified as ER-SIG-N=(0, 0, 0, s(-58), s(-57), ..., s(-3), 0, ..., 0, s(3), s(2)..., s(58), 0, 0). The extended communication range configuration is only used with the optional NTX-STBC modes (described in subclause 20.3.5.10) and only with rate-1/2 encoding using BPSK modulation. The SIGNAL-N field is composed of 54 bits, which shall be interpreted according to the bit assignment specified in Figure 017 and Table 011. The REXT bit, indicating extended range communication, can only be set in the optional NTX-STBC modes with rate-1/2 encoding and BPSK modulation. Table 011—SIG-N field bit assignment <table><tr><th>Bits</th><th>Field</th><th>Subfield</th><th>Parameter</th><th>Values</th></tr><tr><td>B0 : b5</td><td>RSVD</td><td></td><td>Reserved bits</td><td>111111, Bits shall be ignored at the receiver</td></tr><tr><td>B6 : b21</td><td>CONFIG</td><td></td><td>Configuration</td><td></td></tr></table>	Bits	Field	Subfield	Parameter	Values	B0 : b5	RSVD		Reserved bits	111111, Bits shall be ignored at the receiver	B6 : b21	CONFIG		Configuration	
Bits	Field	Subfield	Parameter	Values												
B0 : b5	RSVD		Reserved bits	111111, Bits shall be ignored at the receiver												
B6 : b21	CONFIG		Configuration													

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)					
		B6 : b8		NSS	Number of spatial streams	000: 1, 001: 2, 010: 3, 011: 4
		B9 : b11		NTX	Number of transmit antennas	000: 1, 001: 2, 010: 3, 011: 4
		B12 : b13		BW	Bandwidth	00: 20 MHz, 01: 40 MHz
		B14: b16		R	Code rate	000: 1/2, 001: 2/3, 010: 3/4, 011: 5/6
		B17 : b18		CT	ECC type	00 : convolutional, 01 : LDPC
		B19 : b21		CON	Constellation type	000: BPSK, 001: QPSK, 010: 16-QAM, 011: 64-QAM
		B22 : b34	LEN		Length	Number of bytes in the payload. The value of 0 is allowed.
		b35	LPI		Last PSDU indicator	1 indicates that this is the last PSDU to be aggregated into the current PPDU. LPI shall have the value of 1 when the value of the LEN field is 0.
		b36	REXT		Standard or extended communication range configuration	0 indicates the standard configuration, 1 indicates the extended communication range configuration
		b37 : b43	RSVD		Reserved	0000000, bits shall be ignored at the receiver
		b44 : b47	CRC		Cyclic Redundancy Check	CRC calculated on bits 0-43 using generator polynomial x^4+x+1
		b48 : b53	TAIL			000000

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	In all 20 MHz modes, the encoding of the single SIG-N MIMO-OFDM symbol shall be performed with QPSK modulation of the subcarriers of the first antenna and shall use convolutional coding at $R = 1/2$. In all 40 MHz modes, the encoding of the single SIG-N MIMO-OFDM symbol shall be performed with BPSK modulation of the subcarriers of the first antenna and shall use using convolutional coding at $R = 1/2$. The contents of the SIG-N field are not scrambled. [WWiSE 2005, pp. 69-70] 20.3.7 PLCP data modulation and modulation rate change The PLCP preamble shall be transmitted using a set of OFDM-modulated fixed waveforms, specified in subclause 20.3.3 for each transmit antenna for each mode of operation defined in the MIMO-OFDM PHY. The SIG-N field, composed of 54 bits, shall indicate the bandwidth, modulation, code rate, code type, number of TX antennas, and number of spatial streams that shall be used to transmit the MPDU. The transmitter (receiver) shall initiate the modulation constellation, code rate, code type, and other configuration parameters according to the CONFIG indicated in the SIG-N field. The MPDU transmission rate shall be set by the DATARATE parameter in the TXVECTOR, issued with the PHY-TXSTART.request primitive described in 20.2. 20.3.8 PMD operating specifications Subclauses 20.3.8.1 through 20.3.8.8 provide general specifications for the various modes and options defined in the MIMO-OFDM PMD sublayer. These specifications apply to both the receive and transmit functions and general operation of the MIMO-OFDM PHY. 20.3.8.1 TX Block diagram

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	The general block diagram of the transmitter for the MIMO-OFDM PHY is shown in Figure 024. The blocks that are shaded in the figure may be replicated N_{TX} times in a MIMO-OFDM system with N_{TX} transmit antennas.  Figure 024 – Transmitter block diagram for the MIMO-OFDM PHY [WWiSE 2005, p. 83]
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	WWiSE 2005 disclosed that the first narrower (e.g., the 20MHz channel) and second wider (e.g., the 40MHz channel) frequency bands have one or more overlapping frequency regions (e.g., the 20MHz frequency region shared between them). <u>9.14 40 MHz Channel Pairs</u> Clause 20 defines a mode in which High Throughput PHYs can transmit a frame utilising a 40 MHz channel pair in order to achieve lower frame durations than if a single 20 MHz channel was used. This clause describes the MAC support for this feature in an infrastructure BSS. 40 MHz transmissions shall only be used when the STA has joined or started an Infrastructure BSS. A 40 MHz channel pair consists of two 20 MHz channels, and a BSS operating on a 40 MHz Channel Pair will make use of one of these channels (called the primary channel) for 20 MHz transmissions. The other channel (called the secondary channel) will not be used by the BSS for 20 MHz transmissions.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	9.14.1 40 MHz Fundamentals of Operation A 40 MHz channel pair consists of two 20 MHz channels, on each of which there could be 20 MHz transmissions (from an overlapping BSS on either channel, or from 20 MHz transmissions on the primary channel), and on each of which the Carrier Sense mechanism described in clause 9.2.1 could be run. However, it is not possible to combine two Carrier Sense mechanisms without degrading the effective priority of 40 MHz transmissions to such an extent that they would provide no benefit. For this reason the MAC models a 40 MHz channel pair as a single 20 MHz channel (the primary channel) in which some transmissions happen to “overflow” into the Secondary Channel. A STA that wishes to transmit on both channels of a 40MHz channel shall conduct CCA on the primary channel, with the following extension. For any frame transmission that requires the CCA function to indicate a clear channel before transmission, the secondary channel CCA state shall also be checked. If the secondary channel CCA indicates a busy channel, the STA shall not transmit on the secondary channel. It shall either fall back to 20MHz operation (for only the current transmission), or shall consider the frame transmission to have failed (including all incrementing of retry counters and contention windows etc where required). An AP shall indicate that it is operating on a 40 MHz channel pair by including the Channel Set information element in its Beacon frames. An AP shall not change the information contained in the Channel Set information element without invoking the channel move procedure described in clause 11.6.7. A STA that has joined a BSS and that wishes to use 40 MHz transmissions shall check the setting of the Secondary_Channel_Used bit in the ERP Information Element in the last valid Beacon frame received from the BSS, and shall not use 40 MHz transmissions where the Secondary_Channel_Used bit is set to 1.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	A STA shall not send a 20 MHz transmission to a member STA of a BSS on the secondary channel of that BSS. A STA that has joined or started a BSS operating on a 40 MHz channel pair shall discard all 20 MHz transmissions received on the secondary channel. A STA shall not join a BSS on its secondary channel. An AP that detects significant evidence of collisions on the secondary channel may invoke the channel move procedure described in clause 11.6.7. [WWiSE 2005, pp. 48-49] 20.3.8.3 Operating channel frequencies The range of operating frequencies for the MIMO-OFDM PHY shall be 2400-2497 MHz and 4920-5805 MHz. The channel numbering shall be as defined in IEEE 802.11b-1999 clause 18.4.6.2, and clause 17.3.8.3.2 of IEEE P802.11j/D1.5, May 2004. The relationship between center frequency and channel number is given by the following equations: Channel center frequency = $5000 + (\text{channel number}) \times 5$ (MHz) for center frequency > 5000 MHz (25) Channel center frequency = $4000 + (\text{channel number}) \times 5$ (MHz) for $4900 \leq \text{center frequency} \leq 5000$ MHz (26) 40 MHz operation shall be restricted to the 5 GHz band only. Each 40 MHz channel shall occupy two 20 MHz channels, with the center frequency of the 40 MHz transmission selected to be midway between the center frequencies of the two occupied 20 MHz channels. For example, if the two occupied 20 MHz channels are centered at channel number 149 and 153, then the 40 MHz transmission shall be centered at channel number 151.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	[WWiSE 2005, pp. 82-83]
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	WWiSE 2005 discloses wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. <i>See, e.g.</i>, claim element 1.C above. <i>See also, e.g.:</i> “MIMO-OFDM: Multiple input multiple output orthogonal frequency division multiplexing” [WWiSE 2005, p. 14] <u>20. High throughput PHY specification for the 2.4 and 5 GHz bands</u> <u>20.1 Overview</u> This clause specifies the PHY entity for a multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system and the additions that have to be made to the base standard to accommodate the MIMO-OFDM PHY. The radio frequency LAN system is aimed for both the 2.4 GHz band and the 5 GHz bands, as specified in subclause 20.3.8.3. 20.1.1 Introduction The MIMO-OFDM system provides a wireless LAN with mandatory data payload communication capabilities of up to 135 Mbit/s and with optional modes capable of supporting data rates up to 540 Mbit/s. The MIMO-OFDM PHY draws from the basic OFDM PHY defined in Clause 17, and builds its extensions to two, three, and four transmit

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	antenna modes (hereafter known as 2TX, 3TX, and 4TX, respectively), operating in 20 MHz bandwidth. Additionally, 1TX, 2TX, 3TX, and 4TX modes are also defined for operation in 40 MHz bandwidth. 20.1.2 Operational Modes The radio portion of all Clause 20 compliant MIMO-OFDM PHY systems shall implement all mandatory and optional data rates defined in Clause 17, all mandatory data rates defined in Clause 19, and all optional data rates of the OFDM-based ERP defined in Clause 19, in their respective bands of operation. In addition, support for transmitting and receiving data using the MIMO-OFDM PHY defined in this Clause is mandatory for all rates specified for the 2TX, 20 MHz mode in subclause 20.3.2.2. Support for 3TX and 4TX modes in 20 MHz; 1TX, 2TX, 3TX, and 4TX modes in 40 MHz; and all modes defined in subclause 20.3.5.10 shall be optional. Furthermore, the amendment extends the optional ‘half-clocked’ operation with 10 MHz channel spacings described in Section 17 and Annex J to high throughput modes. For each mode offered at 20 MHz channel spacing, a corresponding mode with half the data rate is offered with 10 MHz channel spacing. Support of the 27, 40.5, 54, 60.75, and 67.5 Mbps modes corresponding to the modes in Table 003 is mandatory when using 10 MHz channel spacing. [WWiSE 2005, p. 55] To the extent that it is determined that WWiSE 2005 does not expressly or inherently disclose this limitation or render the limitation obvious, this reference in combination with one or more of the following secondary prior art references renders this limitation obvious: • TGN Sync Proposal 2005 and TGN Sync Proposal 2004 (See Exhibit A1) • 2006 802.11n Joint PHY Proposal (See Exhibit A2) • Maltsev (See Exhibit A3); • Mujtaba (See Ex. A4); • The G.9960 Draft, Schrum, Kol, and Brown (See Ex. A5); • Takahashi (See Exhibit A6);

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	• Van Nee (See Exhibit A8); • Williams, Ma, and Soliman (See Ex. A9) • Yonge (See Ex. A11) • Zelst (See Exhibit A12); • Zhang '159 (See Exhibit A13); Citations on a limitation-by-limitation basis can be found in the claim chart for these secondary references in the Exhibits identified above. One of ordinary skill in the art would have been motivated to combine each of these references, either individually or in combination, with the primary reference cited in this claim chart because, among other things, each of these references relates to systems and methods for wireless communication, most relate to OFDM wireless communications, and relate to Wi-Fi networking. Moreover, a POSA would have understood that the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band is an inherent aspect of the system disclosed in WWiSE 2005.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	WWiSE 2005 discloses wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. <i>See e.g.</i>, claim element 1.C above. <i>See also, e.g.:</i> To the extent that it is determined that WWiSE 2005 does not expressly or inherently disclose this limitation or render the limitation obvious, this reference in combination with one or more of the following secondary prior art references renders this limitation obvious: • TGn Sync Proposal 2005 and TGn Sync Proposal 2004 (See Exhibit A1) • 2006 802.11n Joint PHY Proposal (See Exhibit A2) • Maltsev (See Exhibit A3); • Mujtaba (See Ex. A4); • The G.9960 Draft, Schrum, Kol, and Brown (See Ex. A5); • Takahashi (See Exhibit A6); • Van Nee (See Exhibit A8); • Williams, Ma, and Soliman (See Ex. A9)

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	• Yonge (See Ex. A11) • Zelst (See Exhibit A12); • Zhang '159 (See Exhibit A13); Citations on a limitation-by-limitation basis can be found in the claim chart for these secondary references in the Exhibits identified above. One of ordinary skill in the art would have been motivated to combine each of these references, either individually or in combination, with the primary reference cited in this claim chart because, among other things, each of these references relates to systems and methods for wireless communication, most relate to OFDM wireless communications, and relate to Wi-Fi networking. Moreover, a POSA would have understood that the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band is an inherent aspect of the system disclosed in WWiSE 2005.
[4.PRE] The wireless transceiver of claim 1,	WWiSE 2005 disclosed a wireless OFDM transceiver. See, e.g.: “MIMO-OFDM: Multiple input multiple output orthogonal frequency division multiplexing” [WWiSE 2005, pp. 14] <u>20. High throughput PHY specification for the 2.4 and 5 GHz bands</u> <u>20.1 Overview</u> This clause specifies the PHY entity for a multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system and the additions that have to be made to the base standard to accommodate the MIMO-OFDM PHY. The radio frequency LAN system is aimed for both the 2.4 GHz band and the 5 GHz bands, as specified in subclause 20.3.8.3 20.1.1 Introduction

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	The MIMO-OFDM system provides a wireless LAN with mandatory data payload communication capabilities of up to 135 Mbit/s and with optional modes capable of supporting data rates up to 540 Mbit/s. The MIMO-OFDM PHY draws from the basic OFDM PHY defined in Clause 17, and builds its extensions to two, three, and four transmit antenna modes (hereafter known as 2TX, 3TX, and 4TX, respectively), operating in 20 MHz bandwidth. Additionally, 1TX, 2TX, 3TX, and 4TX modes are also defined for operation in 40 MHz bandwidth. 20.1.2 Operational Modes The radio portion of all Clause 20 compliant MIMO-OFDM PHY systems shall implement all mandatory and optional data rates defined in Clause 17, all mandatory data rates defined in Clause 19, and all optional data rates of the OFDM-based ERP defined in Clause 19, in their respective bands of operation. In addition, support for transmitting and receiving data using the MIMO-OFDM PHY defined in this Clause is mandatory for all rates specified for the 2TX, 20 MHz mode in subclause 20.3.2.2. Support for 3TX and 4TX modes in 20 MHz; 1TX, 2TX, 3TX, and 4TX modes in 40 MHz; and all modes defined in subclause 20.3.5.10 shall be optional. Furthermore, the amendment extends the optional ‘half-clocked’ operation with 10 MHz channel spacings described in Section 17 and Annex J to high throughput modes. For each mode offered at 20 MHz channel spacing, a corresponding mode with half the data rate is offered with 10 MHz channel spacing. Support of the 27, 40.5, 54, 60.75, and 67.5 Mbps modes corresponding to the modes in Table 003 is mandatory when using 10 MHz channel spacing. [WWiSE 2005, p. 55]
[4.A] wherein the second wider frequency band is two times wider than the first narrower frequency band.	WWiSE 2005 discloses wherein the second wider frequency band is two times wider than the first narrower frequency band. See e.g., 9.14.1 40 MHz Fundamentals of Operation

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	A 40 MHz channel pair consists of two 20 MHz channels, on each of which there could be 20 MHz transmissions (from an overlapping BSS on either channel, or from 20 MHz transmissions on the primary channel), and on each of which the Carrier Sense mechanism described in clause 9.2.1 could be run. However, it is not possible to combine two Carrier Sense mechanisms without degrading the effective priority of 40 MHz transmissions to such an extent that they would provide no benefit. For this reason the MAC models a 40 MHz channel pair as a single 20 MHz channel (the primary channel) in which some transmissions happen to “overflow” into the Secondary Channel. A STA that wishes to transmit on both channels of a 40MHz channel shall conduct CCA on the primary channel, with the following extension. For any frame transmission that requires the CCA function to indicate a clear channel before transmission, the secondary channel CCA state shall also be checked. If the secondary channel CCA indicates a busy channel, the STA shall not transmit on the secondary channel. It shall either fall back to 20MHz operation (for only the current transmission), or shall consider the frame transmission to have failed (including all incrementing of retry counters and contention windows etc where required). An AP shall indicate that it is operating on a 40 MHz channel pair by including the Channel Set information element in its Beacon frames. An AP shall not change the information contained in the Channel Set information element without invoking the channel move procedure described in clause 11.6.7. A STA that has joined a BSS and that wishes to use 40 MHz transmissions shall check the setting of the Secondary_Channel_Used bit in the ERP Information Element in the last valid Beacon frame received from the BSS, and shall not use 40 MHz transmissions where the Secondary_Channel_Used bit is set to 1. A STA shall not send a 20 MHz transmission to a member STA of a BSS on the secondary channel of that BSS. A STA that has joined or started a BSS operating on a 40 MHz channel pair shall discard all 20 MHz transmissions received on the secondary channel. A STA shall not join a BSS on its secondary channel.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	An AP that detects significant evidence of collisions on the secondary channel may invoke the channel move procedure described in clause 11.6.7. 9.14.2.1 Secondary Channel Beacon In order to reduce the chance of the secondary channel being used by an overlapping BSS, an AP may send a Beacon frame using the secondary channel with contents chosen to discourage use of the secondary channel by other BSSes. The frame body of such a beacon is shown in Clause 7.2.3.1.1. These beacons contain a rate set consisting of a single clause 20 basic rate, and so should not cause non-clause 20 STAs to attempt to associate with the AP on the secondary channel. When transmitting a beacon on the secondary channel, the AP may observe the channel access mechanisms described elsewhere in clause 9 for the transmission of Beacon frames, or it may transmit the Beacon frame without consideration of the state of the secondary channel.
[8.PRE] The wireless transceiver of claim 1,	WWiSE 2005 disclosed a wireless OFDM transceiver. See, e.g.: “MIMO-OFDM: Multiple input multiple output orthogonal frequency division multiplexing” [WWiSE 2005, p. 14] <u>20. High throughput PHY specification for the 2.4 and 5 GHz bands</u> <u>20.1 Overview</u>

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	This clause specifies the PHY entity for a multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system and the additions that have to be made to the base standard to accommodate the MIMO-OFDM PHY. The radio frequency LAN system is aimed for both the 2.4 GHz band and the 5 GHz bands, as specified in subclause 20.3.8.3 20.1.1 Introduction The MIMO-OFDM system provides a wireless LAN with mandatory data payload communication capabilities of up to 135 Mbit/s and with optional modes capable of supporting data rates up to 540 Mbit/s. The MIMO-OFDM PHY draws from the basic OFDM PHY defined in Clause 17, and builds its extensions to two, three, and four transmit antenna modes (hereafter known as 2TX, 3TX, and 4TX, respectively), operating in 20 MHz bandwidth. Additionally, 1TX, 2TX, 3TX, and 4TX modes are also defined for operation in 40 MHz bandwidth. 20.1.2 Operational Modes The radio portion of all Clause 20 compliant MIMO-OFDM PHY systems shall implement all mandatory and optional data rates defined in Clause 17, all mandatory data rates defined in Clause 19, and all optional data rates of the OFDM-based ERP defined in Clause 19, in their respective bands of operation. In addition, support for transmitting and receiving data using the MIMO-OFDM PHY defined in this Clause is mandatory for all rates specified for the 2TX, 20 MHz mode in subclause 20.3.2.2. Support for 3TX and 4TX modes in 20 MHz; 1TX, 2TX, 3TX, and 4TX modes in 40 MHz; and all modes defined in subclause 20.3.5.10 shall be optional. Furthermore, the amendment extends the optional ‘half-clocked’ operation with 10 MHz channel spacings described in Section 17 and Annex J to high throughput modes. For each mode offered at 20 MHz channel spacing, a corresponding mode with half the data rate is offered with 10 MHz channel spacing. Support of the 27, 40.5, 54, 60.75, and 67.5 Mbps modes corresponding to the modes in Table 003 is mandatory when using 10 MHz channel spacing. [WWiSE 2005, p. 55]

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
[8.A] wherein the wireless transceiver supports one or more wireless standards.	WWiSE 2005 disclosed a wireless transceiver that is supported by IEEE 802.11 wireless standard. <u>20. High throughput PHY specification for the 2.4 and 5 GHz bands</u> <u>20.1 Overview</u> This clause specifies the PHY entity for a multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system and the additions that have to be made to the base standard to accommodate the MIMO-OFDM PHY. The radio frequency LAN system is aimed for both the 2.4 GHz band and the 5 GHz bands, as specified in subclause 20.3.8.3 20.1.1 Introduction The MIMO-OFDM system provides a wireless LAN with mandatory data payload communication capabilities of up to 135 Mbit/s and with optional modes capable of supporting data rates up to 540 Mbit/s. The MIMO-OFDM PHY draws from the basic OFDM PHY defined in Clause 17, and builds its extensions to two, three, and four transmit antenna modes (hereafter known as 2TX, 3TX, and 4TX, respectively), operating in 20 MHz bandwidth. Additionally, 1TX, 2TX, 3TX, and 4TX modes are also defined for operation in 40 MHz bandwidth. 20.1.2 Operational Modes The radio portion of all Clause 20 compliant MIMO-OFDM PHY systems shall implement all mandatory and optional data rates defined in Clause 17, all mandatory data rates defined in Clause 19, and all optional data rates of

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	the OFDM-based ERP defined in Clause 19, in their respective bands of operation. In addition, support for transmitting and receiving data using the MIMO-OFDM PHY defined in this Clause is mandatory for all rates specified for the 2TX, 20 MHz mode in subclause 20.3.2.2. Support for 3TX and 4TX modes in 20 MHz; 1TX, 2TX, 3TX, and 4TX modes in 40 MHz; and all modes defined in subclause 20.3.5.10 shall be optional. Furthermore, the amendment extends the optional ‘half-clocked’ operation with 10 MHz channel spacings described in Section 17 and Annex J to high throughput modes. For each mode offered at 20 MHz channel spacing, a corresponding mode with half the data rate is offered with 10 MHz channel spacing. Support of the 27, 40.5, 54, 60.75, and 67.5 Mbps modes corresponding to the modes in Table 003 is mandatory when using 10 MHz channel spacing. 20.1.3 Scope This subclause describes the PHY services provided to the IEEE 802.11 wireless LAN MAC by the MIMO-OFDM system. The MIMO-OFDM PHY layer consists of two protocol functions, defined as follows: a) A PHY convergence function, which adapts the capabilities of the physical medium dependent (PMD) system to the PHY service. This function is supported by the physical layer convergence procedure (PLCP), which defines a method of mapping the IEEE 802.11 PHY sublayer service data units (PSDU) into a framing format suitable for sending and receiving user data and management information between two or more stations using the associated PMD system. b) A PMD system whose function defines the characteristics and method of transmitting and receiving data through a wireless medium between two or more stations, each using the MIMO-OFDM PHY. 20.1.4 MIMO-OFDM PHY functions

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
	The architecture of the MIMO-OFDM PHY is depicted in the ISO/IEC basic reference model shown in Figure 141 of 18.4.1. The MIMO-OFDM PHY contains three functional entities: the PMD function, the PHY convergence function (PLCP), and the layer management function. The MIMO-OFDM PHY service is provided to the MAC through the PHY service primitives defined in Clause 12. Interoperability is addressed by use of the carrier sense mechanism specified in 9.2.1 and the protection mechanism in 9.10. This mechanism allows non-MIMO-OFDM stations to know of MIMO-OFDM traffic that they cannot demodulate so they may defer the medium to that traffic. <u>20.2 PHY-specific service parameter list</u> The architecture of the IEEE 802.11 MAC is intended to be PHY independent. Some PHY implementations require PHY-dependent MAC state machines running in the MAC sublayer in order to meet certain PMD requirements. The PHY-dependent MAC state machine resides in a sublayer defined as the MAC sublayer management entity (MLME). In certain PMD implementations, the MLME may need to interact with the PLME as part of the normal PHY SAP primitives. These interactions are defined by the PLME parameter list currently defined in the PHY service primitives as TXVECTOR and RXVECTOR. The list of these parameters, and the values they may represent, are defined in the specific PHY specifications for each PMD. This subclause addresses the TXVECTOR and RXVECTOR for the MIMO-OFDM PHY. The parameters in Table 001 are defined as part of the TXVECTOR parameter list in the PHY-TXSTART.request service and PLME-TXTIME.request primitives. Table 001—TXVECTOR parameters

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)													
	<table><tr><th>Parameter</th><th>Value</th></tr><tr><td>DATARATE</td><td> The rate used to transmit the PSDU in Mbit/s. Allowed value depends on the values of TRANSMISSION_MODE and NUM_STREAMS parameters Values: 6.75, 10.125, 13.5, 20.25, 27, 40.5, 54, 60.75, 67.5, 81, 108, 121.5, 135, 162, 182.25, 202.5, 216, 243, 270, 324, 364.5, 405, 432, 486, 540 </td></tr><tr><td>LENGTH</td><td> The length of the PSDU in octets Range: 1-8191 </td></tr><tr><td>TRANSMISSION_MODE</td><td> The mode used for transmission of the PPDU. Determines the preamble type used. Enumerated type: 2TX20GF, 3TX20GF, 4TX20GF, 2TX20MM, 3TX20MM, 4TX20MM, 1TX40GF, 2TX40GF, 3TX40GF, 4TX40GF, 1TX40MM, 2TX40MM, 3TX40MM, 4TX40MM. </td></tr><tr><td>NUM_STREAMS</td><td> The number of independent spatial streams transmitted. Values: 1, 2, 3, 4. </td></tr><tr><td>CODE_TYPE</td><td>Convolutional or LDPC</td></tr></table>		Parameter	Value	DATARATE	The rate used to transmit the PSDU in Mbit/s. Allowed value depends on the values of TRANSMISSION_MODE and NUM_STREAMS parameters Values: 6.75, 10.125, 13.5, 20.25, 27, 40.5, 54, 60.75, 67.5, 81, 108, 121.5, 135, 162, 182.25, 202.5, 216, 243, 270, 324, 364.5, 405, 432, 486, 540	LENGTH	The length of the PSDU in octets Range: 1-8191	TRANSMISSION_MODE	The mode used for transmission of the PPDU. Determines the preamble type used. Enumerated type: 2TX20GF, 3TX20GF, 4TX20GF, 2TX20MM, 3TX20MM, 4TX20MM, 1TX40GF, 2TX40GF, 3TX40GF, 4TX40GF, 1TX40MM, 2TX40MM, 3TX40MM, 4TX40MM.	NUM_STREAMS	The number of independent spatial streams transmitted. Values: 1, 2, 3, 4.	CODE_TYPE	Convolutional or LDPC
Parameter	Value													
DATARATE	The rate used to transmit the PSDU in Mbit/s. Allowed value depends on the values of TRANSMISSION_MODE and NUM_STREAMS parameters Values: 6.75, 10.125, 13.5, 20.25, 27, 40.5, 54, 60.75, 67.5, 81, 108, 121.5, 135, 162, 182.25, 202.5, 216, 243, 270, 324, 364.5, 405, 432, 486, 540													
LENGTH	The length of the PSDU in octets Range: 1-8191													
TRANSMISSION_MODE	The mode used for transmission of the PPDU. Determines the preamble type used. Enumerated type: 2TX20GF, 3TX20GF, 4TX20GF, 2TX20MM, 3TX20MM, 4TX20MM, 1TX40GF, 2TX40GF, 3TX40GF, 4TX40GF, 1TX40MM, 2TX40MM, 3TX40MM, 4TX40MM.													
NUM_STREAMS	The number of independent spatial streams transmitted. Values: 1, 2, 3, 4.													
CODE_TYPE	Convolutional or LDPC													

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)		
			Values: 0 (convolutional), 1 (LDPC)
	SERVICE		The scrambler initialization vector. 16 null bits
	TXPWR_LEVEL		The transmit power level. The definition of these levels is up to the implementer. Range: 1-8
	LPI		Indicates that this is the last PSDU to be aggregated into the current PPDU Values: true, false
	BURST_DURATION		The length in microseconds of the BURST_DURATION field in the mixed-mode preamble. Only used when a mixed-mode TRANSMISSION_MODE is selected. Range: 0-4095
	The parameters in Table 002 are defined as part of the RXVECTOR parameter list in the PHY-RXSTART.indicate service primitive. When implementations require the use of these vectors, some or all of these parameters may be used in the vectors.		

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)										
	Table 002—RXVECTOR parameters <table> <tr> <th>Parameter</th><th>Value</th></tr> <tr> <td>DATARATE</td><td> The rate at which the PSDU was received in Mbit/s. Allowed value depends on the values of TRANSMISSION_MODE and NUM_STREAMS parameters Values: 6.75, 10.125, 13.5, 20.25, 27, 40.5, 54, 60.75, 67.5, 81, 108, 121.5, 135, 162, 182.25, 202.5, 216, 243, 270, 324, 364.5, 405, 432, 486, 540 </td></tr> <tr> <td>LENGTH</td><td> The length of the PSDU in octets. Range: 1-8191 </td></tr> <tr> <td>TRANSMISSION_MODE</td><td> The transmission type detected during reception of the PPDU Enumerated type: 2TX20GF, 3TX20GF, 4TX20GF, 2TX20MM, 3TX20MM, 4TX20MM, 1TX40GF, 2TX40GF, 3TX40GF, 4TX40GF, 1TX40MM, 2TX40MM, 3TX40MM, 4TX40MM. </td></tr> <tr> <td>NUM_STREAMS</td><td> The number of independent spatial streams transmitted. Values: 1,2,3,4. </td></tr> </table>	Parameter	Value	DATARATE	The rate at which the PSDU was received in Mbit/s. Allowed value depends on the values of TRANSMISSION_MODE and NUM_STREAMS parameters Values: 6.75, 10.125, 13.5, 20.25, 27, 40.5, 54, 60.75, 67.5, 81, 108, 121.5, 135, 162, 182.25, 202.5, 216, 243, 270, 324, 364.5, 405, 432, 486, 540	LENGTH	The length of the PSDU in octets. Range: 1-8191	TRANSMISSION_MODE	The transmission type detected during reception of the PPDU Enumerated type: 2TX20GF, 3TX20GF, 4TX20GF, 2TX20MM, 3TX20MM, 4TX20MM, 1TX40GF, 2TX40GF, 3TX40GF, 4TX40GF, 1TX40MM, 2TX40MM, 3TX40MM, 4TX40MM.	NUM_STREAMS	The number of independent spatial streams transmitted. Values: 1,2,3,4.
Parameter	Value										
DATARATE	The rate at which the PSDU was received in Mbit/s. Allowed value depends on the values of TRANSMISSION_MODE and NUM_STREAMS parameters Values: 6.75, 10.125, 13.5, 20.25, 27, 40.5, 54, 60.75, 67.5, 81, 108, 121.5, 135, 162, 182.25, 202.5, 216, 243, 270, 324, 364.5, 405, 432, 486, 540										
LENGTH	The length of the PSDU in octets. Range: 1-8191										
TRANSMISSION_MODE	The transmission type detected during reception of the PPDU Enumerated type: 2TX20GF, 3TX20GF, 4TX20GF, 2TX20MM, 3TX20MM, 4TX20MM, 1TX40GF, 2TX40GF, 3TX40GF, 4TX40GF, 1TX40MM, 2TX40MM, 3TX40MM, 4TX40MM.										
NUM_STREAMS	The number of independent spatial streams transmitted. Values: 1,2,3,4.										

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)		
		CODE_TYPE	Convolutional or LDPC Values: 0 (convolutional), 1 (LDPC)
		SERVICE	Null
		RSSI	The RSSI is a measure of the RF energy received by the MIMO-OFDM PHY, averaged across all RX antennas. The 8-bit value is in the range of 0 to RSSI maximum as described in 17.2.3.2.
		LPI	Indicates that this is the last PSDU to be aggregated into the current PPDU Values: true, false
		BURST_DURATION	The length in microseconds of the BURST_DURATION field in the mixed-mode preamble. Only valid when a mixed-mode TRANSMISSION_MODE is used. Range: 0-4095
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim 1, preamble above.		
[9.A] a wireless OFDM communications receiver operable to receive a first	See, e.g., claim 1, limitation 1.A above.		

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	See, e.g., claim 1, limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than	See, e.g., claim 1, limitation 1.C above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first	<i>See, e.g.</i> , claim 1, limitation 1.B above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	See, e.g., claim 1, limitation 1.C above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the	See, e.g., claim 1, limitation 1.D above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the	<i>See, e.g.</i> , Claim 2 above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
first packet in the first narrower frequency band.	
[24] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim 1, limitation 1.B above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[25.D] demodulate, by the demodulator, the second	<i>See, e.g.</i> , claim 1, limitation 1.E above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
number of OFDM symbols to determine the second header portion,	
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[27] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) (“WWiSE 2005”)
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.

Exhibit A11

**Defendant's Invalidity Contentions Comparing the Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent No. 8,675,754 to Yonge, III et al. ("Yonge")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under one or more sections of pre-AIA 35 U.S.C. §§ 102(a) and 102(b) as anticipated by Yonge¹; (2) under pre-AIA 35 U.S.C. § 103(a) as obvious in view of Yonge standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Yonge in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;

¹ Yonge was filed on August 19, 2010 and claims priority to provisional application No. 61/235,338 filed on August 19, 2009.

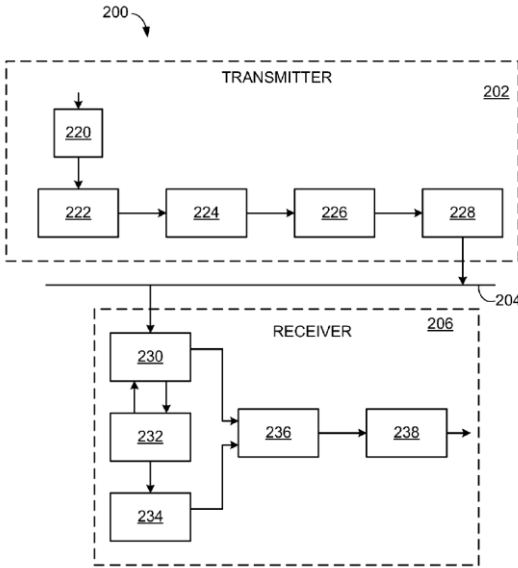
² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

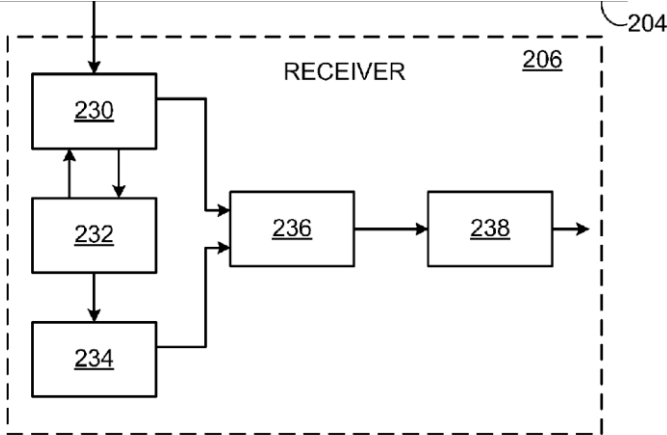
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
- U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
- U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
- U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
- U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
- U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
- U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
- U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
- U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in Yonge
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Yonge discloses a wireless OFDM transceiver. <i>See, e.g., Yonge, Fig. 2 & 8:46-51:</i>

Claim Elements	Disclosure in Yonge
	 FIG. 2 “Referring to FIG. 2, a communication system 200 includes a transmitter 202 for transmitting a signal (e.g., a sequence of OFDM symbols) over a communication medium 204 to a receiver 206. The transmitter 202 and receiver 206 can both be incorporated into a network interface module at each station.” <i>See, e.g., Yonge, 7:15-34</i> (“In some implementations, the network 104 comprises one or more network devices connected to a shared medium such as ... network devices communicating using wireless signals. ... The network 104 can be of any type and form and may include ... a wireless network ...”). <i>See, e.g., Yonge, 8:29-34</i> (“Some implementations of the PHY layer use OFDM modulation. In OFDM modulation, data are transmitted in the form of OFDM ‘symbols.’ Each symbol has a predetermined time duration or symbol time T_s. Each symbol is generated from a superposition of N sinusoidal carrier waveforms that are orthogonal to each

Claim Elements	Disclosure in Yonge
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	other and form the OFDM carriers.”). Yonge renders obvious a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. <i>See, e.g.,</i> Yonge, Fig. 2 & 8:46-51 (“Referring to FIG. 2, a communication system 200 includes a transmitter 202 for transmitting a signal (e.g., a sequence of OFDM symbols) over a communication medium 204 to a receiver 206. The transmitter 202 and receiver 206 can both be incorporated into a network interface module at each station.”).  FIG. 2 <i>See, e.g.,</i> Yonge, 14:38-40 (“In general, information about the modulation scheme used in a transmission is encoded in the header portion of a transmitted data packet.”). <i>See, e.g.,</i> Yonge, 10:34-36 (“The frame control information is also referred to as a header and usually placed between the preamble 305 and the payload 320. ... In some implementations, frame control information includes information necessary for the receiver to properly receive the payload. Examples of such information include the receiver’s

Claim Elements	Disclosure in Yonge
	address, the physical layer parameters used for modulating the payload and the duration of the payload”). <i>See, e.g.</i>, Yonge, 18:14-21 (“In some implementations, the frame control field consists of 128 information bits. These bits are encoded and coherently QPSK modulated over one or two OFDM symbols. ... The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g.</i>, Yonge, 6:26-50: Some of these devices may be new generation devices ... while others ... may be old or legacy type devices. In some implementations, data packets for a new generation device and a legacy device may be configured differently. For example, the new generation devices 110 may require additional frame control bits in the data packets. ... The present disclosure describes efficient methods and system for configuring data packets such that they can efficiently carry additional information for new generation devices while being back compatible with legacy devices. <i>See, e.g.</i>, Yonge, Fig. 3B & 10:50-11:2: Referring now to FIG. 3B, a schematic diagram of an exemplary data frame for both legacy and new generation devices is shown. In some implementations, the data frame includes a payload 320 and overhead information that may include a preamble 305 and frame control information. The frame control information may include legacy frame control 310 and new generation frame control 315. The new generation frame control 315 may include any new information that needs to be communicated to the receiver and other stations in the network to support the new generation functions. ... In some cases, additional information and/or bits of the new generation frame control 315 may be transmitted sequentially after the legacy frame control 310. This can be done, for example by adding extensions to frame control

Claim Elements	Disclosure in Yonge						
	fields of an existing frame (such as a physical layer protocol data unit (PPDU)). The overhead may be increased in such an approach. <table><tr><td>Preamble <u>305</u></td><td>Legacy frame control <u>310</u></td><td>Payload <u>320</u></td></tr><tr><td></td><td>New generation frame control <u>315</u></td><td></td></tr></table> FIG. 3B See, e.g., Yonge, 3:54-59 (“The first main information and the second main information each comprise a portion of main frame control information related to transmission of a frame over the network, and the auxiliary information comprises auxiliary control information related to transmission of the frame over the network.”). See, e.g., Yonge, 3:63-67 (“The auxiliary frame control information is used by a subset of fewer than all of the stations in the network receiving the frame. The main frame control information is used by all of the stations in the network receiving the frame.”). See, e.g., Yonge, Fig. 9 & 14:40-53:	Preamble <u>305</u>	Legacy frame control <u>310</u>	Payload <u>320</u>		New generation frame control <u>315</u>	
Preamble <u>305</u>	Legacy frame control <u>310</u>	Payload <u>320</u>					
	New generation frame control <u>315</u>						

Claim Elements	Disclosure in Yonge
	<pre> graph LR Input1[PHY_H bits] --> 910[First Header FEC encoder 910] 910 --> 930[First Header repetition encoder 930] Input2[PHY_H/2 bits] --> 920[Second Header FEC encoder 920] 920 --> 940[Second Header repetition encoder 940] 930 --> 950[Header mapper 950] 940 --> 950 950 --> Output[] </pre> FIG. 9 FIG. 9 is a block diagram 900 of an example scheme to encode header information for the hybrid modulation schemes described in this application. In the example shown in FIG. 9, the header information bits for a hybrid modulation scheme includes a frame of PHY_H bits that provides interoperability and coexistence with existing (legacy) devices, and an additional PHY_{H/2} bit frame that is available for advanced features supported in a new generation device. The two header frames are processed separately, sometimes, as shown in FIG. 9, in parallel. For example, the first frame (frame of PHY_H bits in this example) passes through a first header FEC encoder 910 while the second frame (the PHY_{H/2} bit frame in this example) passes through a second header FEC encoder 920. <i>See, e.g., Yonge, 11:10-21:</i> Whether or not the additional information related to the new generation frame control 315 is sent depends on the nature of the receiver. For example, when a new generation transmitter sends a unicast transmission to a legacy receiver, the new generation frame control information 315 is not sent. Similarly, when a

Claim Elements	Disclosure in Yonge
	new generation transmitter sends a unicast transmission to a new generation receiver, both the legacy frame control 310 and the new generation frame control 315 are sent. Similarly, when a new generation transmitter is sending a broadcast transmission intended for both new generation and legacy receivers, both the new generation frame control 315 and the legacy frame control 310 are sent.
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	Yonge discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. <i>See, e.g.,</i> Yonge, 19:31-34 (“In general, the main information is demodulated and decoded first and the knowledge related to the main information is then used to demodulate and decode the auxiliary information.”). <i>See, e.g.,</i> Yonge, Fig. 2 & 10:12-15 (“Demodulator/Decoder module 238 maps the complex numbers onto the corresponding bit sequences and performs the appropriate decoding of the bits (including de-interleaving and descrambling.”).

Claim Elements	Disclosure in Yonge
	<pre> graph TD In(()) --> 230 230 <--> 232 232 <--> 234 230 --> 236 234 --> 236 232 --> 238 236 --> 238 238 --> Out(()) subgraph 206 [RECEIVER] 230 232 234 236 238 end style 204 fill:none,stroke-dasharray: 5 5 </pre> FIG. 2 <i>See, e.g., Yonge, 18:14-21</i> (“In some implementations, the frame control field consists of 128 information bits. These bits are encoded and coherently QPSK modulated over one or two OFDM symbols. ... The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g., Yonge, 20:27-29</i> (“As described above, in some implementations, multiple copies of both the main information and the auxiliary information are sent.”). <i>See, e.g., Yonge, 12:43-46</i> (“In some implementations, multiple copies of each frame control bit are transmitted to increase robustness of the transmitted information. This is often referred to as copy coding.”). <i>See, e.g., Yonge, 3:17-23</i> (“The first station modulates copies of the first main information onto multiple respective portions of the signal and modulates copies of the auxiliary information onto multiple respective portions of the signal. Multiple portions of the signal that all carry copies of the first main information also carry copies of the auxiliary information.”).

Claim Elements	Disclosure in Yonge
	<i>See, e.g.,</i> Yonge, 1:63-2:3 (“The signal includes multiple copies of the auxiliary information, with each copy modulated on a respective carrier of the signal. ... Each of the auxiliary information and the copy of the auxiliary information is modulated on a different respective carrier of the signal ...”). <i>See, e.g.,</i> Yonge, 1:32-44 (“In one aspect, in general, a method for transmitting information between stations in a network includes modulating first main information and auxiliary information onto a first portion of a signal (e.g., a first carrier of the signal) according to a predetermined constellation ... [and] modulating second main information and a copy of the auxiliary information onto a second portion of the signal (e.g., a second carrier of the signal) according to the constellation.”). <i>See, e.g.,</i> Yonge, 2:21-31: The first portion of the signal comprises a first carrier included in at least one symbol of the signal, and the second portion of the signal comprises a second carrier included in at least one symbol of the signal. The signal includes orthogonal frequency division multiplexing (OFDM) symbols each including multiple carriers having different frequencies separated by integral multiples of an inverse of a time duration of the symbols. The first carrier and the second carrier have different frequencies.

[1.C] receive, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;

Yonge renders obvious a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits.

See, e.g., Yonge, 15:3-8 (“The first repetition encoder 930 replicate the $2 \cdot \text{PHY}_H$ bits at the output of the header encoder 910 onto the set of supported sub-carriers for maximal spreading of the bit copies. **For transmitting a single header-symbol, this is achieved by transmitting the copies of the interleaved bits consecutively ...**”).

See, e.g., Yonge, Fig. 3A & 10:20-36:

Referring now to Figure 3A, a schematic diagram of an **exemplary data frame for a legacy device is shown**. In broad overview, the frame may include a payload 320 and overhead information. ... The overhead information may include ... a preamble 305 used to detect the start of the data unit and frame control information 310 (referred to in here as legacy frame control to distinguish with the additional frame control information required for new generation devices). The frame control information is also referred to as a header and usually placed between the preamble 305 and the payload 320.

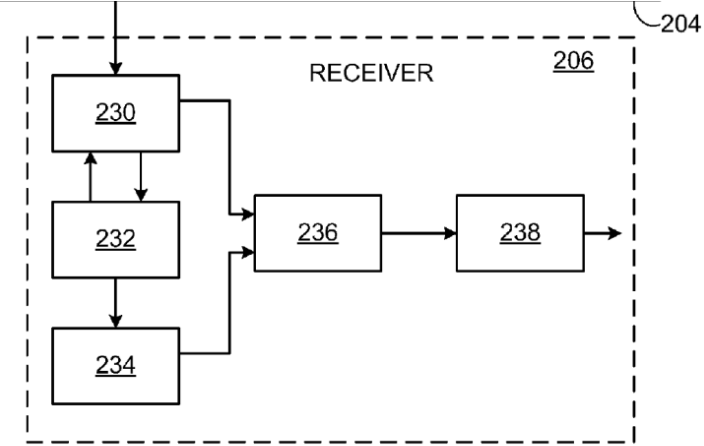
Preamble <u>305</u>	Legacy frame control <u>310</u>	Payload <u>320</u>

FIG. 3A

See, e.g., Yonge, 11:10-21:

Whether or not the additional information related to the new generation frame control 315 is sent depends on the nature of the receiver. For example, **when a new generation transmitter sends a unicast transmission to a legacy receiver, the new generation frame control information 315 is not sent**.

Claim Elements	Disclosure in Yonge
	Similarly, when a new generation transmitter sends a unicast transmission to a new generation receiver, both the legacy frame control 310 and the new generation frame control 315 are sent. Similarly, when a new generation transmitter is sending a broadcast transmission intended for both new generation and legacy receivers, both the new generation frame control 315 and the legacy frame control 310 are sent.
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Yonge discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. <i>See, e.g.,</i> Yonge, 19:31-34 (“In general, the main information is demodulated and decoded first and the knowledge related to the main information is then used to demodulate and decode the auxiliary information.”). <i>See, e.g.,</i> Yonge, Fig. 2 & 10:12-15 (“Demodulator/Decoder module 238 maps the complex numbers onto the corresponding bit sequences and performs the appropriate decoding of the bits (including de-interleaving and descrambling.”).

Claim Elements	Disclosure in Yonge
	 FIG. 2 <i>See, e.g., Yonge, 18:14-21 (“In some implementations, the frame control field consists of 128 information bits. These bits are encoded and coherently QPSK modulated over one or two OFDM symbols. ... The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”).</i>
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Yonge renders obvious the first narrower and second wider frequency bands have one or more overlapping frequency regions. <i>See, e.g., Yonge, 22:48-51 (“The method of claim 1, wherein the first selected region of the constellation in the first carrier of the signal overlaps with the second selected region of the constellation in the second carrier signal.”).</i>
[2.] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Yonge discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. <i>See, e.g., Yonge, 12:43-60:</i> In some implementations, multiple copies of each frame control bit are

Claim Elements	Disclosure in Yonge
	transmitted to increase robustness of the transmitted information. This is often referred to as copy coding. In some implementations, the copy coding is done prior to modulating the additional information on top of the existing modulation scheme for the legacy devices. In such cases, multiple copies of the new generation frame control information (or the copycoded bits) are encoded over an existing modulation scheme in a way that there is at least some variation in characteristic among the constellation points corresponding to the different copies. For example, if one copy of a bit is sent at a given amplitude of a QPSK signal, another copy of the same bit is sent at a different amplitude. This deliberate introduction of diversity in the copy coded bits may be referred to as constellation-mapping diversity and is illustrated with an example below. In some implementations, each of the copy coded bits are modulated on a different carrier frequency. <i>See, e.g., Yonge, 18:19-21</i> (“The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g., Yonge, 13:54-58</i> (“Therefore deliberately introducing diversity in the transmission of copy coded bits can help achieve substantially the same probability of error for a ‘0’ and a ‘1’ (or for any of multiple possible sequences of bits that may be transmitted).”).
[3.] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Yonge discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. <i>See, e.g., Yonge, 12:43-60:</i> In some implementations, multiple copies of each frame control bit are transmitted to increase robustness of the transmitted information. This is often referred to as copy coding. In some implementations, the copy coding is done prior to modulating the additional information on top of the existing modulation scheme for the legacy devices. In such cases, multiple copies of the

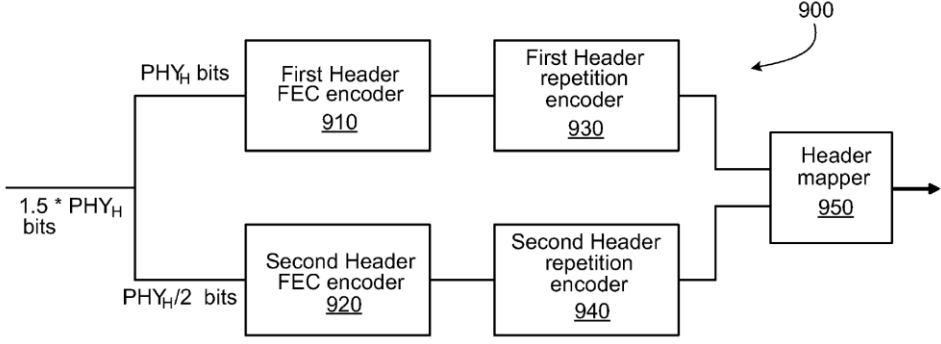
Claim Elements	Disclosure in Yonge
	new generation frame control information (or the copycoded bits) are encoded over an existing modulation scheme in a way that there is at least some variation in characteristic among the constellation points corresponding to the different copies. For example, if one copy of a bit is sent at a given amplitude of a QPSK signal, another copy of the same bit is sent at a different amplitude. This deliberate introduction of diversity in the copy coded bits may be referred to as constellation-mapping diversity and is illustrated with an example below. In some implementations, each of the copy coded bits are modulated on a different carrier frequency. <i>See, e.g., Yonge, 18:19-21 (“The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”).</i> <i>See, e.g., Yonge, 13:54-58 (“Therefore deliberately introducing diversity in the transmission of copy coded bits can help achieve substantially the same probability of error for a ‘0’ and a ‘1’ (or for any of multiple possible sequences of bits that may be transmitted).”).</i>
[4.] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	To the extent that it is determined that Yonge does not expressly or inherently disclose this limitation or render the limitation obvious, this reference in combination with one or more of the following secondary prior art references renders this limitation obvious: • TGn Sync Proposal 2005 and TGn Sync Proposal 2004 (<i>See Ex. A1</i>) • 2006 802.11n Joint PHY Proposal (<i>See Ex. A2</i>) • Maltsev (<i>See Ex. A3</i>); • Mujtaba (<i>See Ex. A4</i>); • The G.9960 Draft, Schrum, Kol, and Brown (<i>See Ex. A5</i>); • Takahashi (<i>See Ex. A6</i>); • Van Nee (<i>See Ex. A8</i>); • Williams, Ma, and Soliman (<i>See Ex. A9</i>) • Wwise 2005 (<i>See Ex. A10</i>); • Zelst (<i>See Ex. A12</i>); • Zhang '159 (<i>See Ex. A13</i>);

Claim Elements	Disclosure in Yonge
	Citations on a limitation-by-limitation basis can be found in the claim chart for these secondary references in the Exhibits identified above. One of ordinary skill in the art would have been motivated to combine each of these references, either individually or in combination, with the primary reference cited in this claim chart because, among other things, each of these references relates to systems and methods for wireless communication, most relate to OFDM wireless communications, and relate to Wi-Fi networking. Moreover, It would have been a routine adaption for a person of ordinary skill in the art to merely specify the relative width of the first and second frequency bands of the wireless transceiver disclosed in Yonge to meet this claim limitation.
[8.] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Yonge discloses wherein the wireless transceiver supports one or more wireless standards. To the extent that it is determined that Yonge does not expressly or inherently disclose this limitation or render the limitation obvious, this reference in combination with one or more of the following secondary prior art references renders this limitation obvious: • TGN Sync Proposal 2005 and TGN Sync Proposal 2004 (See Ex. A1) • 2006 802.11n Joint PHY Proposal (See Ex. A2) • Maltsev (See Ex. A3); • Mujtaba (See Ex. A4); • The G.9960 Draft, Schrum, Kol, and Brown (See Ex. A5); • Takahashi (See Ex. A6); • Van Nee (See Ex. A8); • Williams, Ma, and Soliman (See Ex. A9) • Wwise 2005 (See Ex. A10); • Zelst (See Ex. A12); • Zhang '159 (See Ex. A13); Citations on a limitation-by-limitation basis can be found in the claim chart for these secondary references in the Exhibits identified above. One of ordinary skill in the art would have been motivated to combine each of these references, either individually or in combination, with the primary reference cited in this claim chart because, among other

Claim Elements	Disclosure in Yonge
	things, each of these references relates to systems and methods for wireless communication, most relate to OFDM wireless communications, and relate to Wi-Fi networking. Moreover, It would have been a routine adaption for a person of ordinary skill in the art to modify Yonge's transceiver to support one or more wireless standards, which were known to a person of skill as of the priority date of the '262 patent, and because Yonge, for example, describes implementation of a wireless network.
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	To the extent the preamble is limiting, Yonge discloses a wireless OFDM transceiver. <i>See, e.g.,</i> Yonge, Fig. 2 & 8:46-51 ("Referring to FIG. 2, a communication system 200 includes a transmitter 202 for transmitting a signal (e.g., a sequence of OFDM symbols) over a communication medium 204 to a receiver 206. The transmitter 202 and receiver 206 can both be incorporated into a network interface module at each station."). <i>See, e.g.,</i> Yonge, 7:15-34 ("In some implementations, the network 104 comprises one or more network devices connected to a shared medium such as ... network devices communicating using wireless signals. ... The network 104 can be of any type and form and may include ... a wireless network ..."). <i>See, e.g.,</i> Yonge, 8:29-34 ("Some implementations of the PHY layer use OFDM modulation. In OFDM modulation, data are transmitted in the form of OFDM 'symbols.' Each symbol has a predetermined time duration or symbol time T_s. Each symbol is generated from a superposition of N sinusoidal carrier waveforms that are orthogonal to each other and form the OFDM carriers.").
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of	Yonge renders obvious a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols. <i>See, e.g.,</i> Yonge, Fig. 2 & 8:46-51 ("Referring to FIG. 2, a communication system 200 includes a transmitter 202 for transmitting a signal (e.g., a sequence of OFDM symbols) over a communication medium 204 to a receiver 206. The transmitter 202 and receiver 206 can both be incorporated into a network interface module at each station.").

Claim Elements	Disclosure in Yonge
OFDM symbols;	<pre> graph TD subgraph 204 [] direction TB subgraph 206 [RECEIVER] direction TB 230[230] 232[232] 234[234] 236[236] 238[238] 230 --> 236 232 --> 236 234 --> 236 236 --> 238 end end In[] --> 230 In --> 232 In --> 234 238 --> Out[] </pre> FIG. 2 <i>See, e.g.,</i> Yonge, 14:38-40 (“In general, information about the modulation scheme used in a transmission is encoded in the header portion of a transmitted data packet.”). <i>See, e.g.,</i> Yonge, 10:34-36 (“The frame control information is also referred to as a header and usually placed between the preamble 305 and the payload 320. ... In some implementations, frame control information includes information necessary for the receiver to properly receive the payload. Examples of such information include the receiver’s address, the physical layer parameters used for modulating the payload and the duration of the payload”). <i>See, e.g.,</i> Yonge, 18:14-21 (“In some implementations, the frame control field consists of 128 information bits. These bits are encoded and coherently QPSK modulated over one or two OFDM symbols. ... The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g.,</i> Yonge, Fig. 3B & 10:50-11:2:

Claim Elements	Disclosure in Yonge						
	Referring now to FIG. 3B, a schematic diagram of an exemplary data frame for both legacy and new generation devices is shown. In some implementations, the data frame includes a payload 320 and overhead information that may include a preamble 305 and frame control information. The frame control information may include legacy frame control 310 and new generation frame control 315. The new generation frame control 315 may include any new information that needs to be communicated to the receiver and other stations in the network to support the new generation functions. ... In some cases, additional information and/or bits of the new generation frame control 315 may be transmitted sequentially after the legacy frame control 310. This can be done, for example by adding extensions to frame control fields of an existing frame (such as a physical layer protocol data unit (PPDU)). The overhead may be increased in such an approach. <table><tr><td>Preamble <u>305</u></td><td>Legacy frame control <u>310</u></td><td>Payload <u>320</u></td></tr><tr><td></td><td>New generation frame control <u>315</u></td><td></td></tr></table> FIG. 3B <i>See, e.g., Yonge, 6:26-50</i> (“Some of these devices may be new generation devices ... while others ... may be old or legacy type devices. In some implementations, data packets for a new generation device and a legacy device may be configured differently. For example, the new generation devices 110 may require additional frame control bits in the data packets. ... The present disclosure describes efficient methods and system for configuring data packets such that they can efficiently carry additional information for new generation devices while being back compatible with legacy devices”). <i>See, e.g., Yonge, 3:54-59</i> (“The first main information and the second main information each comprise a portion of main frame control information related to transmission of a frame over the network, and the auxiliary information comprises auxiliary control information related to transmission of the frame over the network.”).	Preamble <u>305</u>	Legacy frame control <u>310</u>	Payload <u>320</u>		New generation frame control <u>315</u>	
Preamble <u>305</u>	Legacy frame control <u>310</u>	Payload <u>320</u>					
	New generation frame control <u>315</u>						

Claim Elements	Disclosure in Yonge
	See, e.g., Yonge, 3:63-67 (“The auxiliary frame control information is used by a subset of fewer than all of the stations in the network receiving the frame. The main frame control information is used by all of the stations in the network receiving the frame.”). See, e.g., Yonge, Fig. 9 & 14:40-53:  FIG. 9 FIG. 9 is a block diagram 900 of an example scheme to encode header information for the hybrid modulation schemes described in this application. In the example shown in FIG. 9, the header information bits for a hybrid modulation scheme includes a frame of PHY_H bits that provides interoperability and coexistence with existing (legacy) devices, and an additional $PHY_{H/2}$ bit frame that is available for advanced features supported in a new generation device. The two header frames are processed separately, sometimes, as shown in FIG. 9, in parallel. For example, the first frame (frame of PHY_H bits in this example) passes through a first header FEC encoder 910 while the second frame (the $PHY_{H/2}$ bit frame in this example) passes through a second header FEC encoder 920.

Claim Elements	Disclosure in Yonge
	<i>See, e.g., Yonge, 11:10-21:</i> Whether or not the additional information related to the new generation frame control 315 is sent depends on the nature of the receiver. For example, when a new generation transmitter sends a unicast transmission to a legacy receiver, the new generation frame control information 315 is not sent. Similarly, when a new generation transmitter sends a unicast transmission to a new generation receiver, both the legacy frame control 310 and the new generation frame control 315 are sent. Similarly, when a new generation transmitter is sending a broadcast transmission intended for both new generation and legacy receivers, both the new generation frame control 315 and the legacy frame control 310 are sent.
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	Yonge discloses a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers. <i>See, e.g., Yonge, 19:31-34</i> (“In general, the main information is demodulated and decoded first and the knowledge related to the main information is then used to demodulate and decode the auxiliary information.”). <i>See, e.g., Yonge, Fig. 2 & 10:12-15</i> (“Demodulator/Decoder module 238 maps the complex numbers onto the corresponding bit sequences and performs the appropriate decoding of the bits (including de-interleaving and descrambling.”).

Claim Elements	Disclosure in Yonge
	<pre> graph TD In(()) --> 230 230 <--> 232 232 <--> 234 230 --> 236 232 --> 236 234 --> 236 236 --> 238 238 --> Out(()) subgraph 206 [RECEIVER] 230 232 234 236 238 end style 204 fill:none,stroke-dasharray: 5 5 style 206 fill:none,stroke-dasharray: 5 5 </pre> FIG. 2 <i>See, e.g., Yonge, 18:14-21</i> (“In some implementations, the frame control field consists of 128 information bits. These bits are encoded and coherently QPSK modulated over one or two OFDM symbols. ... The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g., Yonge, 20:27-29</i> (“As described above, in some implementations, multiple copies of both the main information and the auxiliary information are sent.”). <i>See, e.g., Yonge, 12:43-46</i> (“In some implementations, multiple copies of each frame control bit are transmitted to increase robustness of the transmitted information. This is often referred to as copy coding.”). <i>See, e.g., Yonge, 3:17-23</i> (“The first station modulates copies of the first main information onto multiple respective portions of the signal and modulates copies of the auxiliary information onto multiple respective portions of the signal. Multiple portions of the signal that all carry copies of the first main information also carry copies of the auxiliary information.”).

Claim Elements	Disclosure in Yonge
	<i>See, e.g.</i>, Yonge, 1:63-2:3 (“The signal includes multiple copies of the auxiliary information, with each copy modulated on a respective carrier of the signal. ... Each of the auxiliary information and the copy of the auxiliary information is modulated on a different respective carrier of the signal ...”). <i>See, e.g.</i>, Yonge, 1:32-44 (“In one aspect, in general, a method for transmitting information between stations in a network includes modulating first main information and auxiliary information onto a first portion of a signal (e.g., a first carrier of the signal) according to a predetermined constellation ... [and] modulating second main information and a copy of the auxiliary information onto a second portion of the signal (e.g., a second carrier of the signal) according to the constellation.”). <i>See, e.g.</i>, Yonge, 2:21-31: The first portion of the signal comprises a first carrier included in at least one symbol of the signal, and the second portion of the signal comprises a second carrier included in at least one symbol of the signal. The signal includes orthogonal frequency division multiplexing (OFDM) symbols each including multiple carriers having different frequencies separated by integral multiples of an inverse of a time duration of the symbols. The first carrier and the second carrier have different frequencies.
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first	Yonge renders obvious a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. <i>See, e.g.</i>, Yonge, 15:3-8 (“The first repetition encoder 930 replicate the $2 \cdot \text{PHY}_H$ bits at the output of the header encoder 910 onto the set of supported sub-carriers for maximal spreading of the bit copies. For transmitting a single header-symbol, this is achieved by transmitting the copies of the interleaved bits consecutively ...”).

Claim Elements	Disclosure in Yonge			
number of OFDM symbols, and wherein the second header portion is different than the first header portion;	See, e.g., Yonge, Fig. 3A & 10:20-36: Referring now to Figure 3A, a schematic diagram of an exemplary data frame for a legacy device is shown. In broad overview, the frame may include a payload 320 and overhead information. ... The overhead information may include ... a preamble 305 used to detect the start of the data unit and frame control information 310 (referred to in here as legacy frame control to distinguish with the additional frame control information required for new generation devices). The frame control information is also referred to as a header and usually placed between the preamble 305 and the payload 320. <table><tr><td>Preamble 305</td><td>Legacy frame control 310</td><td>Payload 320</td></tr></table> FIG. 3A See, e.g., Yonge, 11:10-21: Whether or not the additional information related to the new generation frame control 315 is sent depends on the nature of the receiver. For example, when a new generation transmitter sends a unicast transmission to a legacy receiver, the new generation frame control information 315 is not sent. Similarly, when a new generation transmitter sends a unicast transmission to a new generation receiver, both the legacy frame control 310 and the new generation frame control 315 are sent. Similarly, when a new generation transmitter is sending a broadcast transmission intended for both new generation and legacy receivers, both the new generation frame control 315 and the legacy frame control 310 are sent.	Preamble 305	Legacy frame control 310	Payload 320
Preamble 305	Legacy frame control 310	Payload 320		
[9.D] the demodulator further	Yonge discloses a demodulator to demodulate the second number of OFDM symbols to			

Claim Elements	Disclosure in Yonge
operable to demodulate the second number of OFDM symbols to determine the second header portion,	determine the second plurality of header bits. <i>See, e.g.,</i> Yonge, 19:31-34 (“In general, the main information is demodulated and decoded first and the knowledge related to the main information is then used to demodulate and decode the auxiliary information.”). <i>See, e.g.,</i> Yonge, Fig. 2 & 10:12-15 (“Demodulator/Decoder module 238 maps the complex numbers onto the corresponding bit sequences and performs the appropriate decoding of the bits (including de-interleaving and descrambling.”). <pre> graph TD subgraph 204 subgraph 206 RECEIVER 230 --> 232 232 --> 230 232 --> 234 234 --> 232 230 --> 236 232 --> 236 234 --> 236 236 --> 238 end end </pre> FIG. 2 <i>See, e.g.,</i> Yonge, 18:14-21 (“In some implementations, the frame control field consists of 128 information bits. These bits are encoded and coherently QPSK modulated over one or two OFDM symbols. ... The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”).
[9.E] wherein the first narrower and second wider frequency bands have one or more	Yonge renders obvious the first narrower and second wider frequency bands having one or more overlapping frequency regions.

Claim Elements	Disclosure in Yonge
overlapping frequency regions.	<i>See, e.g.,</i> Yonge, 22:48-51 (“The method of claim 1, wherein the first selected region of the constellation in the first carrier of the signal overlaps with the second selected region of the constellation in the second carrier signal.”).
[10.] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Yonge discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. <i>See, e.g.,</i> Yonge, 12:43-60: In some implementations, multiple copies of each frame control bit are transmitted to increase robustness of the transmitted information. This is often referred to as copy coding. In some implementations, the copy coding is done prior to modulating the additional information on top of the existing modulation scheme for the legacy devices. In such cases, multiple copies of the new generation frame control information (or the copycoded bits) are encoded over an existing modulation scheme in a way that there is at least some variation in characteristic among the constellation points corresponding to the different copies. For example, if one copy of a bit is sent at a given amplitude of a QPSK signal, another copy of the same bit is sent at a different amplitude. This deliberate introduction of diversity in the copy coded bits may be referred to as constellation-mapping diversity and is illustrated with an example below. In some implementations, each of the copy coded bits are modulated on a different carrier frequency. <i>See, e.g.,</i> Yonge, 18:19-21 (“The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g.,</i> Yonge, 13:54-58 (“Therefore deliberately introducing diversity in the transmission of copy coded bits can help achieve substantially the same probability of error for a ‘0’ and a ‘1’ (or for any of multiple possible sequences of bits that may be transmitted).”).

Claim Elements	Disclosure in Yonge
[11.] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Yonge discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. <i>See, e.g., Yonge, 12:43-60:</i> In some implementations, multiple copies of each frame control bit are transmitted to increase robustness of the transmitted information. This is often referred to as copy coding. In some implementations, the copy coding is done prior to modulating the additional information on top of the existing modulation scheme for the legacy devices. In such cases, multiple copies of the new generation frame control information (or the copycoded bits) are encoded over an existing modulation scheme in a way that there is at least some variation in characteristic among the constellation points corresponding to the different copies. For example, if one copy of a bit is sent at a given amplitude of a QPSK signal, another copy of the same bit is sent at a different amplitude. This deliberate introduction of diversity in the copy coded bits may be referred to as constellation-mapping diversity and is illustrated with an example below. In some implementations, each of the copy coded bits are modulated on a different carrier frequency. <i>See, e.g., Yonge, 18:19-21</i> (“The use of two symbols for the frame control, when used, can increase frame control robustness, especially in bandwidth-limited cases.”). <i>See, e.g., Yonge, 13:54-58</i> (“Therefore deliberately introducing diversity in the transmission of copy coded bits can help achieve substantially the same probability of error for a ‘0’ and a ‘1’ (or for any of multiple possible sequences of bits that may be transmitted).”).
[12.] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first	<i>See e.g., claim 4 above.</i>

Claim Elements	Disclosure in Yonge
narrower frequency band.	
[16.] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See e.g.</i> , claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	<i>See, e.g.</i> , claim limitation 1.A above.
[17.B] demodulating, by a demodulator, connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Yonge
comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21.] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.
[22.] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[23.] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.

Claim Elements	Disclosure in Yonge
[24.] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band	<i>See, e.g.</i> , claim 3 above.
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim limitation 1.A above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency band,	<i>See, e.g.</i> , claim limitation 1.C above.

Claim Elements	Disclosure in Yonge
by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26.] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27.] The method of claim 25, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosure in Yonge
the first narrower frequency band.	
[28.] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[32.] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.

Exhibit A12

**Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent No. 7,599,332 ("Zelst")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under pre-AIA 35 U.S.C. § 102 as anticipated by Zelst¹; (2) under pre-AIA 35 U.S.C. § 103 as obvious in view of Zelst standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Zelst in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA

¹ Zelst was filed on May 27, 2005.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

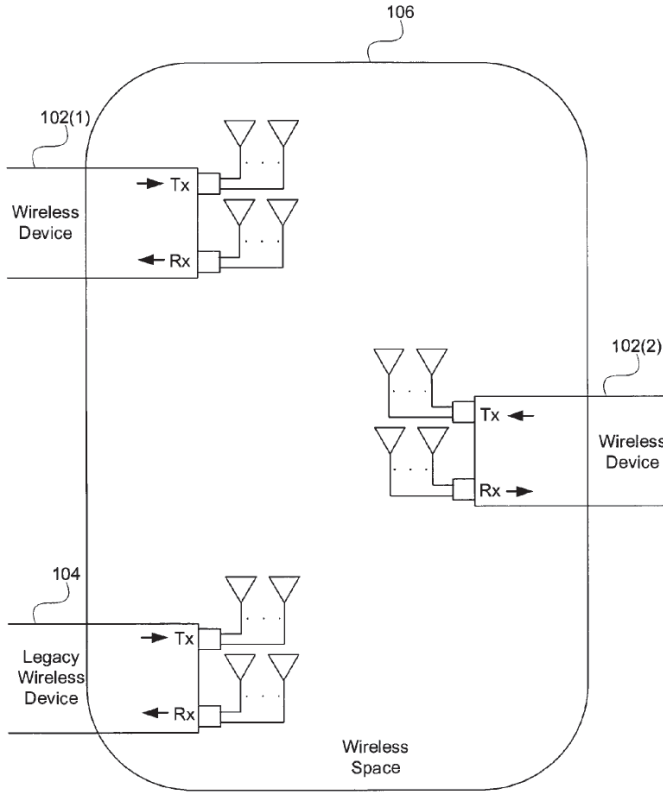
- (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
 - U.S. Patent Application Publication No. 2010/0260159 to Zhang et al. (“Zhang”);
 - U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
 - U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
 - U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
 - U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
 - U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
 - U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

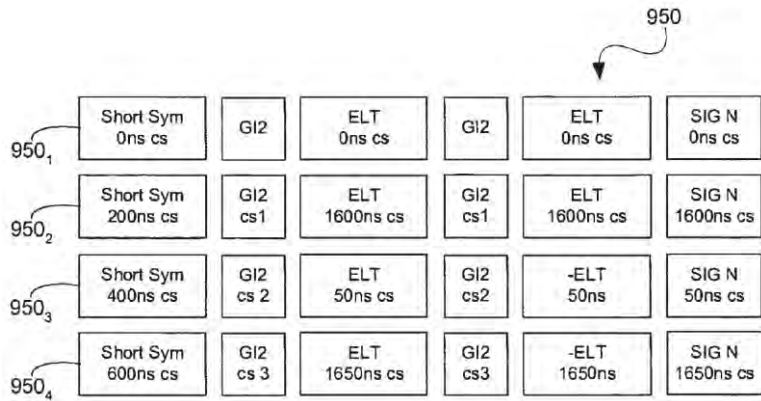
Claim Elements	Disclosure in Zelst
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Zelst discloses a wireless OFDM transceiver. For example, the reference discloses the following: <i>See, e.g., Zelst at 4:24-46:</i> FIG. 3 illustrates just one example of a wireless network being used for communications among transmitters and receivers as indicated. As shown, two wireless devices 102(1), 102(2) might use and interpret the modified preambles, while a legacy wireless device 104 might not be expecting the modified preambles, but might hear signals representing such preambles. Extended wireless devices 102 might operate using multiple channels and/or multiple transmit antennas and/or multiple receive antennas. Devices might have a single transmit antenna and a single receive antenna, or more than one transmit

Claim Elements	Disclosure in Zelst
	antenna and/or more than one receive antenna. While separate transmit and receive antennas are shown, antennas might be used for both transmitting and receiving in some devices. Border 106 is not a physical border, but is shown to represent a space within which signals can be received from devices within the space. Thus, as one device transmits a signal representing a packet within border 106, other devices within border 106 pick up the signals and, as they are programmed, will attempt to determine if the signals represent packets and if so, then demodulate/decode the packets to obtain the data represented therein. <i>Id.</i> at Fig. 3:

Claim Elements	Disclosure in Zelst
	 Fig. 3 <i>Id.</i> at 5:53-65: By allowing for channel estimation for multiple transmitters, MIMO or space-time coding techniques can be supported to achieve 802.11a extensions. One way to do this is by sending a different set of subcarriers from each transmitter. As an example, for the case of two transmitters, a device might modulate its OFDM subcarriers with the 64 values of L3, shown in FIG. 4, where one transmitter transmits the odd subcarriers {1, 3, . . . , 63} and the other transmitter transmits the even subcarriers {0,

Claim Elements	Disclosure in Zelst
	2, . . . , 62}. Thus, one transmitter would take an IFFT of the odd subcarriers and transmit samples of that time varying signal and the other transmitter would take an IFFT of the even subcarriers and transmit samples of that time varying signal. <i>Id.</i> at 14:54-63: The extended preamble portions of preamble 1000, namely those identified by reference numerals 1020 1, 1025 1, 1030 1, 1035 1 of the first transmit antenna as well as 1020 2, 1025 2, 1030 2, 1035 2 of the second transmit antenna provide efficient training symbols for many systems, such MIMO OFDM systems. Therefore, when legacy devices as well as extended devices, like MIMO OFDM devices, are also part of the network, both the legacy as well as the extended devices are able to receive and process the preambles.
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Zelst discloses a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Zelst</i> at 5:2-21: Multi-channel extended 802.11 systems might simultaneously transmit on several 20 MHz channels, whereas a legacy 802.11a system only transmits on a single 20 MHz channel using a single antenna, or if the legacy system does transmit with more than one antenna, each of the antennas transmits the same 802.11a signal, possibly with some delay differences between signals. As a result, data rates can be increased over 802.11a data rates using multiple transmit antennas or multiple channels or a combination of both. Thus, in a communication channel, such as the airspace of a wireless network cloud, several types of packets might be present: 1) Legacy SISO (single-input, single-output) 802.11a, 802.11b, or 802.11g packets transmitted in a single 20 MHz channel; 2) Extended SISO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) 3) Extended MIMO in a single 20 MHz channel; 4) Extended MIMO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) <i>Id.</i> at 5:53-65:

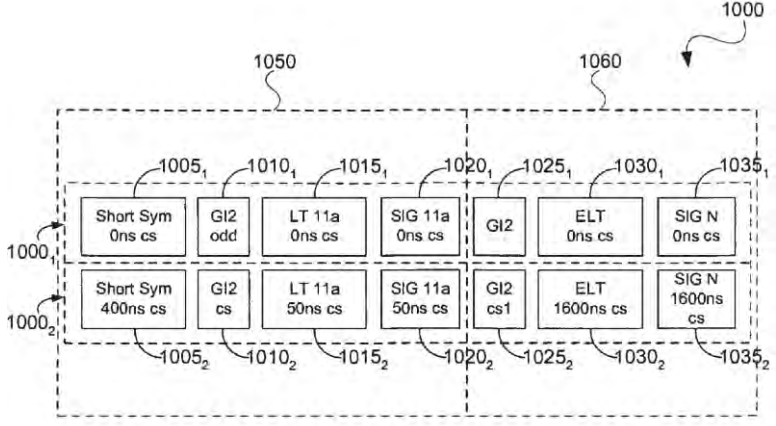
Claim Elements	Disclosure in Zelst
	By allowing for channel estimation for multiple transmitters, MIMO or space-time coding techniques can be supported to achieve 802.11a extensions. One way to do this is by sending a different set of subcarriers from each transmitter. As an example, for the case of two transmitters, a device might modulate its OFDM subcarriers with the 64 values of L3, shown in FIG. 4, where one transmitter transmits the odd subcarriers {1, 3, . . . , 63} and the other transmitter transmits the even subcarriers {0, 2, . . . , 62}. Thus, one transmitter would take an IFFT of the odd subcarriers and transmit samples of that time varying signal and the other transmitter would take an IFFT of the even subcarriers and transmit samples of that time varying signal. <i>Id.</i> at 7:60-8:8: The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. <i>Id.</i> at 11:60-12:30: FIG. 10 shows a modified preamble 950 adapted for a four-transmit antenna, in accordance with one embodiment of the present invention. Modified preamble 950 includes four preambles 950 1, 950 2, 950 3, and 950 4 that are respectively transmitted from the first, second, third, and fourth transmit antennas (not shown). Each of the preambles 950 1, 950 2, 950 3, and 950 4 includes a short training sequence, a Guard interval, a first ELT sequence, which includes two or more consecutive symbols, a second guard interval, a second ELT sequence, and a signal field. It is understood that for a system with three transmit antenna, preamble 950 includes preambles 950 1, 950 2, 950 3, and for a system with two transmit antennas, preamble 950 includes preambles 950 1, 950 2. Each ELT sequence includes, in turn, two ore more consecutive symbols (collectively referred to as a symbol). As is shown in FIG. 10, the short training sequences (alternatively referred to herein as short training sequence field) of 950 4, 950 3, and 950 2 have cyclic shifts of 600 nsec, 400 nsec, and 200 nsec,

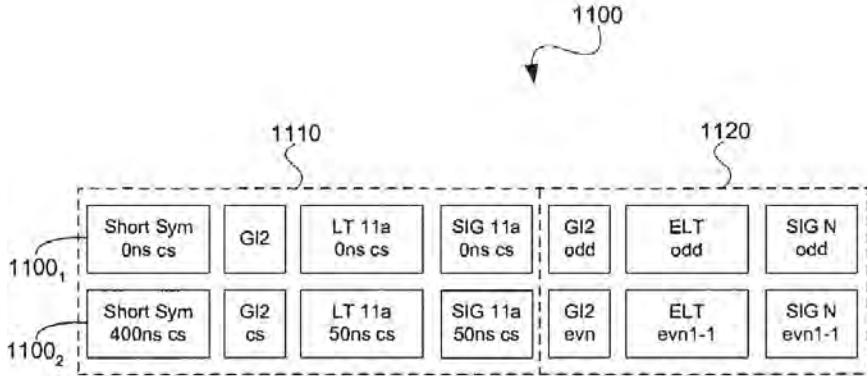
Claim Elements	Disclosure in Zelst
	respectively with respect to the short training sequence fields 950 1. The first ELT sequence field of 950 2 has a cyclic shift of 1600 nsec with respect to the first ELT sequence field of 950 1. The first ELT sequence field of 950 3 has a cyclic shift of 50 nsec with respect to the first ELT sequence field of 950 1. The first ELT sequence field of 950 4 has a cyclic shift of 1650 nsec with respect to the first ELT sequence field of 950 1. The second ELT sequence field of 950 2 has a cyclic shift of 1600 nsec with respect to the second ELT sequence field of 950 1. The second ELT sequence field of 950 3 has a cyclic shift of 50 nsec with respect to the second ELT sequence field of 950 1. The second ELT sequence field of 950 4 has a cyclic shift of 1650 nsec with respect to the first ELT sequence field of 950 1. The Signal field of 950 2 has a cyclic shift of 1600 nsec with respect to the signal field of 950 1. The signal field of 950 3 has a cyclic shift of 50 nsec with respect to the signal field of 950 1. The signal field of 950 4 has a cyclic shift of 1650 nsec with respect to the signal field of ELT sequence of 950 1. In the following, the ELT sequence field is alternatively referred to as ELT sequence. <i>Id.</i> at Fig. 10:  Fig. 10 <i>Id.</i> at 13:30-14:5: FIG. 12 shows a modified preamble 970 configured for transmission via a system having four transmit antennas (not shown), in accordance with another embodiment of the present invention. Preamble 970 includes preamble part 970 1, 970 2, 970 3, and 970 4, each of which parts include two guard intervals

Claim Elements	Disclosure in Zelst
	and two extended long training sequences. The short training sequences of preamble parts 970 2, 970 3, and 970 4 have respective cyclic shifts of 200 nsec, 400 nsec, and 600 nsec with respect to the short training sequence of preamble part 970 1. The guard intervals of preamble part 970 1 are generated by taking the last part of the time-domain representation of the odd tones of the long training sequence or ELT sequence of preamble part 970 1, and the guard intervals of preamble part 970 2 are similarly obtained by taking the last part of the time-domain representation of the long training sequence or ELT sequence of preamble part 970 2. Each of the first and second ELT sequences of preamble 970 1 includes only the odd tones and each of the first and second ELT sequences of preamble 970 2 includes only the modified even tones, i.e., even tone modified by the pattern $\{1, -1, 1, -1, 1, -1 \dots\}$. The first and second ELT sequences of preamble 970 3 include only the odd tones that are cyclically shifted with respect to the corresponding ELT sequence of preamble 970 2 by 50 nsec. The first and second ELT sequences of preamble 970 4 include only the modified even tones that are cyclically shifted with respect to the corresponding ELT sequence of preamble 970 3 by 50 nsec. Moreover, a Walsh code is used such that the first and second ELT sequences of preamble 970 1 and 970 2 and the first ELT sequences of preamble 970 3 and 970 4 are multiplied by 1, and the second ELT sequences of preamble 970 3 and 970 4 are multiplied by -1. This allows for separation between TX1 and TX2 on one side and TX3 and TX4 on the other side. The cyclic shift is used to further the channel training from TX1 and TX2, and TX3 and TX4, respectively. The signal field of preamble 970 1 includes only the odd tones, and the signal field of preamble 970 2 includes only the modified even tones. The signal field of preamble 970 3 includes only the odd tones and has a cyclic shift of 50 nsec with respect to the signal field of preamble 970 2. The signal field of preamble 970 4 includes only the modified even tones and has a cyclic shift of 50 nsec with respect to the signal field of preamble 970 3. <i>Id.</i> at Fig. 12:

Claim Elements	Disclosure in Zelst
	Fig. 12 <i>Id.</i> at 14:6-15:5: In accordance with some embodiments of the present invention, a mixed-mode preamble includes legacy as well as modified preambles. FIG. 13 shows an exemplary mixed-mode preamble 1000 configured for transmission from a system having two-transmit antennas, in accordance with one embodiment of the present invention. Exemplary mixed mode preamble 1000 includes legacy 802.11a/g preamble portion 1050, that may be modified to indicate that an extended training part is appended, e.g., by setting the reserved bit of the legacy signal field, as well as a modified preamble portion 1060, as described above. Mixed mode preamble 1000 includes preamble 1000 1 that is transmitted from the first antenna and preamble 1000 2 that is transmitted from the second antenna. Short training sequence 1005 1, guard interval 1010 1, long training sequence 1015 1, and signal field 1020 1 in combination form a legacy 802.11a/g preamble portion of preamble 1000 1 that is transmitted from the first transmit antenna. Guard interval 1025 1, ELT sequence 1030 1, and Signal field 1035 1 form the modified (extended) preamble portion of 1000 1. Similarly, short training sequence 1005 2, guard interval 1010 2, long training sequence 1015 2, and signal field 1020 2 in combination form a legacy 802.11a/g preamble portion of preamble 1000 2 that is transmitted from the first transmit antenna. Guard interval 1025 2, ELT sequence 1030 2, and Signal field 1035 2 form the extended preamble portion of preamble 1000 2 that is transmitted from the second antenna.

Claim Elements	Disclosure in Zelst
	The various fields of the 802.11a/g preamble portion of preamble 1000 2 are cyclically shifted with respect to the various fields of the 802.11a/g preamble portion of preamble 1000 1. Similarly, the various fields of the extended preamble portion of preamble 1000 2 are cyclically shifted with respect to the various fields of the extended preamble portion of preamble 1000 1. For example, in the exemplary embodiment shown in FIG. 13, the short training sequence 1005 2 of the second transmit antenna have a cyclic shift of 400 nsec with respect to the short training sequence 1005 1 of the first transmit antenna. Similarly, the long training sequence 1015 2 of the second transmit antenna has a cyclic shift of 50 nsec with respect to the long training sequence 1015 1 of the first transmit antenna. The Signal field 1020 2 of the second transmit antenna has a cyclic shift of 50 nsec with respect to the Signal field 1020 1 of the first transmit antenna. The ELT sequence 1030 2 of the second transmit antenna has a cyclic shift of 1600 nsec with respect to the ELT sequence 1030 1 of the first transmit antenna. The Signal field 1035 2 of the second transmit antenna has a cyclic shift of 1600 nsec with respect to the Signal field 1035 1 of the first transmit antenna. The extended preamble portions of preamble 1000, namely those identified by reference numerals 1020 1, 1025 1, 1030 1, 1035 1 of the first transmit antenna as well as 1020 2, 1025 2, 1030 2, 1035 2 of the second transmit antenna provide efficient training symbols for many systems, such MIMO OFDM systems. Therefore, when legacy devices as well as extended devices, like MIMO OFDM devices, are also part of the network, both the legacy as well as the extended devices are able to receive and process the preambles. Through the use of one or more bits of the preamble, (e.g., by setting the reserved bit in the signal field of the legacy portion of the preamble) or by auto-detecting that a second training sequence follows the legacy signal field, extended devices are triggered that enable, for example, channel estimation after the legacy portion of the preamble is received. One advantage of having a modified preamble following a legacy preamble is PHY level backwards compatibility. Hence, no MAC protection mechanisms are needed to communicate at extended rates, leading to enhanced efficiency. <i>Id.</i> at Fig. 13:

Claim Elements	Disclosure in Zelst
	 Fig. 13 <i>Id.</i> at 15:6-33: FIG. 14 shows an exemplary mixed-mode preamble 1100, in accordance with another embodiment of the present invention, configured for transmission from a system having two transmit antennas. Exemplary mixed mode preamble 1100 includes legacy 802.11a/g preamble portion 1110 as well as a modified preamble portion 1120. Legacy 802.11a/g preamble portion 1110 is similar to legacy 802.11a/g preamble portion 1050 of FIG. 13. The guard interval of the preamble portion 1100 1, configured for transmission from the first transmit antenna, is generated by taking the last part of the time-domain representation of the odd tones of the long training sequence or ELT sequence of preamble 1100 1, and the guard interval of preamble part 1100 2 is similarly obtained by taking the last part of the time-domain representation of the long training sequence of 1100 2. The ELT sequence of preamble portion 1100 1 only includes the odd tones. The ELT sequence of preamble portion 1100 2 only includes modified even tones that are generated by multiplying the original unmodified tones by the sequence {1, 0, -1, 0, 1, 0, -1, 0, 1, 0, -1 . . . }. Similarly, the signal field of preamble portion 1100 1 only includes the odd tones. The signal field of preamble portion 1100 2 only includes modified even tones that are generated by multiplying the original unmodified tones by the sequence {1, 0, -1, 0, 1, 0, -1, 0, 1, 0, -1 . . . }. The mixed-mode preamble, in accordance with any of the exemplary embodiments described above, enables the legacy

Claim Elements	Disclosure in Zelst
	devices to defer to extended devices if they have properly received the legacy part of the mixed-mode preamble. <i>Id.</i> at Fig. 14:  Fig. 14
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits,	Zelst discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. For example, the reference discloses the following: <i>See, e.g., Zelst at 4:38-46:</i> Border 106 is not a physical border, but is shown to represent a space within which signals can be received from devices within the space. Thus, as one device transmits a signal representing a packet within border 106, other devices within border 106 pick up the signals and, as they are programmed, will attempt to determine if the signals represent packets and if so, then demodulate/decode the packets to obtain the data represented therein. <i>Id.</i> at 5:53-6:5:

Claim Elements	Disclosure in Zelst
wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;	By allowing for channel estimation for multiple transmitters, MIMO or space-time coding techniques can be supported to achieve 802.11a extensions. One way to do this is by sending a different set of subcarriers from each transmitter. As an example, for the case of two transmitters, a device might modulate its OFDM subcarriers with the 64 values of L3, shown in FIG. 4, where one transmitter transmits the odd subcarriers {1, 3, . . . , 63} and the other transmitter transmits the even subcarriers {0, 2, . . . , 62}. Thus, one transmitter would take an IFFT of the odd subcarriers and transmit samples of that time varying signal and the other transmitter would take an IFFT of the even subcarriers and transmit samples of that time varying signal. Notice that it typically does not matter for a single-channel 20 MHz receiver whether the out-of-band subcarriers depicted in FIGS. 5-7 are attenuated. For instance, if a single-channel receiver demodulates channel 2 out of the 4 transmitted channels shown in FIG. 7, the receive filter of that single-channel receiver will partly attenuate the out-of-band subcarriers as well as suppress the adjacent channels 1 and 3 to the point where these adjacent channels do not cause interference to the desired signal of channel 2. <i>Id.</i> at 6:36-51: Various methods can be available for a receiver to detect from a received signal whether a transmitter transmitted a conventional 802.11a packet or an extended mode packet. One method for detecting what type of packet was sent will now be described. In this method, enough of the signal is received to identify what should be the two repeated long training symbols, typically sampled as two identical repetitions of 64 samples for each receive antenna. An FFT (fast-Fourier transform) of the sum of the two identical repetitions of 64 samples is taken, generating an output sequence $s_i(k)$, comprising 64 complex values per receive antenna, containing channel amplitudes and phases, as well as phase shifts caused by the long training symbol sequence that was actually used (e.g., sequences such as L1, L2, L3 or L4). <i>Id.</i> at 7:63-8:8: The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of

Claim Elements	Disclosure in Zelst
	the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. <i>Id.</i> at 8:18-43: Interoperability between the different extended modes can be ensured by transmitting the same preamble and signal field in each 20 MHz channel. The preamble time structure can be the same as that of IEEE 802.11a, as illustrated in FIG. 1. For a 20 MHz MIMO transmitter, the long training symbol L can be modified to facilitate MIMO channel estimation and include out-of-band pilots. In one example of an extended transmitter using a plurality of channels, the transmitter transmits an identical copy of the preamble and signal field in each 20 MHz channel used by that transmitter where the out-of-band pilots only have to be attenuated at the edges of a multi-channel and not between adjacent channels of the multi-channel. The subcarriers of the signal field might contain different data bits for different 20 MHz channels, to signal information such as the transmitter's multi-band mode, MIMO mode, channel number, data rate, and/or coding rate. By transmitting the same preamble and signal field in any 20 MHz channel, it is ensured that an extended device that only demodulates one 20 MHz channel at least is able to decode the signal field. From the information in the signal field, the single-channel extended device can either properly defer for the duration of the packet or find out what extended mode is used for this packet in the case that this information is encoded in the signal field. For instance, the receiver could detect from the signal field that the packet is transmitted over four adjacent channels, after which the extended receiver can decide to switch to a four-channel receiving mode. <i>Id.</i> at 9:21-38: A novel way of enabling coexistence or furthering coexistence for MIMO packets is to apply a cyclic delay shift on the long training symbol and Signal field IFFT outputs prior to applying the guard time extension. For example, assume $L(k)$ and $D(k)$ are the 64 subcarrier values for the long training symbol and Signal field symbol, respectively. For a conventional 802.11a single transmitter transmission, the time samples for the long training symbol are derived by taking the 64-point IFFT of $L(k)$ to obtain $l(i)$ and transmitting the samples of $l(i)$. Thus, with the guard time, the long training symbol and guard time are constructed as $[l(32:63) \ l(0:63) \ l(0:63)]$, i.e., the IFFT output is repeated twice and the last 32 samples

Claim Elements	Disclosure in Zelst
	are prepended to form the long training guard interval. As with the conventional timing, the long training guard interval (32 samples) is twice as long as the guard interval for 802.11a data symbols (16 samples). The signal field is formed by $[d(48:63) d(0:63)]$, where $d(0:63)$ are the 64 samples of the IFFT of $D(k)$. <i>Id.</i> at 11:32-59: To be able to decode the signal field without knowing the number of transmit antennas in advance, the signal field, SIG N, is kept the same for each transmit antennas, except that it has the same cyclic shift as that appended to the ELT symbols of that transmit antenna. Accordingly, the SIG N may be decoded using a SIMO (Single-Input Multiple-Output) training. In other words, training for the decoding of SIG N is performed assuming that the ELT sequence is transmitted from a single transmit antenna. The exemplary preambles disclosed in FIGS. 9A, 9B, and 9C provide a number of advantages. First, the 20 microseconds duration of the preamble is relatively short, particularly for systems with three or four transmit antennas, hence a low overhead. Second, the selected cyclic shifts ensure that the power seen by the receiver is not affected by channel constructive or destructive combining. Therefore, automatic gain control may be carried out effectively throughout the preamble. Third, since the impulse responses can be separated in time, the number of spatial streams may be identified by the preamble thus enabling the receiver to identify the number of spatial channels of the MIMO. Fourth, the signal field occurs in the same place, notwithstanding the number of spatial streams. Fifth, the signal field may be decoded by estimating the sum of all the spatial channels (as if it was sent from just one transmitter), and using the sum to decode the data in the signal field. Therefore, the signal field may be decoded the same way for any type of packet, whether it is a MIMO packet (any number of streams) or a SISO packet. <i>Id.</i> at 15:49-63: FIG. 16A (also shown in FIG. 2 as the sequence L4 except that the DC tone in sequence L4 is disposed at the beginning of the sequence) shows the 128 tones of an ELT sequence 1300 adapted for a 40 MHz channel, in accordance with one embodiment of the present invention. Accordingly, energy is transmitted on every single tone except the DC tone. ELT sequence 1400 includes the tones disposed in the 802.11a long-training sequence, shown in FIG. 16B. ELT sequence 1300 carries, next to the two copies of the 802.11a on subcarrier indices $-64, \dots, -59$ the values $-1, -1, 1, 1, 1, 1$, on subcarrier index -32 the value -1, on subcarrier indices $-5, \dots, -1$ the values $-1, -1, -1, 1, -1$, on subcarrier indices $1, \dots, 5$,

Claim Elements	Disclosure in Zelst
	the values -1, 1, 1, 1, 1, on subcarrier index 32 the value -1, and on subcarrier indices 58, . . . , 63 the values -1, -1, -1, 1, -1. <i>Id.</i> at Figs. 16A, 16B: <pre>{ -1, -1, 1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, -1, 1, -1, -1, 1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, -1, 0, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, 1, -1, 1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, -1 }</pre> FIG. 16A FIG. 16B <i>Id.</i> at 17:23-26: The above embodiments of the present invention are illustrative and not limiting. Various alternatives and equivalents are possible. The invention is not limited by the type of encoding, decoding, modulation, demodulation, equalization, filtering, etc., performed.
[1.C] receive, in a second wider frequency band, by the receiver	Zelst discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following:

Id. at Figs. 16A, 16B:

1300

{ -1, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1,
-1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1,
-1, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1,
1, -1, -1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, -1,
0, -1, 1, 1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1,
-1, 1, 1, 1, 1, -1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1,
-1, 1, -1, -1, 1, 1, -1, 1, -1, 1, -1, -1, -1, -1, 1, 1,
1, -1, 1, 1, -1, 1, -1, 1, 1, 1, 1, -1, -1, -1, 1, -1, }

FIG. 16A

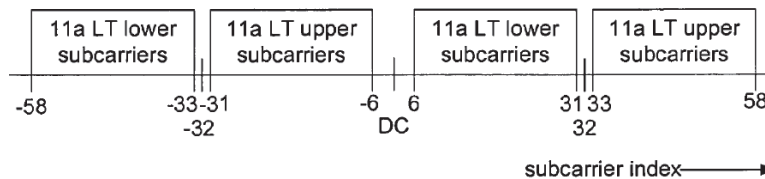


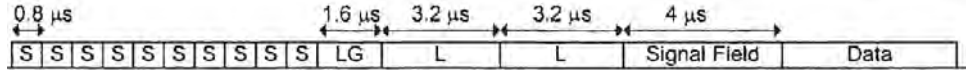
FIG. 16B

Id. at 17:23-26:

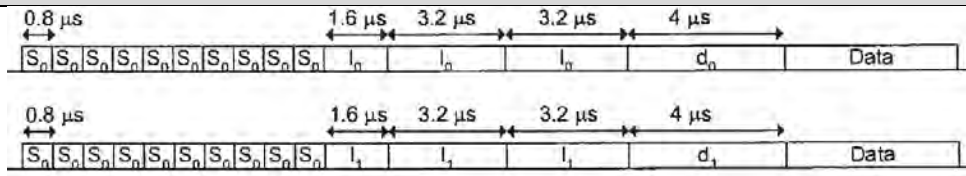
The above embodiments of the present invention are illustrative and not limiting. Various alternatives and equivalents are possible. The invention is not limited by the type of encoding, decoding, modulation, demodulation, equalization, filtering, etc., performed.

[1.C] receive, in a second wider frequency band, by the receiver

Zelst discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following:

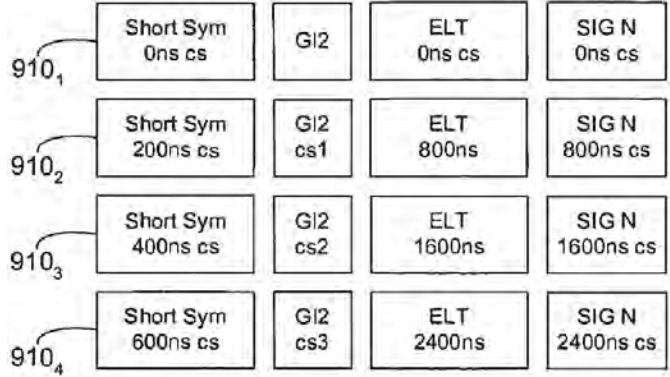
Claim Elements	Disclosure in Zelst
using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	<i>See, e.g., Zelst at 2:1-14:</i> The IEEE 802.11a standard defines a 20 microsecond long preamble with a structure as shown in FIG. 1, having short training symbols S (0.8 microseconds each), a guard interval LG, long training symbols L (3.2 microseconds each) and a signal field (4 microseconds). The preamble is followed by data. The first eight microseconds comprises ten identical short training symbols that are used for packet detection, automatic gain control and coarse frequency estimation. The second eight microseconds comprise two identical long training symbols, L, preceded by a guard interval LG that is the same pattern as the last half (1.6 microseconds) of the long training symbol L. The long training symbols can be used for channel estimation, timing, and fine frequency estimation. <i>Id.</i> at Fig. 1:  FIG. 1 (PRIOR ART) <i>Id.</i> at 5:2-21: Multi-channel extended 802.11 systems might simultaneously transmit on several 20 MHz channels, whereas a legacy 802.11a system only transmits on a single 20 MHz channel using a single antenna, or if the legacy system does transmit with more than one antenna, each of the antennas transmits the same 802.11a signal, possibly with some delay differences between signals. As a result, data rates can be increased over 802.11a data rates using multiple transmit antennas or multiple channels or a combination of both. Thus, in a communication channel, such as the airspace of a wireless network cloud, several types of packets might be present: 1) Legacy SISO (single-input, single-output) 802.11a, 802.11b, or 802.11g packets transmitted in a single 20 MHz channel; 2) Extended SISO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) 3) Extended MIMO in a single 20 MHz channel; 4) Extended MIMO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels)

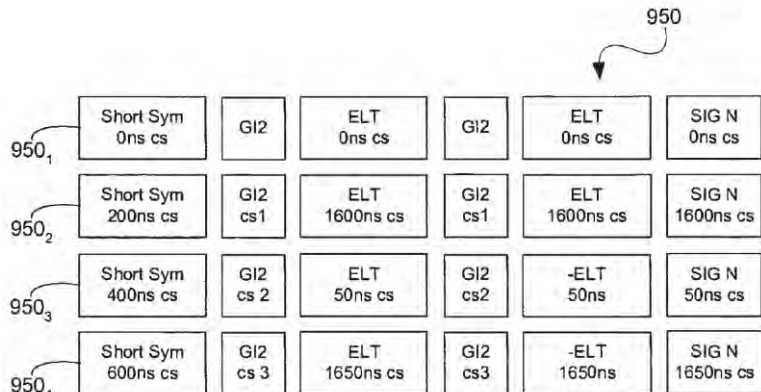
Claim Elements	Disclosure in Zelst
	<i>Id.</i> at 5:53-65: By allowing for channel estimation for multiple transmitters, MIMO or space-time coding techniques can be supported to achieve 802.11a extensions. One way to do this is by sending a different set of subcarriers from each transmitter. As an example, for the case of two transmitters, a device might modulate its OFDM subcarriers with the 64 values of L_3, shown in FIG. 4, where one transmitter transmits the odd subcarriers $\{1, 3, \dots, 63\}$ and the other transmitter transmits the even subcarriers $\{0, 2, \dots, 62\}$. Thus, one transmitter would take an IFFT of the odd subcarriers and transmit samples of that time varying signal and the other transmitter would take an IFFT of the even subcarriers and transmit samples of that time varying signal. <i>Id.</i> at 7:60-8:8: One example of a modified preamble is the preamble shown in FIG. 1 modified as shown in FIG. 8. The long training symbol values for these out-of-band subcarriers can be the same as in the case of FIG. 1. The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. FIG. 8 shows a preamble for a two transmitter MIMO packet. The structure is the same as for 802.11a, but some differences are that a) l_0, l_1, d_0, d_1 may contain out-of-band subcarriers, b) s_1, l_1, d_1 can be cyclically shifted relative to s_0, l_0, d_0 or c) l_0 and l_1 can contain subcarrier sequences that have a low cross-correlation with the same subcarrier sequences of the 802.11a long training symbol sequence. <i>Id.</i> at Fig. 8:

Claim Elements	Disclosure in Zelst
	 FIG. 8 <i>Id.</i> at 10:23-11:59: FIGS. 9A, 9B and 9C show modified preambles (also referred to alternatively as training sequences) configured for transmission via systems having two, three, and four transmit antennas respectively, in accordance with one embodiment of the present invention. Modified preamble 900 of FIG. 9A includes two preamble parts, namely preamble part 910 1 transmitted from the first antenna and preamble part 910 2 transmitted from the second antenna of a two-transmit antenna system. In the following, preamble parts are alternatively referred to as preambles. The short symbols of preamble 910 2 have a cyclic shift of 400 ns with respect to the short symbols of preamble 910 1. The extended long training (ELT) sequence of preamble 910 2 has a cyclic shift of 1600 ns with respect to the ELT sequence of preamble 910 1. Similarly, the Signal field of preamble 910 2 has a cyclic shift of 1600 ns with respect to the Signal field of preamble 910 1. Other cyclic shifts per preamble part may be used. As described above, the combined duration for transmitting the short training sequence, guard intervals, long training sequence, and signal fields, is 20 μs. Preamble 910 1 includes short training sequence 920 1, a guard interval GI 925 1, ELT sequence 930 1 and a Signal field SIG 935 1. Similarly, preamble 910 2 includes short training sequence 920 2, a guard interval GI 925 2, ELT sequence 930 2 and a Signal field SIG 935 2. The GI 925 1 and 925 2 are obtained by taking the last 32 samples (at 20 MHz sampling rate) of ELT 930 1 and 930 2, respectively. Referring to FIG. 9B, preambles 910 1 is transmitted from the first antenna, preamble 910 2 is transmitted from the second antenna, and preamble 910 3 is transmitted from the third antenna of a communication system having three transmit antennas. The short sequence of preamble 910 2 have a cyclic shift of 200 ns with respect to the short sequence of preamble 910 1. The ELT sequence of

Claim Elements	Disclosure in Zelst
	preamble 910 2 has a cyclic shift of 1050 ns with respect to the ELT sequence of preamble 910 1. Similarly, the Signal field of preamble 910 2 has a cyclic shift of 1050 ns with respect to the Signal field of preamble 910 1. The short sequence of preamble 910 3 have a cyclic shift of 400 ns with respect to the short sequence of preamble 910 1. The ELT sequence of preamble 910 3 have a cyclic shift of 2100 ns with respect to the ELT sequence of preamble 910 1. Similarly, the Signal field of preamble 910 3 has a cyclic shift of 2100 ns with respect to the Signal field of preamble 910 1. Other cyclic shifts per preamble part may be used. The short-training sequence in each of the above preambles may or may not be the same as the legacy short training sequence defined by the 802.11a standard. Similarly, the ELT sequence may be the same as the legacy long training sequence or any one of the ELT sequences described. As describe above, the time span of the ELT sequence is divided by the number of transmit antennas from which cyclic shifts are derived. For example, with respect to the IEEE 802.11a preamble, the time span of the long training sequence, excluding the guard interval, is 3.2 μs. In the following, it is assumed that the N_s spatial streams are directly mapped onto the N_t transmit antennas, i.e., $N_s=N_t$, although it is understood that the present invention may be readily applied to more general space-time-frequency mappings where the N_s spatial streams are not directly mapped to the N_t transmit antennas. Furthermore, it is assumed that the cyclic shift on the first transmit antenna is 0, however, values other than 0 are also possible. As is shown above, when there are two transmit antennas, i.e., $N_t=2$, the cyclic shift on the second transmit antenna may be $3.2/2=1.6$ μs. When there are three transmit antenna, $N_t=3$, the cyclic shift on the second and third transmit antennas two may be, respectively, 1.05 μs and 2.1 μs. For $N_t=4$, the cyclic shift on the second, third, and fourth transmit antennas may be, respectively, $3.2/4=0.8$ μs, $2*3.2/4=1.6$ μs, and $3*3.2/4=2.4$ μs, as shown in FIG. 9C. The long-training sequence per transmit antenna may be the same as that of the EEEE 802.11a standard (FIG. 1), including two consecutive long training symbols. The corresponding cyclic shift associated with each transmit antenna and which is appended with a cyclic extension of 1.6 μs, forms the cyclically-shifted ELT symbols for that transmit antenna. To be able to decode the signal field without knowing the number of transmit antennas in advance, the signal field, SIG N, is kept the same for each transmit antennas, except that it has the same cyclic shift as that appended to the ELT symbols of that transmit antenna. Accordingly, the SIG N may be decoded

Claim Elements	Disclosure in Zelst																				
	using a SIMO (Single-Input Multiple-Output) training. In other words, training for the decoding of SIG N is performed assuming that the ELT sequence is transmitted from a single transmit antenna. The exemplary preambles disclosed in FIGS. 9A, 9B, and 9C provide a number of advantages. First, the 20 microseconds duration of the preamble is relatively short, particularly for systems with three or four transmit antennas, hence a low overhead. Second, the selected cyclic shifts ensure that the power seen by the receiver is not affected by channel constructive or destructive combining. Therefore, automatic gain control may be carried out effectively throughout the preamble. Third, since the impulse responses can be separated in time, the number of spatial streams may be identified by the preamble thus enabling the receiver to identify the number of spatial channels of the MIMO. Fourth, the signal field occurs in the same place, notwithstanding the number of spatial streams. Fifth, the signal field may be decoded by estimating the sum of all the spatial channels (as if it was sent from just one transmitter), and using the sum to decode the data in the signal field. Therefore, the signal field may be decoded the same way for any type of packet, whether it is a MIMO packet (any number of streams) or a SISO packet. <i>Id.</i> at Figs. 9A, 9B, 9C: 900 920 925 930 935 910₁ 910₂ <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs1</td><td>ELT 1600ns cs</td><td>SIG N 1600ns cs</td></tr></table> Fig. 9A 910₁ 910₂ 910₃ <table><tr><td>Short Sym 0ns cs</td><td>GI2</td><td>ELT 0ns cs</td><td>SIG N 0ns cs</td></tr><tr><td>Short Sym 200ns cs</td><td>GI2 cs1</td><td>ELT 1050ns</td><td>SIG N 1050ns cs</td></tr><tr><td>Short Sym 400ns cs</td><td>GI2 cs2</td><td>ELT 2100ns</td><td>SIG N 2100ns cs</td></tr></table> Fig. 9B	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs	Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs	Short Sym 200ns cs	GI2 cs1	ELT 1050ns	SIG N 1050ns cs	Short Sym 400ns cs	GI2 cs2	ELT 2100ns	SIG N 2100ns cs
Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs																		
Short Sym 400ns cs	GI2 cs1	ELT 1600ns cs	SIG N 1600ns cs																		
Short Sym 0ns cs	GI2	ELT 0ns cs	SIG N 0ns cs																		
Short Sym 200ns cs	GI2 cs1	ELT 1050ns	SIG N 1050ns cs																		
Short Sym 400ns cs	GI2 cs2	ELT 2100ns	SIG N 2100ns cs																		

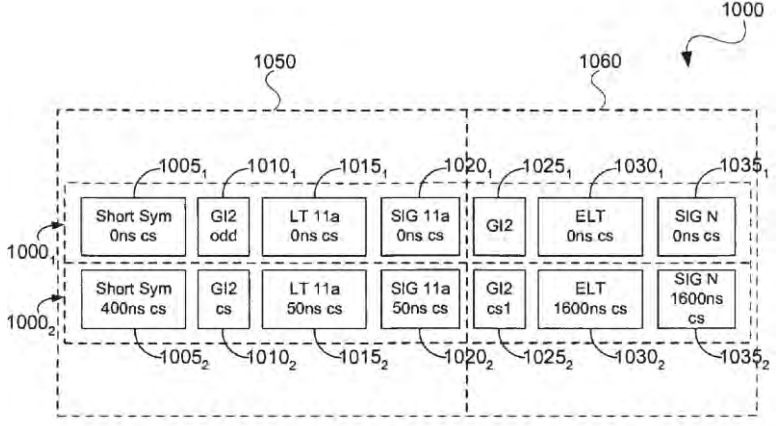
Claim Elements	Disclosure in Zelst
	 Fig. 9C <i>Id.</i> at 11:60-12:30: FIG. 10 shows a modified preamble 950 adapted for a four-transmit antenna, in accordance with one embodiment of the present invention. Modified preamble 950 includes four preambles 950 1, 950 2, 950 3, and 950 4 that are respectively transmitted from the first, second, third, and fourth transmit antennas (not shown). Each of the preambles 950 1, 950 2, 950 3, and 950 4 includes a short training sequence, a Guard interval, a first ELT sequence, which includes two or more consecutive symbols, a second guard interval, a second ELT sequence, and a signal field. It is understood that for a system with three transmit antenna, preamble 950 includes preambles 950 1, 950 2, 950 3, and for a system with two transmit antennas, preamble 950 includes preambles 950 1, 950 2. Each ELT sequence includes, in turn, two ore more consecutive symbols (collectively referred to as a symbol). As is shown in FIG. 10, the short training sequences (alternatively referred to herein as short training sequence field) of 950 4, 950 3, and 950 2 have cyclic shifts of 600 nsec, 400 nsec, and 200 nsec, respectively with respect to the short training sequence fields 950 1. The first ELT sequence field of 950 2 has a cyclic shift of 1600 nsec with respect to the first ELT sequence field of 950 1. The first ELT sequence field of 950 3 has a cyclic shift of 50 nsec with respect to the first ELT sequence field of 950 1. The first ELT sequence field of 950 4 has a cyclic shift of 1650 nsec with respect to the first ELT sequence field of 950 1. The second ELT sequence field of 950 2 has a cyclic shift of 1600 nsec with respect to the second ELT sequence field of 950 1. The second ELT sequence field of 950 3 has a cyclic

Claim Elements	Disclosure in Zelst
	shift of 50 nsec with respect to the second ELT sequence field of 950 1. The second ELT sequence field of 950 4 has a cyclic shift of 1650 nsec with respect to the first ELT sequence field of 950 1. The Signal field of 950 2 has a cyclic shift of 1600 nsec with respect to the signal field of 950 1. The signal field of 950 3 has a cyclic shift of 50 nsec with respect to the signal field of 950 1. The signal field of 950 4 has a cyclic shift of 1650 nsec with respect to the signal field of ELT sequence of 950 1. In the following, the ELT sequence field is alternatively referred to as ELT sequence. <i>Id.</i> at Fig. 10:  Fig. 10 <i>Id.</i> at 13:30-14:5: FIG. 12 shows a modified preamble 970 configured for transmission via a system having four transmit antennas (not shown), in accordance with another embodiment of the present invention. Preamble 970 includes preamble part 970 1, 970 2, 970 3, and 970 4, each of which parts include two guard intervals and two extended long training sequences. The short training sequences of preamble parts 970 2, 970 3, and 970 4 have respective cyclic shifts of 200 nsec, 400 nsec, and 600 nsec with respect to the short training sequence of preamble part 970 1. The guard intervals of preamble part 970 1 are generated by taking the last part of the time-domain representation of the odd tones of the long training sequence or ELT sequence of preamble part 970 1, and the guard intervals of preamble part 970 2 are similarly

Claim Elements	Disclosure in Zelst
	obtained by taking the last part of the time-domain representation of the long training sequence or ELT sequence of preamble part 970 2. Each of the first and second ELT sequences of preamble 970 1 includes only the odd tones and each of the first and second ELT sequences of preamble 970 2 includes only the modified even tones, i.e., even tone modified by the pattern $\{1, -1, 1, -1, 1, -1 \dots\}$. The first and second ELT sequences of preamble 970 3 include only the odd tones that are cyclically shifted with respect to the corresponding ELT sequence of preamble 970 2 by 50 nsec. The first and second ELT sequences of preamble 970 4 include only the modified even tones that are cyclically shifted with respect to the corresponding ELT sequence of preamble 970 3 by 50 nsec. Moreover, a Walsh code is used such that the first and second ELT sequences of preamble 970 1 and 970 2 and the first ELT sequences of preamble 970 3 and 970 4 are multiplied by 1, and the second ELT sequences of preamble 970 3 and 970 4 are multiplied by -1. This allows for separation between TX1 and TX2 on one side and TX3 and TX4 on the other side. The cyclic shift is used to further the channel training from TX1 and TX2, and TX3 and TX4, respectively. The signal field of preamble 970 1 includes only the odd tones, and the signal field of preamble 970 2 includes only the modified even tones. The signal field of preamble 970 3 includes only the odd tones and has a cyclic shift of 50 nsec with respect to the signal field of preamble 970 2. The signal field of preamble 970 4 includes only the modified even tones and has a cyclic shift of 50 nsec with respect to the signal field of preamble 970 3. <i>Id.</i> at Fig. 12:

Claim Elements	Disclosure in Zelst
	Fig. 12 <i>Id.</i> at 14:6-15:5: In accordance with some embodiments of the present invention, a mixed-mode preamble includes legacy as well as modified preambles. FIG. 13 shows an exemplary mixed-mode preamble 1000 configured for transmission from a system having two-transmit antennas, in accordance with one embodiment of the present invention. Exemplary mixed mode preamble 1000 includes legacy 802.11a/g preamble portion 1050, that may be modified to indicate that an extended training part is appended, e.g., by setting the reserved bit of the legacy signal field, as well as a modified preamble portion 1060, as described above. Mixed mode preamble 1000 includes preamble 1000 1 that is transmitted from the first antenna and preamble 1000 2 that is transmitted from the second antenna. Short training sequence 1005 1, guard interval 1010 1, long training sequence 1015 1, and signal field 1020 1 in combination form a legacy 802.11a/g preamble portion of preamble 1000 1 that is transmitted from the first transmit antenna. Guard interval 1025 1, ELT sequence 1030 1, and Signal field 1035 1 form the modified (extended) preamble portion of 1000 1. Similarly, short training sequence 1005 2, guard interval 1010 2, long training sequence 1015 2, and signal field 1020 2 in combination form a legacy 802.11a/g preamble portion of preamble 1000 2 that is transmitted from the first transmit antenna. Guard interval 1025 2, ELT sequence 1030 2, and Signal field 1035 2 form the extended preamble portion of preamble 1000 2 that is transmitted from the second antenna.

Claim Elements	Disclosure in Zelst
	The various fields of the 802.11a/g preamble portion of preamble 1000 2 are cyclically shifted with respect to the various fields of the 802.11a/g preamble portion of preamble 1000 1. Similarly, the various fields of the extended preamble portion of preamble 1000 2 are cyclically shifted with respect to the various fields of the extended preamble portion of preamble 1000 1. For example, in the exemplary embodiment shown in FIG. 13, the short training sequence 1005 2 of the second transmit antenna have a cyclic shift of 400 nsec with respect to the short training sequence 1005 1 of the first transmit antenna. Similarly, the long training sequence 1015 2 of the second transmit antenna has a cyclic shift of 50 nsec with respect to the long training sequence 1015 1 of the first transmit antenna. The Signal field 1020 2 of the second transmit antenna has a cyclic shift of 50 nsec with respect to the Signal field 1020 1 of the first transmit antenna. The ELT sequence 1030 2 of the second transmit antenna has a cyclic shift of 1600 nsec with respect to the ELT sequence 1030 1 of the first transmit antenna. The Signal field 1035 2 of the second transmit antenna has a cyclic shift of 1600 nsec with respect to the Signal field 1035 1 of the first transmit antenna. The extended preamble portions of preamble 1000, namely those identified by reference numerals 1020 1, 1025 1, 1030 1, 1035 1 of the first transmit antenna as well as 1020 2, 1025 2, 1030 2, 1035 2 of the second transmit antenna provide efficient training symbols for many systems, such MIMO OFDM systems. Therefore, when legacy devices as well as extended devices, like MIMO OFDM devices, are also part of the network, both the legacy as well as the extended devices are able to receive and process the preambles. Through the use of one or more bits of the preamble, (e.g., by setting the reserved bit in the signal field of the legacy portion of the preamble) or by auto-detecting that a second training sequence follows the legacy signal field, extended devices are triggered that enable, for example, channel estimation after the legacy portion of the preamble is received. One advantage of having a modified preamble following a legacy preamble is PHY level backwards compatibility. Hence, no MAC protection mechanisms are needed to communicate at extended rates, leading to enhanced efficiency. <i>Id.</i> at Fig. 13:

Claim Elements	Disclosure in Zelst
	 Fig. 13
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Zelst discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Zelst at 4:38-46:</i> Border 106 is not a physical border, but is shown to represent a space within which signals can be received from devices within the space. Thus, as one device transmits a signal representing a packet within border 106, other devices within border 106 pick up the signals and, as they are programmed, will attempt to determine if the signals represent packets and if so, then demodulate/decode the packets to obtain the data represented therein. <i>Id. at 5:53-6:5:</i> By allowing for channel estimation for multiple transmitters, MIMO or space-time coding techniques can be supported to achieve 802.11a extensions. One way to do this is by sending a different set of subcarriers from each transmitter. As an example, for the case of two transmitters, a device might modulate its OFDM subcarriers with the 64 values of L3, shown in FIG. 4, where one transmitter transmits the odd subcarriers {1, 3, . . . , 63} and the other transmitter transmits the even subcarriers {0, 2, . . . , 62}. Thus, one transmitter would take an IFFT of the odd subcarriers and transmit samples of that

Claim Elements	Disclosure in Zelst
	time varying signal and the other transmitter would take an IFFT of the even subcarriers and transmit samples of that time varying signal. Notice that it typically does not matter for a single-channel 20 MHz receiver whether the out-of-band subcarriers depicted in FIGS. 5-7 are attenuated. For instance, if a single-channel receiver demodulates channel 2 out of the 4 transmitted channels shown in FIG. 7, the receive filter of that single-channel receiver will partly attenuate the out-of-band subcarriers as well as suppress the adjacent channels 1 and 3 to the point where these adjacent channels do not cause interference to the desired signal of channel 2. <i>Id.</i> at 6:36-51: Various methods can be available for a receiver to detect from a received signal whether a transmitter transmitted a conventional 802.11a packet or an extended mode packet. One method for detecting what type of packet was sent will now be described. In this method, enough of the signal is received to identify what should be the two repeated long training symbols, typically sampled as two identical repetitions of 64 samples for each receive antenna. An FFT (fast-Fourier transform) of the sum of the two identical repetitions of 64 samples is taken, generating an output sequence $s_i(k)$, comprising 64 complex values per receive antenna, containing channel amplitudes and phases, as well as phase shifts caused by the long training symbol sequence that was actually used (e.g., sequences such as L1, L2, L3 or L4). <i>Id.</i> at 7:63-8:8: The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. <i>Id.</i> at 8:18-43:

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	Interoperability between the different extended modes can be ensured by transmitting the same preamble and signal field in each 20 MHz channel. The preamble time structure can be the same as that of IEEE 802.11a, as illustrated in FIG. 1. For a 20 MHz MIMO transmitter, the long training symbol L can be modified to facilitate MIMO channel estimation and include out-of-band pilots. In one example of an extended transmitter using a plurality of channels, the transmitter transmits an identical copy of the preamble and signal field in each 20 MHz channel used by that transmitter where the out-of-band pilots only have to be attenuated at the edges of a multi-channel and not between adjacent channels of the multi-channel. The subcarriers of the signal field might contain different data bits for different 20 MHz channels, to signal information such as the transmitter's multi-band mode, MIMO mode, channel number, data rate, and/or coding rate. By transmitting the same preamble and signal field in any 20 MHz channel, it is ensured that an extended device that only demodulates one 20 MHz channel at least is able to decode the signal field. From the information in the signal field, the single-channel extended device can either properly defer for the duration of the packet or find out what extended mode is used for this packet in the case that this information is encoded in the signal field. For instance, the receiver could detect from the signal field that the packet is transmitted over four adjacent channels, after which the extended receiver can decide to switch to a four-channel receiving mode. <i>Id.</i> at 11:32-59: To be able to decode the signal field without knowing the number of transmit antennas in advance, the signal field, SIG N, is kept the same for each transmit antennas, except that it has the same cyclic shift as that appended to the ELT symbols of that transmit antenna. Accordingly, the SIG N may be decoded using a SIMO (Single-Input Multiple-Output) training. In other words, training for the decoding of SIG N is performed assuming that the ELT sequence is transmitted from a single transmit antenna. The exemplary preambles disclosed in FIGS. 9A, 9B, and 9C provide a number of advantages. First, the 20 microseconds duration of the preamble is relatively short, particularly for systems with three or four transmit antennas, hence a low overhead. Second, the selected cyclic shifts ensure that the power seen by the receiver is not affected by channel constructive or destructive combining. Therefore, automatic gain control may be carried out effectively throughout the preamble. Third, since the impulse responses can be separated in time, the number of spatial streams may be identified by the preamble thus enabling the receiver to identify the number of spatial channels of the MIMO. Fourth, the signal field occurs in the

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	same place, notwithstanding the number of spatial streams. Fifth, the signal field may be decoded by estimating the sum of all the spatial channels (as if it was sent from just one transmitter), and using the sum to decode the data in the signal field. Therefore, the signal field may be decoded the same way for any type of packet, whether it is a MIMO packet (any number of streams) or a SISO packet. <i>Id.</i> at 17:23-26: The above embodiments of the present invention are illustrative and not limiting. Various alternatives and equivalents are possible. The invention is not limited by the type of encoding, decoding, modulation, demodulation, equalization, filtering, etc., performed.
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Zelst discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following: <i>See, e.g., Zelst</i> at 5:2-21: Multi-channel extended 802.11 systems might simultaneously transmit on several 20 MHz channels, whereas a legacy 802.11a system only transmits on a single 20 MHz channel using a single antenna, or if the legacy system does transmit with more than one antenna, each of the antennas transmits the same 802.11a signal, possibly with some delay differences between signals. As a result, data rates can be increased over 802.11a data rates using multiple transmit antennas or multiple channels or a combination of both. Thus, in a communication channel, such as the airspace of a wireless network cloud, several types of packets might be present: 1) Legacy SISO (single-input, single-output) 802.11a, 802.11b, or 802.11g packets transmitted in a single 20 MHz channel; 2) Extended SISO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) 3) Extended MIMO in a single 20 MHz channel; 4) Extended MIMO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) <i>Id.</i> at 7:60-8:8: The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial

Claim Elements	Disclosure in Zelst
	stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. <i>Id.</i> at 8:18-43: Interoperability between the different extended modes can be ensured by transmitting the same preamble and signal field in each 20 MHz channel. The preamble time structure can be the same as that of IEEE 802.11a, as illustrated in FIG. 1. For a 20 MHz MIMO transmitter, the long training symbol L can be modified to facilitate MIMO channel estimation and include out-of-band pilots. In one example of an extended transmitter using a plurality of channels, the transmitter transmits an identical copy of the preamble and signal field in each 20 MHz channel used by that transmitter where the out-of-band pilots only have to be attenuated at the edges of a multi-channel and not between adjacent channels of the multi-channel. The subcarriers of the signal field might contain different data bits for different 20 MHz channels, to signal information such as the transmitter's multi-band mode, MIMO mode, channel number, data rate, and/or coding rate. By transmitting the same preamble and signal field in any 20 MHz channel, it is ensured that an extended device that only demodulates one 20 MHz channel at least is able to decode the signal field. From the information in the signal field, the single-channel extended device can either properly defer for the duration of the packet or find out what extended mode is used for this packet in the case that this information is encoded in the signal field. For instance, the receiver could detect from the signal field that the packet is transmitted over four adjacent channels, after which the extended receiver can decide to switch to a four-channel receiving mode. <i>Id.</i> at 15:34-63: FIG. 15A (also shown in FIG. 2 as the sequence L2 except that the DC tone in sequence L2 is disposed at the beginning of the sequence) shows the 64 tones of an ELT sequence 1200 adapted for a 20 MHz channel, in accordance with one embodiment of the present invention. Accordingly, energy is transmitted on every single tone except the DC tone. ELT sequence 1200 includes the tones disposed in the 802.11a long-training sequence, shown in FIG. 15B. ELT sequence 1200 thus carries, next to the 802.11a

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	subcarrier information, on subcarrier indices 27, . . . , 31 the values -1, -1, -1, 1, -1, and on subcarrier indices -32, . . . , -27 the values -1, -1, 1, 1, 1, 1. The various tones of ELT sequence 1200 are selected such that the peak-to-average power of the ELT sequence 1200 is only a few tenths of a dB higher than the peak-to-average power of the 802.11a long training sequence. FIG. 16A (also shown in FIG. 2 as the sequence L4 except that the DC tone in sequence L4 is disposed at the beginning of the sequence) shows the 128 tones of an ELT sequence 1300 adapted for a 40 MHz channel, in accordance with one embodiment of the present invention. Accordingly, energy is transmitted on every single tone except the DC tone. ELT sequence 1400 includes the tones disposed in the 802.11a long-training sequence, shown in FIG. 16B. ELT sequence 1300 carries, next to the two copies of the 802.11a on subcarrier indices -64, . . . , -59 the values -1, -1, 1, 1, 1, 1, on subcarrier index -32 the value -1, on subcarrier indices -5, . . . , -1 the values -1, -1, -1, 1, -1, on subcarrier indices 1, . . . , 5, the values -1, 1, 1, 1, 1, on subcarrier index 32 the value -1, and on subcarrier indices 58, . . . , 63 the values -1, -1, -1, 1, -1.
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Zelst discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Zelst at 4:51-67:</i> Preferably, a modified preamble will be such that 1) an extended receiver (e.g., one that can advantageously handle modified preambles) can distinguish between MIMO packets (or other extended mode packets) and conventional 802.11a packets, 2) a legacy receiver (e.g., one that is not configured to receive and interpret the modified preambles and might not expect extended operations) can receive enough of a packet to determine either that the legacy receiver can understand the packet or can defer processing of incoming signals for a time, thereby allowing a measure of coexistence, 3) the modified preamble is usable for MIMO synchronization and channel estimation, and 4) the modified preamble is useful in a process of detecting the use of multi-channel transmission. In some embodiments of wireless devices according to the present invention, modified preambles are used that provide one, two, three or all of the preferable characteristics indicated above. <i>Id.</i> at 11:41-59: The exemplary preambles disclosed in FIGS. 9A, 9B, and 9C provide a number of advantages. First, the 20 microseconds duration of the preamble is relatively short, particularly for systems with three or four

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	transmit antennas, hence a low overhead. Second, the selected cyclic shifts ensure that the power seen by the receiver is not affected by channel constructive or destructive combining. Therefore, automatic gain control may be carried out effectively throughout the preamble. Third, since the impulse responses can be separated in time, the number of spatial streams may be identified by the preamble thus enabling the receiver to identify the number of spatial channels of the MIMO. Fourth, the signal field occurs in the same place, notwithstanding the number of spatial streams. Fifth, the signal field may be decoded by estimating the sum of all the spatial channels (as if it was sent from just one transmitter), and using the sum to decode the data in the signal field. Therefore, the signal field may be decoded the same way for any type of packet, whether it is a MIMO packet (any number of streams) or a SISO packet. <i>Id.</i> at 12:51-60: A modified preamble having two ELT sequences for each transmit antennas, as described above, provides a number of other advantages. First, the power drop per transmit stream is relatively small. Second, because the signal field appears at the end of the training sequence for each transmit stream, processing delays due to channel estimation are minimized and thus are more suitable for media access controller (MAC) options. Moreover, the minimum squared estimation (MSE) for channel estimation is the same for systems with two or four transmit antennas. <i>Id.</i> at 14:63-15:5: Through the use of one or more bits of the preamble, (e.g., by setting the reserved bit in the signal field of the legacy portion of the preamble) or by auto-detecting that a second training sequence follows the legacy signal field, extended devices are triggered that enable, for example, channel estimation after the legacy portion of the preamble is received. One advantage of having a modified preamble following a legacy preamble is PHY level backwards compatibility. Hence, no MAC protection mechanisms are needed to communicate at extended rates, leading to enhanced efficiency. <i>Id.</i> at 16:10-22: FIG. 18 shows a modified signal field 1600, in accordance with one embodiment of the present invention. Signal field 1600 uses a higher constellation density than 802.11a/g. Signal field 1600 uses quadrature phase shift keying (QPSK) instead of binary phase shift keying (BPSK) to maintain the duration of the signal field 4 us (same as 802.11a/g), while carrying twice the data. Signal field 1600 includes 48 bits, of which 6 bits are used to indicate the mode, 16 bits are used to indicate the length, 16

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	bits are used for CRC for error checking, 1 bit is used to indicate the last PSDU of frame, 3 bits are reserved bits, and 6 bits are set to zero to allow the convolutional encoder as specified in the 802.11a standard to return to the zero state.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	Zelst discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Zelst at 4:51-67:</i> Preferably, a modified preamble will be such that 1) an extended receiver (e.g., one that can advantageously handle modified preambles) can distinguish between MIMO packets (or other extended mode packets) and conventional 802.11a packets, 2) a legacy receiver (e.g., one that is not configured to receive and interpret the modified preambles and might not expect extended operations) can receive enough of a packet to determine either that the legacy receiver can understand the packet or can defer processing of incoming signals for a time, thereby allowing a measure of coexistence, 3) the modified preamble is usable for MIMO synchronization and channel estimation, and 4) the modified preamble is useful in a process of detecting the use of multi-channel transmission. In some embodiments of wireless devices according to the present invention, modified preambles are used that provide one, two, three or all of the preferable characteristics indicated above. <i>Id. at 7:60-8:8:</i> The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. <i>Id. at 11:32-59:</i>

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	To be able to decode the signal field without knowing the number of transmit antennas in advance, the signal field, SIG N, is kept the same for each transmit antennas, except that it has the same cyclic shift as that appended to the ELT symbols of that transmit antenna. Accordingly, the SIG N may be decoded using a SIMO (Single-Input Multiple-Output) training. In other words, training for the decoding of SIG N is performed assuming that the ELT sequence is transmitted from a single transmit antenna. The exemplary preambles disclosed in FIGS. 9A, 9B, and 9C provide a number of advantages. First, the 20 microseconds duration of the preamble is relatively short, particularly for systems with three or four transmit antennas, hence a low overhead. Second, the selected cyclic shifts ensure that the power seen by the receiver is not affected by channel constructive or destructive combining. Therefore, automatic gain control may be carried out effectively throughout the preamble. Third, since the impulse responses can be separated in time, the number of spatial streams may be identified by the preamble thus enabling the receiver to identify the number of spatial channels of the MIMO. Fourth, the signal field occurs in the same place, notwithstanding the number of spatial streams. Fifth, the signal field may be decoded by estimating the sum of all the spatial channels (as if it was sent from just one transmitter), and using the sum to decode the data in the signal field. Therefore, the signal field may be decoded the same way for any type of packet, whether it is a MIMO packet (any number of streams) or a SISO packet. <i>Id.</i> at 12:51-60: A modified preamble having two ELT sequences for each transmit antennas, as described above, provides a number of other advantages. First, the power drop per transmit stream is relatively small. Second, because the signal field appears at the end of the training sequence for each transmit stream, processing delays due to channel estimation are minimized and thus are more suitable for media access controller (MAC) options. Moreover, the minimum squared estimation (MSE) for channel estimation is the same for systems with two or four transmit antennas. <i>Id.</i> at 14:63-15:5: Through the use of one or more bits of the preamble, (e.g., by setting the reserved bit in the signal field of the legacy portion of the preamble) or by auto-detecting that a second training sequence follows the legacy signal field, extended devices are triggered that enable, for example, channel estimation after the legacy portion of the preamble is received. One advantage of having a modified preamble following a

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	legacy preamble is PHY level backwards compatibility. Hence, no MAC protection mechanisms are needed to communicate at extended rates, leading to enhanced efficiency. <i>Id.</i> at 16:10-22: FIG. 18 shows a modified signal field 1600, in accordance with one embodiment of the present invention. Signal field 1600 uses a higher constellation density than 802.11a/g. Signal field 1600 uses quadrature phase shift keying (QPSK) instead of binary phase shift keying (BPSK) to maintain the duration of the signal field 4 us (same as 802.11a/g), while carrying twice the data. Signal field 1600 includes 48 bits, of which 6 bits are used to indicate the mode, 16 bits are used to indicate the length, 16 bits are used for CRC for error checking, 1 bit is used to indicate the last PSDU of frame, 3 bits are reserved bits, and 6 bits are set to zero to allow the convolutional encoder as specified in the 802.11a standard to return to the zero state.
[4] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	Zelst discloses that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Zelst</i> at 5:2-21: Multi-channel extended 802.11 systems might simultaneously transmit on several 20 MHz channels, whereas a legacy 802.11a system only transmits on a single 20 MHz channel using a single antenna, or if the legacy system does transmit with more than one antenna, each of the antennas transmits the same 802.11a signal, possibly with some delay differences between signals. As a result, data rates can be increased over 802.11a data rates using multiple transmit antennas or multiple channels or a combination of both. Thus, in a communication channel, such as the airspace of a wireless network cloud, several types of packets might be present: 1) Legacy SISO (single-input, single-output) 802.11a, 802.11b, or 802.11g packets transmitted in a single 20 MHz channel; 2) Extended SISO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) 3) Extended MIMO in a single 20 MHz channel; 4) Extended MIMO in multiple 20 MHz channels (e.g., 40, 60, 80, or 100 MHz channels) <i>Id.</i> at 7:60-8:8:

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	The long training symbol is followed by a replica of the Signal field with identical subcarrier values in each of the 20 MHz channels overlaid by the same effects (e.g., time-domain cyclic shift or frequency-domain scrambling pattern) as the long training symbol of the corresponding transmit antenna or spatial stream. This ensures that a receiver that operates on just one of the 20 MHz channels will still be able to successfully decode at least the first part of the packet containing the Signal field and defer for the rest of the packet, as decoding the Signal field provides the receiver with information about the length of the packet and thus how long to defer. The same technique can be extended to an arbitrary number of channels. <i>Id.</i> at 8:18-43: Interoperability between the different extended modes can be ensured by transmitting the same preamble and signal field in each 20 MHz channel. The preamble time structure can be the same as that of IEEE 802.11a, as illustrated in FIG. 1. For a 20 MHz MIMO transmitter, the long training symbol L can be modified to facilitate MIMO channel estimation and include out-of-band pilots. In one example of an extended transmitter using a plurality of channels, the transmitter transmits an identical copy of the preamble and signal field in each 20 MHz channel used by that transmitter where the out-of-band pilots only have to be attenuated at the edges of a multi-channel and not between adjacent channels of the multi-channel. The subcarriers of the signal field might contain different data bits for different 20 MHz channels, to signal information such as the transmitter's multi-band mode, MIMO mode, channel number, data rate, and/or coding rate. By transmitting the same preamble and signal field in any 20 MHz channel, it is ensured that an extended device that only demodulates one 20 MHz channel at least is able to decode the signal field. From the information in the signal field, the single-channel extended device can either properly defer for the duration of the packet or find out what extended mode is used for this packet in the case that this information is encoded in the signal field. For instance, the receiver could detect from the signal field that the packet is transmitted over four adjacent channels, after which the extended receiver can decide to switch to a four-channel receiving mode. <i>Id.</i> at 15:34-63: FIG. 15A (also shown in FIG. 2 as the sequence L2 except that the DC tone in sequence L2 is disposed at the beginning of the sequence) shows the 64 tones of an ELT sequence 1200 adapted for a 20 MHz

Claim Elements	Disclosure in Zelst
	channel, in accordance with one embodiment of the present invention. Accordingly, energy is transmitted on every single tone except the DC tone. ELT sequence 1200 includes the tones disposed in the 802.11a long-training sequence, shown in FIG. 15B. ELT sequence 1200 thus carries, next to the 802.11a subcarrier information, on subcarrier indices 27, . . . , 31 the values -1, -1, -1, 1, -1, and on subcarrier indices -32, . . . , -27 the values -1, -1, 1, 1, 1, 1. The various tones of ELT sequence 1200 are selected such that the peak-to-average power of the ELT sequence 1200 is only a few tenths of a dB higher than the peak-to-average power of the 802.11a long training sequence. FIG. 16A (also shown in FIG. 2 as the sequence L4 except that the DC tone in sequence L4 is disposed at the beginning of the sequence) shows the 128 tones of an ELT sequence 1300 adapted for a 40 MHz channel, in accordance with one embodiment of the present invention. Accordingly, energy is transmitted on every single tone except the DC tone. ELT sequence 1400 includes the tones disposed in the 802.11a long-training sequence, shown in FIG. 16B. ELT sequence 1300 carries, next to the two copies of the 802.11a on subcarrier indices -64, . . . , -59 the values -1, -1, 1, 1, 1, 1, on subcarrier index -32 the value -1, on subcarrier indices -5, . . . , -1 the values -1, -1, -1, 1, -1, on subcarrier indices 1, . . . , 5, the values -1, 1, 1, 1, 1, on subcarrier index 32 the value -1, and on subcarrier indices 58, . . . , 63 the values -1, -1, -1, 1, -1.
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Zelst discloses that the wireless transceiver supports one or more wireless standards. For example, the reference discloses the following: <i>See, e.g., Zelst at 1:31-43:</i> The IEEE 802.11a standard defines data rates of 6 Mbps (megabits per second) up to 54 Mbps. For some applications, higher data rates for given modulations and data rates higher than 54 Mbps are desirable. Other extensions, such as the use of MIMO (multiple-input, multiple-output) antenna systems and other extensions might be desirable. In order to avoid conflicts with existing standardized communications and devices, extended devices that extend beyond the limits of the 802.11a standard and legacy devices that comply with the existing standard and are not necessarily aware of extended standards both need to coexist in a common communication space and even interoperate at times. <i>Id.</i> at 8:18-21:

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	Interoperability between the different extended modes can be ensured by transmitting the same preamble and signal field in each 20 MHz channel. The preamble time structure can be the same as that of IEEE 802.11a, as illustrated in FIG. 1. <i>Id.</i> at 15:9-13: Exemplary mixed mode preamble 1100 includes legacy 802.11a/g preamble portion 1110 as well as a modified preamble portion 1120. Legacy 802.11a/g preamble portion 1110 is similar to legacy 802.11a/g preamble portion 1050 of FIG. 13.
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim 1, preamble above.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a	See, e.g., claim 1, limitation 1.A above.

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first number of OFDM symbols;	
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.,</i> claim 1, limitation 1.B above.
[9.C] the wireless OFDM communications receiver further operable to receive a second	<i>See, e.g.,</i> claim 1, limitation 1.C above.

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packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.,</i> claim 1, limitation 1.D above.

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[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in Zelst
diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.,</i> Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.,</i> Claim 8 above.

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[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	<i>See, e.g.</i> , claim limitation 1.A above.
[17.B] demodulating, by a demodulator connected to the	<i>See, e.g.</i> , claim limitation 1.B above.

Claim Elements	Disclosure in Zelst
receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a	See, e.g., claim limitation 1.C above.

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second plurality of header bits, different from the first plurality of header bits.	
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	<i>See, e.g.</i> , claim limitation 1.D above.
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21] The method of claim 17, wherein the wireless transceiver	<i>See, e.g.</i> , Claim 8 above.

Claim Elements	Disclosure in Zelst
supports one or more wireless standards.	
[22] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[24] The method of claim 17, wherein the at least one repeated header	<i>See, e.g.</i> , Claim 3 above.

Claim Elements	Disclosure in Zelst
bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	See, e.g., claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band,	See, e.g., claim limitation 1.A above.

Claim Elements	Disclosure in Zelst
wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	See, e.g., claim limitation 1.B above.

Claim Elements	Disclosure in Zelst
[25.C] receiving, a second packet in a second wider frequency band, by the wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	See, e.g., claim limitation 1.C above.
[25.D] demodulate, by the demodulator, the second number of OFDM symbols	See, e.g., claim limitation 1.D above.

Claim Elements	Disclosure in Zelst
to determine the second header portion,	
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27] The method of claim 25, wherein the at	<i>See, e.g.</i> , claim 3 above.

Claim Elements	Disclosure in Zelst
least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.,</i> claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or	<i>See, e.g.,</i> claim 8 above.

Claim Elements	Disclosure in Zelst
more wireless standards.	

Exhibit A13

**Defendant's Invalidity Contentions Comparing Asserted Claims of U.S. Patent No. 9,584,262
to U.S. Patent Publication No. 2010/0260159 ("Zhang")**

AX Wireless LLC v. Dell Inc. et al, Case No. 2:22-cv-00277-JRG-RSP (E.D. Tex.)

As demonstrated in the claim charts below, the Asserted Claims of U.S. Patent No. 9,584,262 ("the '262 Patent") are invalid (1) under pre-AIA 35 U.S.C. § 102 as anticipated by Zhang¹; (2) under pre-AIA 35 U.S.C. § 103 as obvious in view of Zhang standing alone and/or combined with the knowledge of a person of ordinary skill in the art; and (3) additionally as obvious in view of Zhang in combination with one or more of the following, including as described in the cover document accompanying Defendant's Invalidity Contentions: (1) the general knowledge of one of ordinary skill in the art; (2) the teachings of any of the prior art identified below.²

- TGn Sync Proposal Technical Specification, Document No. IEEE 802.11-04/0889r6 ("TGn Sync Proposal 2005"), published and made publicly available at least as early as May 18, 2005;
- TGn Sync Proposal, Document No. IEEE 802.11-04/888r0 ("TGnSync 2004"), published and made publicly available at least as early as August 13, 2004;
- WWiSE Proposal: High Throughput Extension to the 802.11 Standard, Document No. IEEE 802.11-05/0149r5 (March 18, 2005) ("WWiSE 2005");
- IEEE P802.11 Wireless LANs Joint Proposal: High throughput extension to the 802.11 Standard: PHY, Document No. IEEE 802.11-05/1102r4 (January 13, 2006) ("2006 802.11n Joint PHY Proposal");
- ITU-T Recommendation G.9960 - Draft generation home Networking transceivers ("the G.9960 Draft"), published and made publicly available at least as early as August 17, 2009;
- G.hn: Extended PHY frame header, ITU-T SGJ 5/Q4 09XC-119 by Sid Schrum at Intellon Corporation ("Schrum"), published and made publicly available at least as early as July 27, 2009;
- G.hn: Using Two Symbols for the Header of a PHY frame on Coax, ITU-T SGJ 5/Q4 09XC-1 19 by Boaz Kol at CoperGate ("Kol"), published and made publicly available at least as early as July 27, 2009;
- G.hn: 09CC-R12 HomePlug AV interoperability updates, ITU-T 09CC-062R1 by Les Brown at Infineon Technologies USA

¹ Zhang was filed on April 12, 2010, claiming priority to earlier provisional applications filed as early as April 13, 2009.

² Discovery in this case is ongoing and, accordingly, this invalidity chart is not to be considered final. Defendant has conducted the invalidity analysis herein based at least in part and in some instances entirely upon Plaintiff's apparent application of the claims of the '262 patent. By charting the prior art against the claims and limitations herein, Defendant is not admitting nor agreeing to Plaintiff's application of the claims at issue in this case, and these charts should not be interpreted as an admission or concession by Defendant that any particular construction or application of any claim limitation by Plaintiff is correct or proper. Additionally, these charts provide representative examples of portions of the charted references that disclose the indicated limitations under Plaintiff's application of the claims; additional portions of these references other than the representative examples provided herein may also disclose the indicated limitation(s) and Defendant contends that the asserted claims are invalid in light of the charted reference(s) as a whole in its or their entirety. Where a particular figure is cited, the citation should be understood to encompass the caption and description of the figure as well as any text relating to or describing the figure. Conversely, where particular text referring to a figure is cited, the citation should be understood to include the figure as well.

- (“Brown”), published and made publicly available at least as early as August 20, 2009;
- The 802.11n MIMO-OFDM Standard for Wireless LAN and Beyond, IEEE, 2006 (“Van Nee”);
 - U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”);
 - U.S. Patent No. 7,903,755 to Mujtaba (“Mujtaba”);
 - U.S. Patent No. 7,599,332 to Zelst et al. (“Zelst”);
 - U.S. Patent Application Publication No. 2008/021269 to Takahashi et al. (“Takahashi”);
 - U.S. Patent Application Publication No. 2005/0169261 to Williams et al. (“Williams”);
 - U.S. Patent No. 8,018,975 to Ma et al. (“Ma”);
 - U.S. Patent No. 9,313,067 to Soliman (“Soliman”).

One of ordinary skill in the art, as of the priority date of the ’262 patent, would have known to combine the prior art elements disclosed by the foregoing references using known methods, and to use those elements according to their established functions in order to achieve a known and predictable result.

To the extent that the following invalidity contentions reflect constructions of claim limitations consistent with or suggested by Plaintiff’s Infringement Contentions, no inference is intended nor should any be drawn that Defendant agrees with Plaintiff’s apparent claim constructions or infringement contentions. Defendant offers such invalidity contentions solely in the alternative to any position it may ultimately take as to any claim construction issues. Defendant denies that the accused products infringe the asserted claims and expressly reserves the right to contest Plaintiff’s apparent claim constructions and infringement contentions. Where the chart below states that a reference “discloses” a limitation, such disclosure may be express or inherent.

Claim Elements	Disclosure in Zhang
[1.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver operable to:	To the extent the preamble is limiting, Zhang discloses a wireless OFDM transceiver. For example, the reference discloses the following: <i>See, e.g.,</i> Zhang, ¶ [0064]: FIG. 1 is a block diagram of an example wireless local area network (WLAN) 10, according to an embodiment. An AP 14 includes a host processor 15 coupled to a network interface 16. The network interface 16 includes a medium access control (MAC) unit 18 and a physical layer (PHY) unit 20. The PHY unit 20 includes a plurality of transceivers 21, and the transceivers are coupled to a plurality of antennas 24. Although three transceivers 21 and three antennas 24 are illustrated in FIG. 1, the

Claim Elements	Disclosure in Zhang
	AP 14 can include different numbers (e.g., 1, 2, 4, 5, etc.) of transceivers 21 and antennas 24 in other embodiments. In one embodiment, the MAC unit 18 and the PHY unit 20 are configured to operate according to a first communication protocol (e.g., the IEEE 802.11ac Standard, now in the process of being standardized). In another embodiment, the MAC unit 18 and the PHY unit 20 are also configured to operate according to a second communication protocol (e.g., the IEEE 802.11n Standard). In yet another embodiment, the MAC unit 18 and the PHY unit 20 are additionally configured to operate according to the second communication protocol and a third communication protocol (e.g., the IEEE 802.11a Standard). <i>Id.</i>, ¶ [0067]: In an embodiment, one or both of the client stations 25-2 and 25-3, has a structure the same as or similar to the client station 25-1. In an embodiment, the client station 25-4, has a structure similar to the client station 25-1. In these embodiments, the client stations 25 structured the same as or similar to the client station 25-1 have the same or a different number of transceivers and antennas. For example, the client station 25-2 has only two transceivers and two antennas, according to an embodiment.” <i>Id.</i> at Fig. 1:

Claim Elements	Disclosure in Zhang
	FIG. 1 <i>Id.</i>, ¶ [0071]: FIG. 2A is a diagram of a prior art data unit 60 that the legacy client station 25-4 is configured to transmit to the AP 14 via orthogonal frequency domain multiplexing (OFDM) modulation, according to an embodiment. The data unit 60 conforms to the IEEE 802.11a Standard and occupies a 20 Megahertz (MHz) band. The data unit 60 includes a preamble having a legacy short training field (L-STF) 62, a legacy long training field (L-LTF) 64, and a legacy signal field (L-SIG) 66. The data unit 60 also includes a data portion 68. FIG. 2B is a diagram of an example data portion 68 (not low density parity check

Claim Elements	Disclosure in Zhang
	encoded), which includes a service field, a scrambled physical layer service data unit (PSDU), tail bits, and padding bits, if needed. <i>Id.</i>, ¶ [0084]: FIG. 6 a diagram of an OFDM data unit 150 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 150 to the AP 14. The data unit 150 is the same as the data unit 100 of FIG. 5, except that the data unit 150 includes third very high throughput signal fields (VHT-SIG3s) 154 to convey physical layer (PHY) information. In the embodiment of FIG. 6, a CRC may cover each VHT-SIG1, VHT-SIG3, VHT-SIG3 tuple. In an embodiment, the CRC that covers the VHT-SIG1, VHT-SIG3, VHT-SIG3 tuple is the same as defined for HT-SIG in the IEEE 802.11n Standard.
[1.A] receive, in a first narrower frequency band, by a receiver using wireless OFDM communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	Zhang discloses a receiver to receive, in a first narrower frequency band, using wireless OFDM communications, a first packet having a first number of OFDM symbols that carry a first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Zhang, ¶¶ [0074]-[0075]:</i> FIG. 5 is a diagram of an OFDM data unit 100 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 100 to the AP 14. The data unit 100 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 100 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 100 is suitable for “mixed mode” situations, i.e., when the WLAN 10 includes a client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 100 can be utilized in other situations as well. The data unit 100 includes a preamble having four L-STFs 104, four L-LTFs 108, four L-SIGs 112, four first very high throughput signal fields (VHT-SIG1) 116, four second very high throughput signal fields (VHT-SIG2) 120, a very high throughput short training field

Claim Elements	Disclosure in Zhang
	(VHT-STF) 124, and N very high throughput long training fields (VHT-LTFs) 128, where N is an integer. The data unit 100 also includes a data portion 140. The L-STFs 104, the L-LTFs 108, and the L-SIGs 112 form a legacy portion. The VHT-STF 124, the VHT-LTFs 128, and the data portion 140 form a very high throughput (VHT) portion. In the embodiment of FIG. 5, each of the L-STFs 104, each of the L-LTFs 108, each of the L-SIGs 112, each of the VHT-SIG1s, and each of the VHT-SIG2s occupy a 20 MHz band. In the present disclosure, several example data units, including the data unit 100, having an 80 MHz contiguous bandwidth are described for the purposes of illustrating embodiments of frame formats, but these frame format embodiments and other embodiments are applicable to other suitable bandwidths (including noncontiguous bandwidths). For instance, although the preamble of FIG. 5 includes four of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s, in other embodiments in which the OFDM data unit occupies a cumulative bandwidth other than 80 MHz, such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, etc., a different suitable number of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s is utilized accordingly (e.g., one of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s for an OFDM data unit occupying 20 MHz, two of each of the fields for a 40 MHz bandwidth OFDM data unit, six of each of the fields for a 120 MHz bandwidth OFDM data unit, and eight of each of the fields for a 160 MHz bandwidth OFDM data unit). Also in 80 MHz and 160 MHz bandwidth OFDM data units, for example, the band is not contiguous in frequency, in some embodiments and situations. Thus, for example, the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s occupy two or more bands that are separated from each other in frequency, and adjacent bands are separated in frequency by at least one MHz, at least five MHz, at least 10 MHz, at least 20 MHz, for example, in some embodiments. In the embodiment of FIG. 5, each of the STF 124, the VHT-LTFs 128, and the data portion 140 occupy an 80 MHz band. If the data unit conforming to the first communication protocol is an OFDM data unit that occupies a cumulative bandwidth such as 20 MHz, 40 MHz, 120 MHz, or 160 MHz OFDM, the VHT-STF, VHT-LTFs and VHT data portion occupy the corresponding whole bandwidth of the data unit, according to an embodiment.

Claim Elements	Disclosure in Zhang
	<i>Id.</i> at Fig. 5: FIG. 5 <i>Id.</i>, ¶¶ [0084]-[0085]: FIG. 6 a diagram of an OFDM data unit 150 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 150 to the AP 14. The data unit 150 is the same as the data unit 100 of FIG. 5, except that the data unit 150 includes third very high throughput signal fields (VHT-SIG3s) 154 to convey physical layer (PHY) information. In the embodiment of FIG. 6, a CRC may cover each VHT-SIG1, VHT-SIG3, VHT-SIG3 tuple. In an embodiment, the CRC that covers the VHT-SIG1, VHT-SIG3, VHT-SIG3 tuple is the same as defined for HT-SIG in the IEEE 802.11n Standard. In an embodiment, the 3 VHT-SIG subfield formats are substantially different from HT-SIG fields in the IEEE 802.11n Standard (e.g. use 2 bits to signal 20/40/80 MHz bandwidth, or no indication of 20/40/80 MHz in an implementation that only 80 MHz is allowed for

Claim Elements	Disclosure in Zhang
	VHT packets). In an embodiment, the same CRC check as in HT-SIG specified by the IEEE 802.11n Standard is moved to VHT-SIG3, and the CRC checks the correctness of the data in all the 3 VHT-SIG fields. <i>Id.</i> at Fig. 6: FIG. 6 <i>Id.</i>, ¶¶ [0100]-[0101]: FIG. 9 is a diagram of an OFDM data unit 200 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 200 to the AP 14. The data unit 200 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 200 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the band in which the OFDM data unit is transmitted need not be contiguous, but may include two or more smaller bands separated in frequency. In an embodiment in which the OFDM data

Claim Elements	Disclosure in Zhang
	unit 200 has an 80 MHz bandwidth, for example, the OFDM data unit 200 may occupy two separate 40 MHz bands, separated in frequency. The data unit 200 is suitable for “Greenfield” situations, i.e., when the WLAN 10 does not include any client stations (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 200 can be utilized in other situations as well. For example, in some embodiments, the data unit 200 can be utilized i.e., when the WLAN 10 does not include any client stations that conforms to the IEEE 802.11a Standard but not the first communication protocol, but includes one or more client stations that conform to the IEEE 802.11n Standard but not the first communication protocol. The data unit 200 is similar to the data unit 100 of FIG. 5, but omits the legacy portion. Additionally, the VHT-STF 124 and the first VHT-LTF 128-1 occur before the VHT-SIG1s 116 and the VHT-SIG2s 120. Otherwise, the VHT-SIG1s 116, the VHT-SIG2s 120, the VHT-STF 124, and the VHT-LTFs 128 are the same as described above with respect to FIGS. 5 and 6. For example, in an embodiment in which the modulations in VHT-SIG fields in FIG. 9 are as in FIG. 7B or 7C, a legacy client configured according to the IEEE 802.11n Standard will interpret the VHT-SIG1s 116 and the VHT-SIG2s 120 as HT-SIG1s and HT-SIG2s, but will generate a CRC error. In another embodiment, when the modulations in VHT-SIG fields in FIG. 9 are as in FIG. 7D, a legacy client configured according to the IEEE 802.11n Standard will interpret the VHT-SIG1s 116 and the VHT-SIG2s 120 as L-SIGs and HT-SIG1s respectively, but will generate a CRC error. In general, the Greenfield data unit 200 is designed for utilization in a network having only devices that conform to the first communication protocol, and not including any legacy devices. In some situations, however, the Greenfield data unit 200 may be transmitted in a network having one or more legacy devices. <i>Id.</i> at Fig. 9:

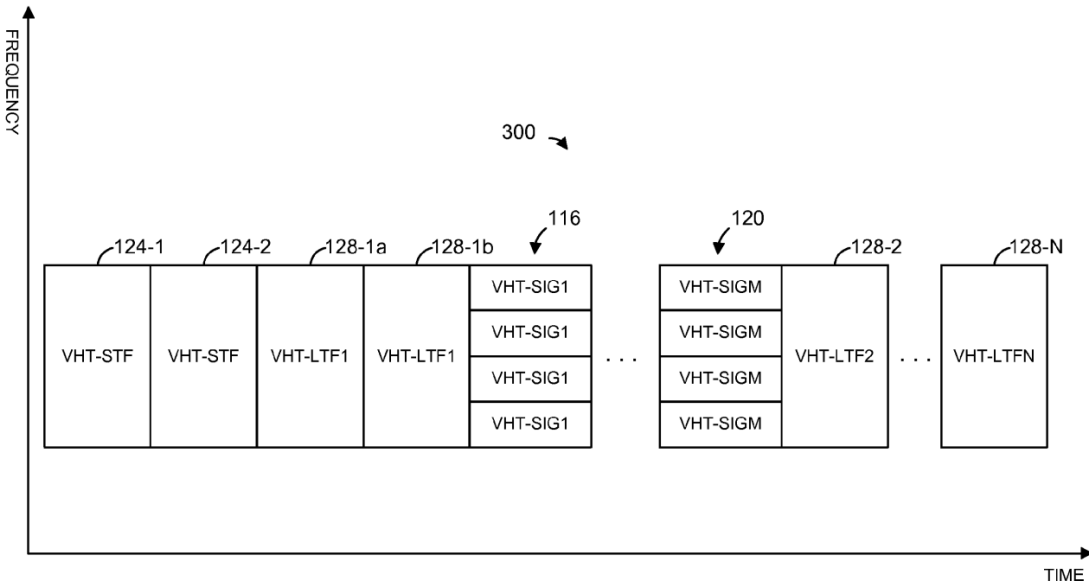
Claim Elements	Disclosure in Zhang
	FIG. 9 <i>Id.</i>, ¶¶ [0102]-[0105]: FIG. 10 is a diagram of an OFDM data unit 250 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 250 to the AP 14. The data unit 250 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 200 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 250 is suitable for “mixed mode” situations, i.e., when the WLAN 10 includes at least one client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 250 can be utilized in other situations as well. For example, in some embodiments, the data unit 250 can be utilized i.e., when the WLAN 10 does not include any client stations that conforms to the

Claim Elements	Disclosure in Zhang
	IEEE 802.11a Standard but not the first communication protocol, but includes one or more client stations that conform to the IEEE 802.11n Standard but not the first communication protocol. The data unit 250 is similar to the data unit 100 of FIG. 5, but includes HT-SIG1s 254 and HT-SIG2s 258. Further, the rate and length fields in the L-SIGs are set according to the duration T1, which includes the HT-SIG1s 254 and the HT-SIG2s 258. In an embodiment, the “HT-Length” field, the “MCS” field, the space-time coding block (STBC) field, etc., in the HT-SIG1 254 are set so that a device configured according to the IEEE 802.11n Standard will compute the true duration of the data unit 250. In an embodiment, the “reserved” bit in the HT-SIG1s 254 and/or the HT-SIG2s 258 is set to “0” to signal devices that conform to the first communication protocol that the data unit 250 conforms to the first communication protocol. Additionally, when the “reserved” bit in the HT-SIG2s 258 is set to “0”, a device configured according to the IEEE 802.11n Standard will determine “carrier lost” after decoding HT-SIG2. According to the state machine defined in the IEEE 802.11n Standard, the 802.11n device will hold CCA until the end of the duration computed according to the “HT-Length” field, the “MCS” field, the STBC field, etc. The VHT-SIG1s 116 and the VHT-SIG2s 120 have a different format than the HT-SIG1s 254 and the HT-SIG2s 258, in an embodiment. <i>Id.</i> at Fig. 10:

Claim Elements	Disclosure in Zhang
	FIG. 10 <i>Id.</i>, ¶¶ [0106]-[0108]: FIG. 11 is a diagram of an OFDM data unit 270 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 270 to the AP 14. The data unit 250 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 200 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 270 is suitable for “mixed mode” situations in which the WLAN 10 includes at least one client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11n Standard, but not the first communication protocol, but the WLAN 10 does not include any client stations that conforms to the IEEE 802.11a Standard but not IEEE 802.11n Standard and not the first communication protocol. The data unit 270 can be utilized in other situations as well.

Claim Elements	Disclosure in Zhang
	The data unit 270 is similar to the data unit 200 of FIG. 9, but includes HT-SIG1s 274 and HT-SIG2s 278. The HT-SIG1s 274 and HT-SIG2s 278 are configured the same as the HT-SIG1s 254 and HT-SIG2s 258 described with reference to FIG. 10, according to an embodiment. The VHT-SIG1s 116 and the VHT-SIG2s 120 have a different format than the HT-SIG1s 274 and the HT-SIG2s 278, in an embodiment. The example data unit formats and signaling approaches (e.g., L-SIG subfield (reserved bit) changes from the IEEE 802.11a and the IEEE 802.11n Standards, VHT-SIG subfield changes, and modulation changes from HT-SIG in the IEEE 802.11n Standard) described in this disclosure may be used to signal to a device that conforms to the first communication protocol that the data unit conforms to the first communication protocol, that the data unit includes VHT-SIG fields, etc. For data units that conform to the first communication protocol and have a bandwidth less than 80 MHz (e.g., 40 MHz or 20 MHz), such data units can utilize a similar preamble. For 40 MHz wide data units, the data unit preamble that conforms to the first communication protocol has an upper frequency and lower frequency duplication structure similar to or the same as described in the IEEE 802.11n Standard, according to an embodiment. <i>Id.</i> at Fig. 11:

Claim Elements	Disclosure in Zhang
	FIG. 11 <i>Id.</i>, ¶ [0116]: In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be repeated two or more times (e.g., for the purpose of more reliable channel estimation, frequency synchronization, automatic gain control (AGC) refinements, etc.). For example, in Greenfield mode data units, the VHT-STF and the first VHT-LTF symbol may be repeated two times each as shown in FIG. 13, which is preamble 300, according to an embodiment. The preamble 300 is similar to the preamble of FIG. 9, but includes two VHT-STFs 124-1, 124-2, two VHT-SIG1s, 128-1 a, 128-1 b, and M VHT-SIG fields, where M is an integer greater than or equal to two. <i>Id.</i> at Fig. 13:

Claim Elements	Disclosure in Zhang
	FIG. 13  <i>Id.</i>, ¶ [0117]: In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be extended beyond 4 μs. For example, in some embodiments, the VHT-STF is extended to 8 μs. FIG. 14 is a Fig diagram of an OFDM data unit 330 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. The data unit 330 is similar to the data unit 100 of FIG. 5, but with a VHT-STF field 334 that is extended to 8 μs. Additionally, in some embodiment, a cyclic prefix (CP) of one or more VHT-LTF symbols is extended to 1.6 μs. FIG. 15 is a diagram of an OFDM data unit 340 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. The data unit 340 is similar to the data unit 330 of FIG. 14, but with a first VHT-LTF field 344 that includes a CP extended to 1.6 μs. In some embodiments, repetition of VHT-STF and/or VHT-LTFs is similar to repetition of the L-LTF field as described in the IEEE 802.11n Standard. For example, a single CP (e.g. 0.8 μs) or double-length CP (1.6 μs) is followed by two repetitions of an OFDM symbol of VHT-STF or VHT-LTF. FIG. 16 is a diagram

Claim Elements	Disclosure in Zhang
	illustrating repetition of two VHT-LTF symbols with a single CP for the two VHT-LTF symbols. The CP is 0.8 μs in some embodiments, and is 1.6 μs in other embodiments. <i>Id.</i> at Fig. 14: FIG. 14 <i>Id.</i> at Fig. 15:

Claim Elements	Disclosure in Zhang
	FIG. 15 <i>Id.</i>, ¶¶ [0121]-[0122]: Compared with the mixed mode preamble in the IEEE 802.11n Standard, the preamble of at least some data units conforming to the first communication protocol may be made shorter, but still backward compatible with the IEEE 802.11a and IEEE 802.11n Standards. In an embodiment, a Greenfield-like preamble is utilized, but with L-SIG fields inserted before the VHT-SIG fields. FIG. 17 is a diagram of an example preamble, according to an embodiment. L-SIG fields inserted before the three sets of VHT-SIG fields. In another embodiment, the VHT-SIG3 fields are omitted. In the data unit 350, the modulations of the VHT-SIG fields is the same as those described in FIGS. 5 and 6, e.g., as illustrated in FIGS. 7B-7E, in various embodiments. In an embodiment, the spatial mapping approach of L-SIG is in the same way as VHT-SIG field (e.g. the single stream L-SIG is mapped to NTX transmit antennas by a matrix QP1, where Q is the spatial mapping matrix applied to the VHT data, and P1 is the first column of the P matrix as introduced above or as in the IEEE 802.11n Standard), and the modulation/coding of L-SIG is the same as the SIG field of the

Claim Elements	Disclosure in Zhang
	IEEE 802.11a Standard. In this embodiment, a receiver can use VHT-LTF1 as the channel estimation to demodulate the L-SIG field, as it does on demodulating VHT-SIG field for the example Greenfield mode preambles described above. In one embodiment, devices that transmit data units according to the first communication protocol utilize data unit preambles such as in FIG. 17 for Greenfield mode. In one embodiment, “spoofing” is applied by the duration T1 (determined according to rate and length fields in L-SIG, and the reserved bit of L-SIG is set to 1 to signal that the data unit conforms to the first communication protocol. In other embodiments, various modulation and numbers of OFDM symbols of VHT-SIG fields, and the format/length of VHT-STF and VHT-LTF fields such as described above are utilized. In embodiments utilizing a preamble such as in FIG. 17, and if the LTS symbol duplicates 20 MHz L-LTS symbols in each 20 MHz sub-band and non-zero values are utilized in the tones corresponding to IEEE 802.11n Standard legacy “DC/Guard tones” in each sub-band of L-LTS, then a receiver, when decoding L-SIG and VHT-SIG in one or more 20 MHz sub-bands will assume an IEEE 802.11a data unit of rate 6 Mbps (assuming the SIG fields set rate to 6 Mbps), and will determine worse channel estimation quality at tones around “DC” and “Guard band” in each sub-band, due to the non-zero values in “DC/Guard tones” at VHT-LTF1. In particular, the non-zero “DC” may be more problematic. <i>Id.</i> at Fig. 17:

Claim Elements	Disclosure in Zhang
	FIG. 17 <i>Id.</i>, ¶ [0125]: “FIG. 18 is a diagram of an example data unit 400 for use in embodiments in which the first communication protocol supports downlink SDMA (DL-SDMA). A first portion of the data unit 400 includes L-STF, L-LTF, L-SIG, VHT-SIG1, and VHT-SIG2 fields. The first portion is transmitted omni-directional and includes the same information for all client devices, in an embodiment. A second portion of the data unit 400 includes a VHT-STF field 401, a VHT-LTF1 field 402, a VHT-SIG3 field 404, a VHT-SIG4 field 408, VHT-LTF2 through VHT-LTFN fields 412, and a VHT data portion 416. At least some of the second portion includes different data for different client devices, wherein the different data is beamsteered to the different client devices.” <i>Id.</i> at Fig. 18:

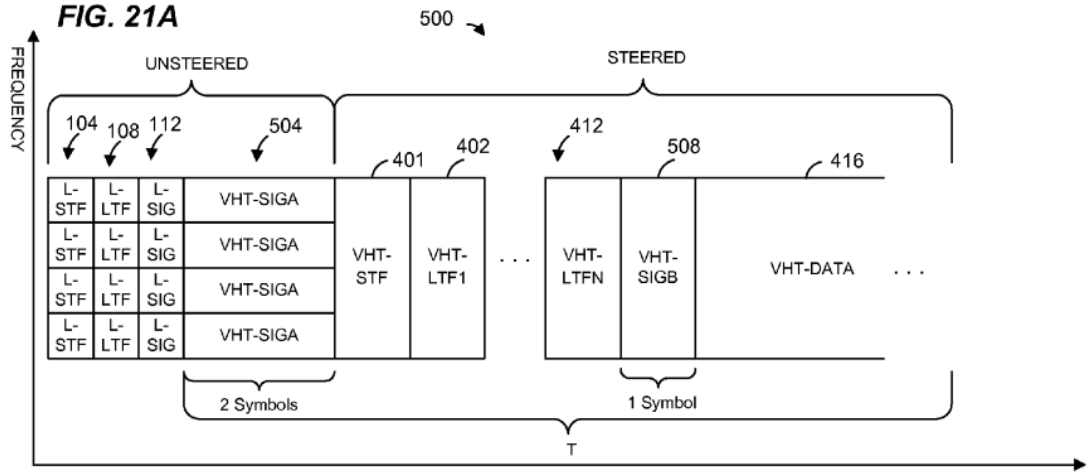
Claim Elements	Disclosure in Zhang
	FIG. 18 <i>Id.</i>, ¶¶ [129]-[130]: FIG. 19 is a diagram of another example data unit 450 for use in embodiments in which the first communication protocol supports downlink SDMA (DL-SDMA). A first portion of the data unit 450 includes L-STF, L-LTF, L-SIG, and VHT-SIG1 fields. The first portion is transmitted omni-directional and includes the same information for all client devices, in an embodiment. A second portion of the data unit 400 includes VHT-STF, VHT-LTF1, a VHT-SIG2 field 454, a VHT-SIG3 field 458, the VHT-LTF2 through VHT-LTFN fields 412, and the VHT data portion 416. The second portion includes different data for different client devices, wherein the different data is beamsteered to the different client devices. The data unit 450 is similar to the data unit 400, but one symbol shorter before the VHT-STF. In an embodiment, the “reserved” bit in L-SIG is set to 1, permitting first communication protocol data unit detection. VHT-SIG1 can be modulated such as described above. If VHT-SIG1 is modulated using BPSK, this permits spoofing and first

Claim Elements	Disclosure in Zhang
	communication protocol data unit detection. In an embodiment, content of VHT-SIG1 is a repetition of L-SIG, or any other suitable value. <i>Id.</i> at Fig. 19: FIG. 19 <i>Id.</i>, ¶¶ [131]-[134]: FIG. 20 is a diagram of another example data unit 470 for use in embodiments in which the first communication protocol supports downlink SDMA (DL-SDMA). A first portion of the data unit 470 includes L-STF, L-LTF, L-SIG, HT-SIG1, and HT-SIG2 fields. The first portion is transmitted omni-directional and includes the same information for all client devices, in an embodiment. A second portion of the data unit 400 includes VHT-STF, VHT-LTF1, a VHT-SIG1 field 474, a VHT-SIG2 field 478, the VHT-LTF2 through VHT-LTFN fields 412, and the VHT data portion 416. The second portion includes different data for different client devices, wherein the different data is beamsteered to the different client devices.

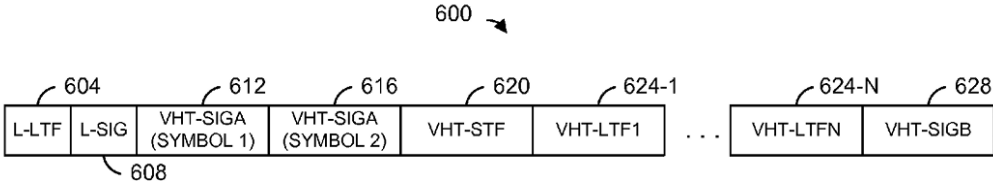
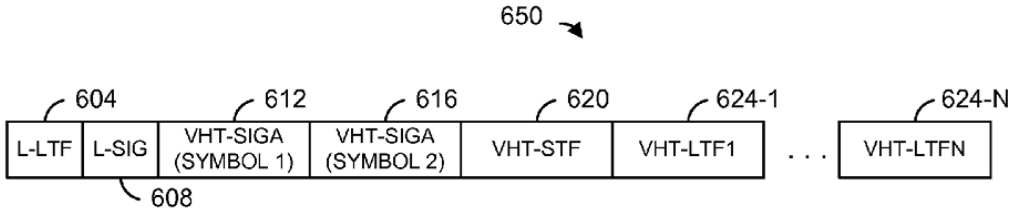
Claim Elements	Disclosure in Zhang
	The data unit 470 is similar to the data unit 400, but includes HT-SIG fields in the first portion. In this embodiment, the length field in HT-SIG is used to indicate the length of the data unit 470 for IEEE 802.11n spoofing. In embodiments similar to those described above, the VHT-SIG blocks contain 3 OFDM symbols, conforming to all the previous cases where 3 OFDM symbols are needed for each VHT-SIG field. Also, in embodiments similar to those described above, the VHT-SIG placed after one VHT-LTF is applied regardless of DL-SDMA. In the above mentioned examples in which two VHT-SIG blocks are present (e.g., one after L-SIG and the other after one of the VHT-LTFs), in some embodiments the two VHT-SIG blocks have different numbers of OFDM symbols. For example, the first VHT-SIG block has 3 symbols and second VHT-SIG block has 2 or 1 symbols. In another example, the first VHT-SIG block has 2 symbols and the second VHT-SIG block has 1 symbol. <i>Id.</i> at Fig. 20:

Claim Elements	Disclosure in Zhang
	FIG. 20 <i>Id.</i>, ¶¶ [0135]-[0136]: In some embodiments that support DL-SDMA, the same preamble utilized regardless of DL-SDMA or not. In one embodiment of a non DL-SDMA case, the first VHT-SIG block signals the PHY information. In this embodiment, in the DL-SDMA case, the first VHT-SIG block delivers common PHY information for all the DL-SDMA users (e.g., bandwidth, short GI, etc.), and the second VHT-SIG block includes user-specific PHY information (e.g., MCS, length, etc.). In some embodiments, other fields are omitted in the second VHT-SIG block (e.g., sounding, extension, VHT-LTFs, etc.), so the second VHT-SIG block can be shorter than the first VHT-SIG block. In one embodiment, the first VHT-SIG block has 2 OFDM symbols, and the second VHT-SIG block has 1 OFDM symbol, and the same preamble is applied for both single user and SDMA. In this embodiment, the first VHT-SIG always signals common PHY information for all users regardless of single user or SDMA, and the second VHT-SIG block has user specific information in the case of SDMA. For example, the first VHT-SIG block includes

Claim Elements	Disclosure in Zhang
	Length, GI Length, Bandwidth, Coding Type, Non-Sounding, number of VHT-LTFs (or 1 bit for whether only single VHT-LTF is present for single user case), BCC Tail, CRC, according to an embodiment. On the other hand, the second VHT-SIG block includes MCS, STBC type, smoothing, BCC Tail, CRC, according to an embodiment. In other embodiment, some of the above listed subfields are not present. <i>Id.</i>, ¶ [0139]: FIG. 21A is a diagram of another example data unit 500, according to an embodiment, that can be used in both DL-SDMA and non DL-SDMA scenarios. A first portion of the data unit 470 includes L-STF, L-LTF, L-SIG fields, and VHT-SIGA fields 504. A second portion includes VHT-STF, VHT-LTF1, the zero or more VHT-LTF2 through VHT-LTFN fields 412, a VHT-SIGB field 508, and the VHT data portion 416. In the non DL-SDMA case, the VHT data portion 416 includes data for a single device. In the DL-SDMA case, VHT-STF, VHT-LTF1, the VHT-LTF2 through VHT-LTFN fields 412, the VHT-SIGB field 508, and the VHT data portion 416 include different information for different client devices. In non-DL-SDMA cases, the first portion of the data unit 500 need not be steered differently than the second portion of the data unit 500 (e.g., need not be unsteered vs. steered). <i>Id.</i> at Fig. 21A:

Claim Elements	Disclosure in Zhang
	FIG. 21A  The diagram illustrates the frequency-time structure of data unit 500. The vertical axis represents frequency, and the horizontal axis represents time (T). The structure is divided into two main regions: UNSTEERED and STEERED. The UNSTEERED region (left) contains four rows of fields: L-STF (104), L-LTF (108), L-SIG (112), and VHT-SIGA (504). This region is labeled as '2 Symbols'. The STEERED region (right) contains three rows of fields: VHT-STF (401), VHT-LTF1 (402), and VHT-LTFN (412). This region is labeled as '1 Symbol'. The total duration of the data unit is T. The diagram also shows a VHT-SIGB field (508) and a VHT-DATA field (416) in the STEERED region. <i>Id.</i>, ¶ [0156]: FIG. 22 is a diagram of another example data unit 550, according to an embodiment, that can be used in both DL-SDMA and non DL-SDMA scenarios. The data unit 550 is similar to the data unit 500 of FIG. 21A, but omits the VHT-SIGB field 508. The L-SIG fields 112 and the VHT-SIGA fields 504 are modulated according to FIG. 21B, in an embodiment. The data unit 550 is an example data unit for an 80 MHz bandwidth transmission. The data unit 550 can be suitably modified for transmissions of different bandwidths as 20 MHz, 40 MHz, 160 MHz, etc. <i>Id.</i> at Fig. 22:

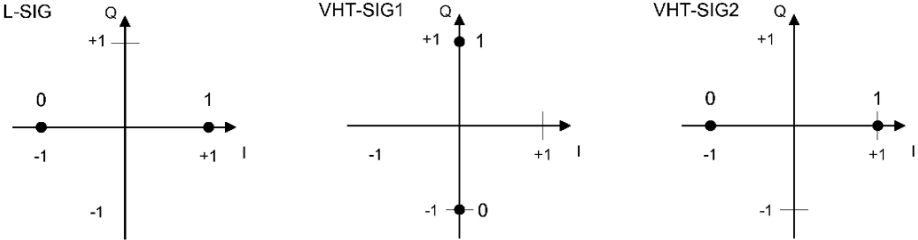
Claim Elements	Disclosure in Zhang
	FIG. 22 <i>Id.</i>, ¶ [0162]: FIG. 23 is a diagram of an example sounding data unit 600, according to an embodiment. The sounding data unit 600 omits a data portion. The sounding data unit 600 includes an L-LTF field 604, an L-SIG field 608, a VHT-SIGA field having a first symbol 612 and a second symbol 616. The sounding data unit 600 also includes a VHT-STF field 620, one or more VHT-LTF fields 624, and a VHT-SIGB field 628. In one embodiment, the L-SIG field 604 and/or the VHT-SIGA field 612, 616 and/or the VHT-SIGB field 628 indicates that the data unit does not have a data portion. In another embodiment, the L-SIG field 604 and/or the VHT-SIGA field 612, 616 and/or the VHT-SIGB field 628 additionally or alternatively include “non-sounding” information (i.e., a “non-sounding” bit) that indicates that the data unit 600 is a sounding data unit. <i>Id.</i> at Fig. 23:

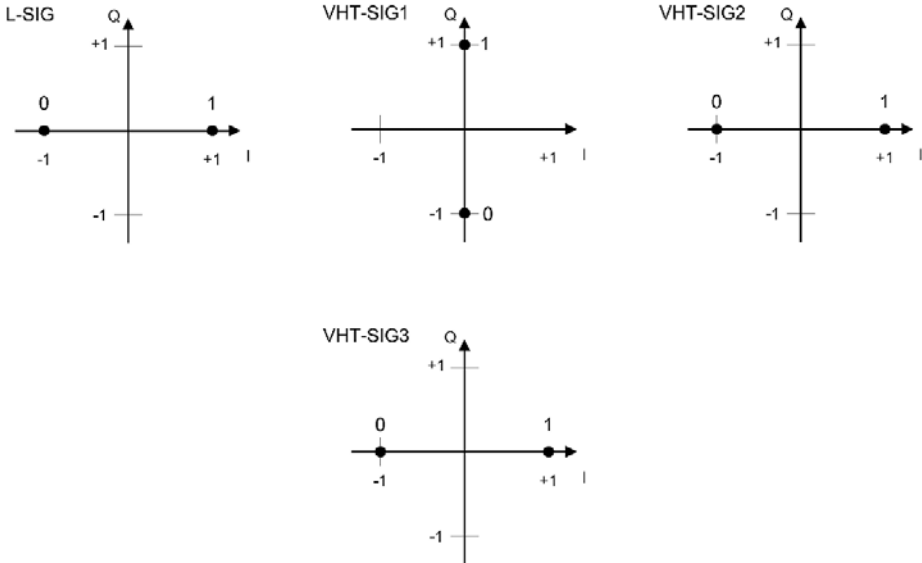
Claim Elements	Disclosure in Zhang
	FIG. 23  <i>Id.</i>, ¶ [0163]: FIG. 24 is a diagram of another example sounding data unit 650, according to an embodiment. The sounding data unit 650 is similar to the sounding data unit 600, but omits VHT-SIGB 628. <i>Id.</i> at Fig. 24: FIG. 24 
[1.B] demodulate, by a demodulator connected to and in communication with the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a	Zhang discloses a demodulator, connected to and in communication with the receiver, that demodulates the first number of OFDM symbols to determine the first plurality of header bits, where at least one of the first plurality of header bits is repeated on a plurality of OFDM subcarriers. For example, the reference discloses the following: <i>See, e.g., Zhang, ¶¶ [0121]-[0123]:</i> Compared with the mixed mode preamble in the IEEE 802.11n Standard, the preamble of at least some data units conforming to the first communication protocol may be made shorter, but still backward compatible with the IEEE 802.11a and IEEE 802.11n Standards. In an embodiment, a Greenfield-like preamble is utilized, but with L-SIG fields inserted before

Claim Elements	Disclosure in Zhang
plurality of OFDM subcarriers;	the VHT-SIG fields. FIG. 17 is a diagram of an example preamble, according to an embodiment. L-SIG fields inserted before the three sets of VHT-SIG fields. In another embodiment, the VHT-SIG3 fields are omitted. In the data unit 350, the modulations of the VHT-SIG fields is the same as those described in FIGS. 5 and 6, e.g., as illustrated in FIGS. 7B-7E, in various embodiments. In an embodiment, the spatial mapping approach of L-SIG is in the same way as VHT-SIG field (e.g. the single stream L-SIG is mapped to NTX transmit antennas by a matrix QP1, where Q is the spatial mapping matrix applied to the VHT data, and P1 is the first column of the P matrix as introduced above or as in the IEEE 802.11n Standard), and the modulation/coding of L-SIG is the same as the SIG field of the IEEE 802.11a Standard. In this embodiment, a receiver can use VHT-LTF1 as the channel estimation to demodulate the L-SIG field, as it does on demodulating VHT-SIG field for the example Greenfield mode preambles described above. In one embodiment, devices that transmit data units according to the first communication protocol utilize data unit preambles such as in FIG. 17 for Greenfield mode. In one embodiment, “spoofing” is applied by the duration T1 (determined according to rate and length fields in L-SIG, and the reserved bit of L-SIG is set to 1 to signal that the data unit conforms to the first communication protocol. In other embodiments, various modulation and numbers of OFDM symbols of VHT-SIG fields, and the format/length of VHT-STF and VHT-LTF fields such as described above are utilized. In embodiments utilizing a preamble such as in FIG. 17, and if the LTS symbol duplicates 20 MHz L-LTS symbols in each 20 MHz sub-band and non-zero values are utilized in the tones corresponding to IEEE 802.11n Standard legacy “DC/Guard tones” in each sub-band of L-LTS, then a receiver, when decoding L-SIG and VHT-SIG in one or more 20 MHz sub-bands will assume an IEEE 802.11a data unit of rate 6 Mbps (assuming the SIG fields set rate to 6 Mbps), and will determine worse channel estimation quality at tones around “DC” and “Guard band” in each sub-band, due to the non-zero values in “DC/Guard tones” at VHT-LTF1. In particular, the non-zero “DC” may be more problematic. In some embodiments, to improve the detection of SIG fields, zero values are kept at the “DC” tones and/or “Guard” tones in each of the sub-bands of the LTS symbols in each of the VHT-LTF fields, and also not to transmit data in these tones in the Data field (VHT portion). In these embodiments, SIG field decoding quality will tend to be improved, at

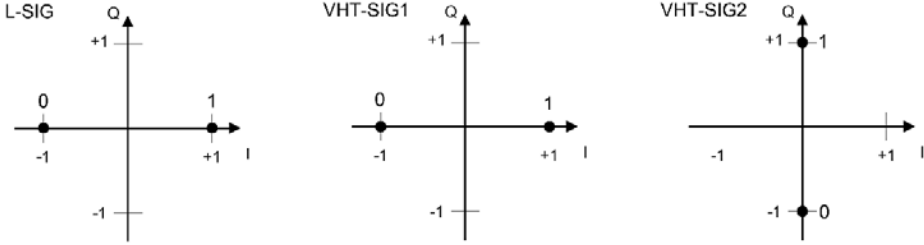
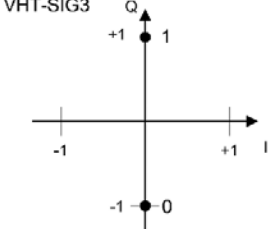
Claim Elements	Disclosure in Zhang
	the expense of a lower data rate. On the other hand, a benefit of a short mixed mode preamble compared with the other embodiments is obtained. . . . If a VHT-SIG occurs after VHT-LTF_n, then it can be spatially mapped the same way as VHT-LTF_n (e.g., by vector QP_n) or the same way as VHT-LTF₁ (e.g. by vector QP₁) so the receiver can use the channel estimation from VHT-LTF_n or VHT-LTF₁ to decode this VHT-SIG block after VHT-LTF_n. <i>Id.</i>, ¶ [0148]: Whenever a first communication protocol receiver detects that there are signals on these 4 tones, and/or the detected symbols (after demodulation and slicing) matches the predefined symbols on these 4 tones, then the receiver determines that the data unit conforms to the first communication protocol. <i>Id.</i>, ¶ [0020]: The preamble includes a first field having information that indicates a duration of the data unit, the first field being formatted such that the first field is decodable by a receiver device that conforms to a second communication protocol but does not conform to the first communication protocol to determine the duration of the data unit based on the first field. Additionally, the preamble is formatted such that a portion of the preamble is decodable by a receiver device that conforms to a third communication protocol but does not conform to the first communication protocol. <i>Id.</i>, ¶ [0022]: A portion of the data unit that is decodable by the receiver device that conforms to the third communication protocol but does not conform to the first communication protocol includes the first field, and wherein the first field is formatted such that the first field is decodable by the receiver device that conforms to the third communication protocol but does not conform to the first communication protocol to determine the duration of the data unit based on the first field. <i>Id.</i>, ¶ [0026]:

Claim Elements	Disclosure in Zhang
	A second field of the preamble includes information that indicates the duration of the data unit, and wherein the portion of the preamble that is decodable by the receiver device that conforms to the third communication protocol but does not conform to the first communication protocol includes the second field. <i>Id.</i>, ¶ [0068]: On the other hand, the legacy client station 25-4 is enabled to receive and fully decode and transmit data units according to the second communication protocol and/or the third communication protocol. <i>Id.</i>, ¶¶ [0079]-[0081]: For example, a modulation and coding scheme (MCS) field in VHT-SIG1 and/or VHT-SIG2 is the same as the MCS field in HT-SIG, but applied to an 80 MHz band. In one embodiment, MCS 32 is disallowed for VHT data units such as the data unit 100. In other embodiments, MCS 32 is allowed for VHT data units such as the data unit 100. In some embodiments, the format and/or modulation of VHT-SIG1 and/or VHT-SIG2 is at least different to cause a legacy device operating according to the IEEE 802.11n Standard to detect an error, such as a cyclic redundancy check (CRC) error. Further according to the IEEE 802.11n Standard, the legacy client device will wait until the energy of the data unit 100 drops out before switching to CCA idle mode. In some embodiments, the modulation of the VHT-SIG1s and/or the VHT-SIG2s in the different 20 MHz sub-bands signals is rotated by different angles. <i>Id.</i>, ¶¶ [0087]-[0088]: FIG. 7B is a set of diagrams illustrating modulation of the L-SIG, VHT-SIG1, and VHT-SIG2 fields of the data unit 100 of FIG. 5, according to an embodiment. Similar to the HT-SIG1 field in FIG. 7A, the VHT-SIG1 field is rotated by 90 degrees as compared to the modulation of the L-SIG field. On the other hand, unlike the HT-SIG2 field of FIG. 7A, the VHT-SIG2 field is the same as the modulation of the L-SIG field. In an embodiment, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will cause a legacy device configured according to the IEEE 802.11n

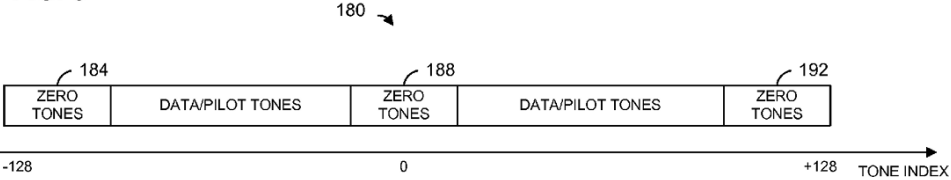
Claim Elements	Disclosure in Zhang
	Standard to detect an error, such as a CRC error, upon receiving a VHT-SIG2 field. Additionally, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will permit a device configured according to the first communication protocol to determine that the data unit 100 conforms to the first communication protocol. In other embodiments, the VHT-SIG2 field is rotated by 90 degrees as compared to the modulation of the L-SIG field, similar to the HT-SIG2 field of FIG. 7A. <i>Id.</i> at Fig. 7B: FIG. 7B  <i>Id.</i>, ¶ [0089]: FIG. 7C is a set of diagrams illustrating modulation of the L-SIG, VHT-SIG1, VHT-SIG2, and VHT-SIG3 fields of the data unit 150 of FIG. 6, according to an embodiment. Similar to the HT-SIG1 field in FIG. 7A, the VHT-SIG1 field is rotated by 90 degrees as compared to the modulation of the L-SIG field. On the other hand, unlike the HT-SIG2 field of FIG. 7A, the VHT-SIG2 field is the same as the modulation of the L-SIG field. Additionally, the VHT-SIG3 field is the same as the modulation of the L-SIG field. In an embodiment, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will cause a legacy device configured according to the IEEE 802.11n Standard to detect an error, such as a CRC error, upon receiving a VHT-SIG2 field. Additionally, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will permit a device configured according to the first

Claim Elements	Disclosure in Zhang
	communication protocol to determine that the data unit 150 conforms to the first communication protocol. <i>Id.</i> at Fig. 7C: FIG. 7C  <i>Id.</i>, ¶ [0094]: For example, in one embodiment, all of the VHT-SIG symbols are modulated using BPSK. As another example, the first VHT-SIG symbol is BPSK, and the remaining symbols are modulated using Q-BPSK. FIG. 7D is a set of diagrams illustrating modulation of the L-SIG, VHT-SIG1, and VHT-SIG2 fields of the data unit 100 of FIG. 5, according to an embodiment. Unlike the HT-SIG1 field in FIG. 7A, the VHT-SIG1 field is not rotated by 90 degrees as compared to the modulation of the L-SIG field (i.e., the VHT-SIG1 field is BPSK modulated). On the other hand, like the HT-SIG2 field of FIG. 7A, the VHT-SIG2 field is rotated by 90 degrees as compared to the modulation of the L-SIG field. In the

Claim Elements	Disclosure in Zhang
	embodiment of FIG. 7D, devices conforming to the IEEE 802.11n Standard will treat the data unit as an IEEE 802.11a data unit, because the modulation of the VHT-SIG1 field is not BPSK, as specified by the IEEE 802.11n standard. In this embodiment, the device conforming to the IEEE 802.11n Standard will set the CCA idle duration according to L-SIG. The modulation of FIG. 7D can also be used with the data unit 150 of FIG. 6, and FIG. 7E is a diagram of modulation for the VHT-SIG3 field of FIG. 6, according to an embodiment. In another embodiment, all or the first or some of the VHT-SIG symbols are modulated with neither BPSK, nor Q-BPSK. For example, VHT-SIG1 or VHT-SIG2 or all the VHT-SIGs are modulated with 45-deg rotated BPSK. As another example, VHT-SIG1 or VHT-SIG2 or all the VHT-SIGs are modulated with $R \times 45$-deg rotated BPSK, wherein $R=1, 2$, or 3. As another example, VHT-SIG1 or VHT-SIG2 or all the VHT-SIGs are modulated with BPSK and Q-BPSK alternatively or not alternatively but in a predetermined manner (e.g. any N tones using Q-BPSK, the other $52-N$ tones using BPSK) across the data and pilot tones (52 tones in each 20 MHz sub-band) i.e., a predetermined mapping of the tones for BPSK and Q-BPSK modulations. <i>Id.</i> at Figs. 7D, 7E:

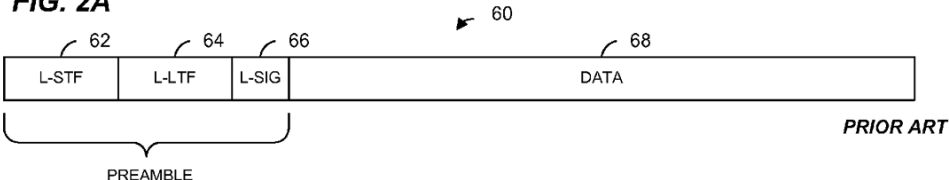
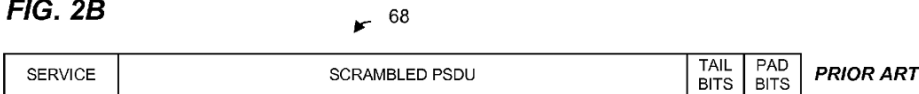
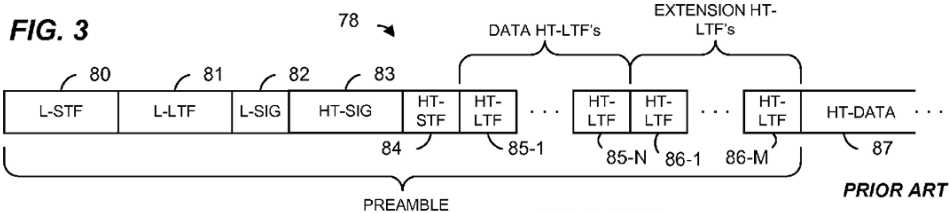
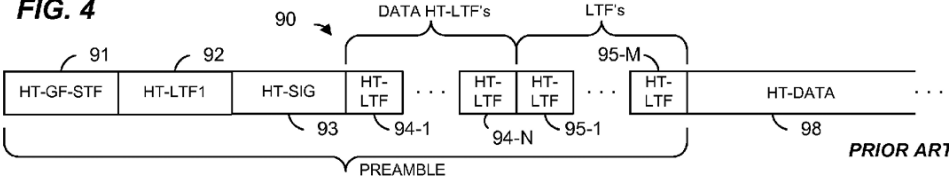
Claim Elements	Disclosure in Zhang
	FIG. 7D  FIG. 7E  <i>Id.</i> at Figs. 12A, 12B, 21B. <i>Id.</i>, ¶ [0111]: In embodiments in which signaling in VHT-SIG2 is utilized, after a station that conforms to the first communication protocol detects that the data unit conforms to the first communication protocol at VHT-SIG2 (e.g., with the modulation of FIG. 7D, in an embodiment), the device combines VHT-SIG1 and VHT-SIG2 decoded bits to check CRC and get PHY parameters, according to an embodiment. <i>Id.</i>, ¶ [0137]: In this embodiment, an IEEE 802.11n Standard compliant station, when decoding the L-SIG and finding Rate is not 6 Mbps, will automatically treat the packet as a legacy IEEE 802.11a packet, and set CCA according to the “Rate” and “Length” subfields in L-SIG.

Claim Elements	Disclosure in Zhang
	<i>Id.</i>, ¶ [0151]: In embodiments in which VHT-SIG-B is placed after VHT-LTF_n (e.g., after the last VHT-LTF, as in FIG. 21A), VHT-SIG-B is spatially mapped the same way as VHT-LTF_n (e.g. by vector Q_{Pn}) so a receiver can use the channel estimation from VHT-LTF_n to decode VHT-SIG-B. In another embodiment, VHT-SIG-B is spatially mapped the same way as VHT-LTF₁ (e.g. by vector Q_{P1}), so a receiver can use the channel estimation from VHT-LTF₁ to decode VHT-SIG-B. <i>Id.</i>, ¶ [0077]: The frequency domain symbols of the legacy portion are repeated over four 20 MHz sub-bands of the 80 MHz band. Legacy client devices that are configured according to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard with 20 MHz bandwidth will recognize a legacy IEEE 802.11a Standard preamble in any of the 20 MHz sub-bands. In some embodiments, the modulation of different 20 MHz sub-bands signals is rotated by different angles. For example, in one embodiment, a first subband is rotated 0-degrees, a second subband is rotated 90-degrees, a third sub-band is rotated 180-degrees, and a fourth sub-band is rotated 270-degrees. In other embodiments, different suitable rotations are utilized. As just one example, a first sub-band is rotated 45-degrees, a second sub-band is rotated 90-degrees, a third sub-band is rotated −45-degrees, and a fourth sub-band is rotated −90-degrees. <i>Id.</i>, ¶ [0099]: FIG. 8 is a diagram illustrating an example OFDM tone structure for an 80 MHz OFDM symbol for the VHT-data portions of FIGS. 5 and 6, according to an embodiment. An OFDM symbol 180 includes a group 184 of zero tones at a lower frequency end, a group 188 of zero tones at a center section, and a group 192 of zero tones at an upper frequency end. Data and pilot tones are located between the groups of zero tones. <i>Id.</i> at Fig. 8:

Claim Elements	Disclosure in Zhang
	FIG. 8  <i>Id.</i>, ¶ [0108]: For 40 MHz wide data units, the data unit preamble that conforms to the first communication protocol has an upper frequency and lower frequency duplication structure similar to or the same as described in the IEEE 802.11n Standard, according to an embodiment. <i>Id.</i>, ¶ [0116]: In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be repeated two or more times (e.g., for the purpose of more reliable channel estimation, frequency synchronization, automatic gain control (AGC) refinements, etc.). For example, in Greenfield mode data units, the VHT-STF and the first VHT-LTF symbol may be repeated two times each as shown in FIG. 13, which is preamble 300, according to an embodiment. The preamble 300 is similar to the preamble of FIG. 9, but includes two VHT-STFs 124-1, 124-2, two VHT-SIGs, 128-1 a, 128-1 b, and M VHT-SIG fields, where M is an integer greater than or equal to two. <i>Id.</i>, ¶ [0118]: In some embodiments, the training sequences used for the VHT-STF and the VHT-LTFs are defined differently from those in the IEEE 802.11n Standard. For example, if in VHT-STF and/or VHT-LTF, a pilot $P_{s,n}(k)$ is transmitted on the k-th subcarrier for the n-th training symbol at the s-th spatial stream, the VHT-STF and/or the VHT-LTF can be expressed as (expression before spatial mapping) $P(k)s(k)$, where $s(k)$ is the training STF or LTF symbol at the k-th subcarrier. The matrix $P(k)$ used for the k-th subcarrier may be any invertible matrix that is known at both the transmitter and the receiver. As just one example of a P matrix, the P vectors for different streams are interleaved in the same VHT-LTF. In

Claim Elements	Disclosure in Zhang
	another example of a P matrix, in the embodiment of repeated VHT-STFs and/or VHT-LTFs, columns of the P matrix are repeated x times, if x-time repetition is applied for the VHT-STFs or VHT-LTFs. <i>Id.</i>, ¶ [0122]: In embodiments utilizing a preamble such as in FIG. 17, and if the LTS symbol duplicates 20 MHz L-LTS symbols in each 20 MHz sub-band and non-zero values are utilized in the tones corresponding to IEEE 802.11n Standard legacy “DC/Guard tones” in each sub-band of L-LTS, then a receiver, when decoding L-SIG and VHT-SIG in one or more 20 MHz sub-bands will assume an IEEE 802.11a data unit of rate 6 Mbps (assuming the SIG fields set rate to 6 Mbps), and will determine worse channel estimation quality at tones around “DC” and “Guard band” in each sub-band, due to the non-zero values in “DC/Guard tones” at VHT-LTF1. In particular, the non-zero “DC” may be more problematic. <i>Id.</i>, ¶ [0130]: The data unit 450 is similar to the data unit 400, but one symbol shorter before the VHT-STF. In an embodiment, the “reserved” bit in L-SIG is set to 1, permitting first communication protocol data unit detection. VHT-SIG1 can be modulated such as described above. If VHT-SIG1 is modulated using BPSK, this permits spoofing and first communication protocol data unit detection. In an embodiment, content of VHT-SIG1 is a repetition of L-SIG, or any other suitable value. <i>Id.</i>, ¶ [0146]: In an embodiment, Q-BPSK is utilized on MQ data tones in the first symbol of VHT-SIG-A or both of the symbols of VHT-SIG-A, and BPSK is utilized on the remaining MI=48–MQ data tones. As just two examples, the (MQ, MI) tuple equals (24, 24) or (16, 32). In an embodiment, the different modulations are spread across the whole band to explore frequency diversity, e.g. by equal or substantially equal separations. The specific tone indices with the different modulations can be specified by the first communication protocol.
[1.C] receive, in a second wider frequency band, by the	Zhang discloses a receiver to receive, in a second wider frequency band, using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the

Claim Elements	Disclosure in Zhang
receiver using wireless OFDM communications, a second packet comprising a second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits;	first number of OFDM symbols, that carry a second plurality of header bits, different than the first plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Zhang, ¶¶ [0071]-[0073]:</i> FIG. 2A is a diagram of a prior art data unit 60 that the legacy client station 25-4 is configured to transmit to the AP 14 via orthogonal frequency domain multiplexing (OFDM) modulation, according to an embodiment. The data unit 60 conforms to the IEEE 802.11a Standard and occupies a 20 Megahertz (MHz) band. The data unit 60 includes a preamble having a legacy short training field (L-STF) 62, a legacy long training field (L-LTF) 64, and a legacy signal field (L-SIG) 66. The data unit 60 also includes a data portion 68. FIG. 2B is a diagram of an example data portion 68 (not low density parity check encoded), which includes a service field, a scrambled physical layer service data unit (PSDU), tail bits, and padding bits, if needed. FIG. 3 is a diagram of a prior art OFDM data unit 78 that the legacy client station 25-4 is configured to transmit to the AP 14, according to an embodiment. The data unit 78 conforms to the IEEE 802.11n Standard, occupies a 20 MHz band, and is designed for mixed mode situations, i.e., when the WLAN includes one or more client stations that conform to the IEEE 802.11a Standard but not the IEEE 802.11n Standard. The data unit 78 includes a preamble having an L-STF 80, an L-LTF 81, an L-SIG 82, a high throughput signal field (HT-SIG) 83, a high throughput short training field (HT-STF) 84, N data high throughput long training fields (HT-LTFs) 85, where N is an integer, and M extension HT-LTFs 86, where M is an integer. The data unit 78 also includes a data portion 87. FIG. 4 is a diagram of a prior art OFDM data unit 90 that the legacy client station 25-4 is configured to transmit to the AP 14, according to an embodiment. The data unit 90 conforms to the IEEE 802.11n Standard, occupies a 20 MHz band, and is designed for “Greenfield” situations, i.e., when the WLAN does not include any client stations that conform to the IEEE 802.11a Standard but not the IEEE 802.11n Standard. The data unit 90 includes a preamble having a high throughput Greenfield short training field (HT-GF-STF) 91, a first high throughput long training field (HT-LTF1) 92, a HT-SIG 93, N data HT-

Claim Elements	Disclosure in Zhang
	LTFs 94, where N is an integer, and M extension HT-LTFs 95, where M is an integer. The data unit 90 also includes a data portion 98. <i>Id.</i> at Figs. 2A, 2B, 3, and 4: FIG. 2A  FIG. 2B  FIG. 3  FIG. 4  <i>Id.</i>, ¶¶ [0074]-[0075]: FIG. 5 is a diagram of an OFDM data unit 100 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 100 to the AP 14. The data unit 100 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 100 occupy different bandwidths such as 20

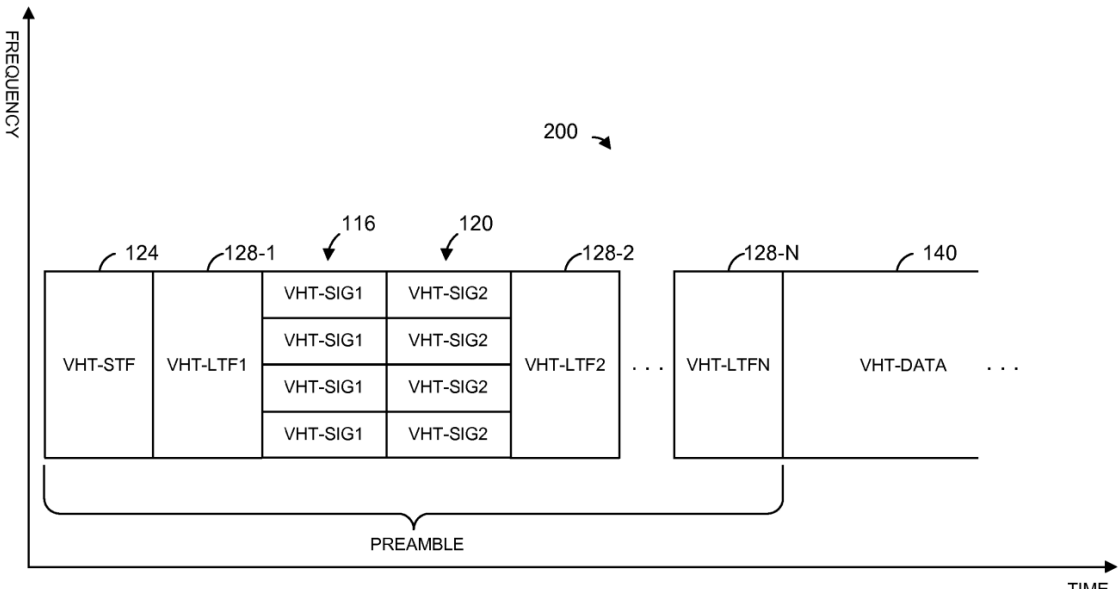
Claim Elements	Disclosure in Zhang
	MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 100 is suitable for “mixed mode” situations, i.e., when the WLAN 10 includes a client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 100 can be utilized in other situations as well. The data unit 100 includes a preamble having four L-STFs 104, four L-LTFs 108, four L-SIGs 112, four first very high throughput signal fields (VHT-SIG1) 116, four second very high throughput signal fields (VHT-SIG2) 120, a very high throughput short training field (VHT-STF) 124, and N very high throughput long training fields (VHT-LTFs) 128, where N is an integer. The data unit 100 also includes a data portion 140. The L-STFs 104, the L-LTFs 108, and the L-SIGs 112 form a legacy portion. The VHT-STF 124, the VHT-LTFs 128, and the data portion 140 form a very high throughput (VHT) portion. In the embodiment of FIG. 5, each of the L-STFs 104, each of the L-LTFs 108, each of the L-SIGs 112, each of the VHT-SIG1s, and each of the VHT-SIG2s occupy a 20 MHz band. In the present disclosure, several example data units, including the data unit 100, having an 80 MHz contiguous bandwidth are described for the purposes of illustrating embodiments of frame formats, but these frame format embodiments and other embodiments are applicable to other suitable bandwidths (including noncontiguous bandwidths). For instance, although the preamble of FIG. 5 includes four of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s, in other embodiments in which the OFDM data unit occupies a cumulative bandwidth other than 80 MHz, such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, etc., a different suitable number of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s is utilized accordingly (e.g., one of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s for an OFDM data unit occupying 20 MHz, two of each of the fields for a 40 MHz bandwidth OFDM data unit, six of each of the fields for a 120 MHz bandwidth OFDM data unit, and eight of each of the fields for a 160 MHz bandwidth OFDM data unit). Also in 80 MHz and 160 MHz bandwidth OFDM data units, for example, the band is not contiguous in frequency, in some embodiments and situations. Thus, for example, the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-

Claim Elements	Disclosure in Zhang
	SIG2s occupy two or more bands that are separated from each other in frequency, and adjacent bands are separated in frequency by at least one MHz, at least five MHz, at least 10 MHz, at least 20 MHz, for example, in some embodiments. In the embodiment of FIG. 5, each of the STF 124, the VHT-LTFs 128, and the data portion 140 occupy an 80 MHz band. If the data unit conforming to the first communication protocol is an OFDM data unit that occupies a cumulative bandwidth such as 20 MHz, 40 MHz, 120 MHz, or 160 MHz OFDM, the VHT-STF, VHT-LTFs and VHT data portion occupy the corresponding whole bandwidth of the data unit, according to an embodiment. <i>Id.</i> at Fig. 5: FIG. 5 <i>Id.</i>, ¶¶ [0084]-[0085]:

Claim Elements	Disclosure in Zhang
	FIG. 6 a diagram of an OFDM data unit 150 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 150 to the AP 14. The data unit 150 is the same as the data unit 100 of FIG. 5, except that the data unit 150 includes third very high throughput signal fields (VHT-SIG3s) 154 to convey physical layer (PHY) information. In the embodiment of FIG. 6, a CRC may cover each VHT-SIG1, VHT-SIG3, VHT-SIG3 tuple. In an embodiment, the CRC that covers the VHT-SIG1, VHT-SIG3, VHT-SIG3 tuple is the same as defined for HT-SIG in the IEEE 802.11n Standard. In an embodiment, the 3 VHT-SIG subfield formats are substantially different from HT-SIG fields in the IEEE 802.11n Standard (e.g. use 2 bits to signal 20/40/80 MHz bandwidth, or no indication of 20/40/80 MHz in an implementation that only 80 MHz is allowed for VHT packets). In an embodiment, the same CRC check as in HT-SIG specified by the IEEE 802.11n Standard is moved to VHT-SIG3, and the CRC checks the correctness of the data in all the 3 VHT-SIG fields. <i>Id.</i> at Fig. 6:

Claim Elements	Disclosure in Zhang
	FIG. 6 <i>Id.</i>, ¶¶ [0100]-[0101]: FIG. 9 is a diagram of an OFDM data unit 200 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 200 to the AP 14. The data unit 200 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 200 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the band in which the OFDM data unit is transmitted need not be contiguous, but may include two or more smaller bands separated in frequency. In an embodiment in which the OFDM data unit 200 has an 80 MHz bandwidth, for example, the OFDM data unit 200 may occupy two separate 40 MHz bands, separated in frequency. The data unit 200 is suitable for “Greenfield” situations, i.e., when the WLAN 10 does not include any client stations (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 200 can be

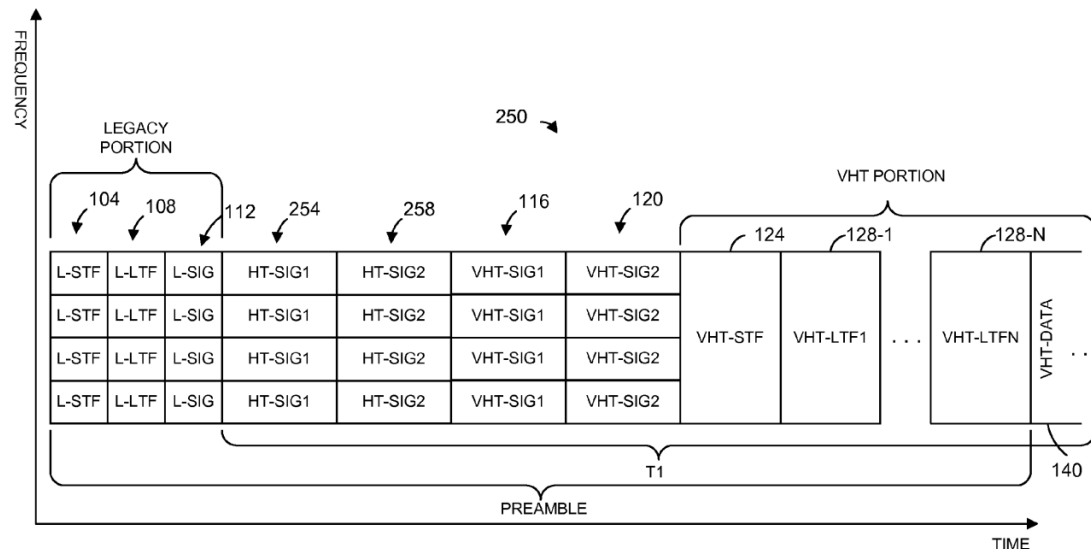
Claim Elements	Disclosure in Zhang
	utilized in other situations as well. For example, in some embodiments, the data unit 200 can be utilized i.e., when the WLAN 10 does not include any client stations that conforms to the IEEE 802.11a Standard but not the first communication protocol, but includes one or more client stations that conform to the IEEE 802.11n Standard but not the first communication protocol. The data unit 200 is similar to the data unit 100 of FIG. 5, but omits the legacy portion. Additionally, the VHT-STF 124 and the first VHT-LTF 128-1 occur before the VHT-SIG1s 116 and the VHT-SIG2s 120. Otherwise, the VHT-SIG1s 116, the VHT-SIG2s 120, the VHT-STF 124, and the VHT-LTFs 128 are the same as described above with respect to FIGS. 5 and 6. For example, in an embodiment in which the modulations in VHT-SIG fields in FIG. 9 are as in FIG. 7B or 7C, a legacy client configured according to the IEEE 802.11n Standard will interpret the VHT-SIG1s 116 and the VHT-SIG2s 120 as HT-SIG1s and HT-SIG2s, but will generate a CRC error. In another embodiment, when the modulations in VHT-SIG fields in FIG. 9 are as in FIG. 7D, a legacy client configured according to the IEEE 802.11n Standard will interpret the VHT-SIG1s 116 and the VHT-SIG2s 120 as L-SIGs and HT-SIG1s respectively, but will generate a CRC error. In general, the Greenfield data unit 200 is designed for utilization in a network having only devices that conform to the first communication protocol, and not including any legacy devices. In some situations, however, the Greenfield data unit 200 may be transmitted in a network having one or more legacy devices. <i>Id.</i> at Fig. 9:

Claim Elements	Disclosure in Zhang
	FIG. 9  <i>Id.</i>, ¶¶ [0102]-[0105]: FIG. 10 is a diagram of an OFDM data unit 250 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 250 to the AP 14. The data unit 250 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 200 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 250 is suitable for “mixed mode” situations, i.e., when the WLAN 10 includes at least one client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 250 can be utilized in other situations as well. For example, in some embodiments, the data unit 250 can be

Claim Elements	Disclosure in Zhang
	utilized i.e., when the WLAN 10 does not include any client stations that conforms to the IEEE 802.11a Standard but not the first communication protocol, but includes one or more client stations that conform to the IEEE 802.11n Standard but not the first communication protocol. The data unit 250 is similar to the data unit 100 of FIG. 5, but includes HT-SIG1s 254 and HT-SIG2s 258. Further, the rate and length fields in the L-SIGs are set according to the duration T1, which includes the HT-SIG1s 254 and the HT-SIG2s 258. In an embodiment, the “HT-Length” field, the “MCS” field, the space-time coding block (STBC) field, etc., in the HT-SIG1 254 are set so that a device configured according to the IEEE 802.11n Standard will compute the true duration of the data unit 250. In an embodiment, the “reserved” bit in the HT-SIG1s 254 and/or the HT-SIG2s 258 is set to “0” to signal devices that conform to the first communication protocol that the data unit 250 conforms to the first communication protocol. Additionally, when the “reserved” bit in the HT-SIG2s 258 is set to “0”, a device configured according to the IEEE 802.11n Standard will determine “carrier lost” after decoding HT-SIG2. According to the state machine defined in the IEEE 802.11n Standard, the 802.11n device will hold CCA until the end of the duration computed according to the “HT-Length” field, the “MCS” field, the STBC field, etc. The VHT-SIG1s 116 and the VHT-SIG2s 120 have a different format than the HT-SIG1s 254 and the HT-SIG2s 258, in an embodiment. <i>Id.</i> at Fig. 10:

Claim Elements

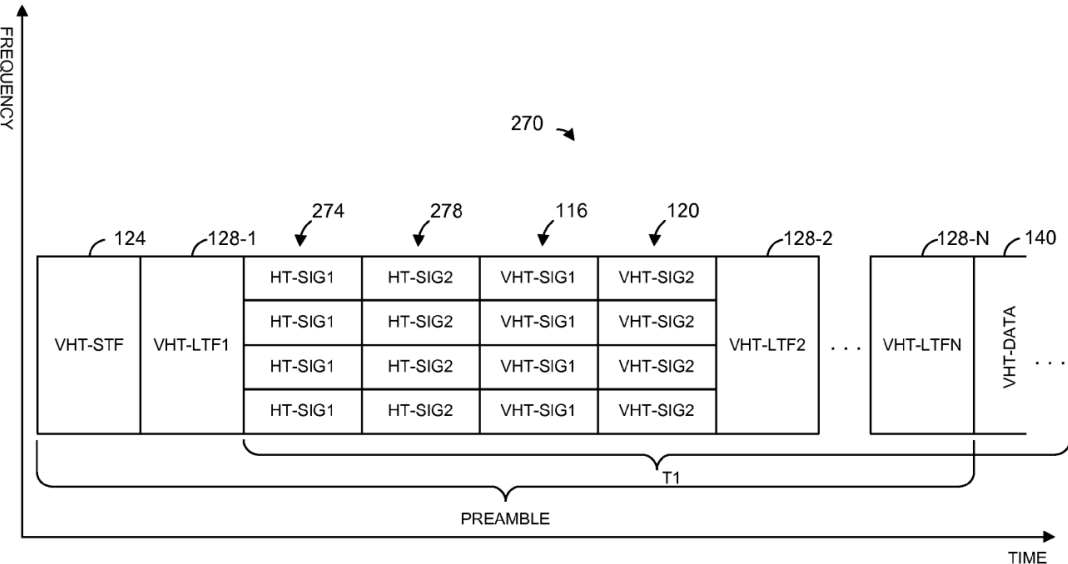
Disclosure in Zhang

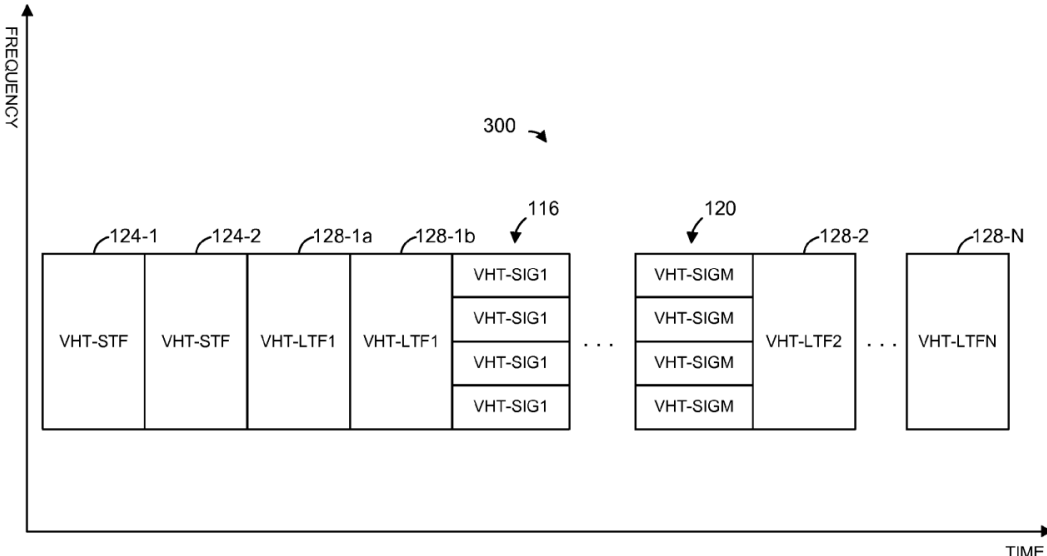
FIG. 10

Id., ¶¶ [0106]-[0108]:

FIG. 11 is a diagram of an OFDM data unit 270 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 270 to the AP 14. The data unit 250 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 200 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 270 is suitable for “mixed mode” situations in which the WLAN 10 includes at least one client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11n Standard, but not the first communication protocol, but the WLAN 10 does not include any client stations that conforms to the IEEE 802.11a Standard but not IEEE 802.11n Standard and not the first communication protocol. The data unit 270 can be utilized in other situations as well.

Claim Elements	Disclosure in Zhang
	The data unit 270 is similar to the data unit 200 of FIG. 9, but includes HT-SIG1s 274 and HT-SIG2s 278. The HT-SIG1s 274 and HT-SIG2s 278 are configured the same as the HT-SIG1s 254 and HT-SIG2s 258 described with reference to FIG. 10, according to an embodiment. The VHT-SIG1s 116 and the VHT-SIG2s 120 have a different format than the HT-SIG1s 274 and the HT-SIG2s 278, in an embodiment. The example data unit formats and signaling approaches (e.g., L-SIG subfield (reserved bit) changes from the IEEE 802.11a and the IEEE 802.11n Standards, VHT-SIG subfield changes, and modulation changes from HT-SIG in the IEEE 802.11n Standard) described in this disclosure may be used to signal to a device that conforms to the first communication protocol that the data unit conforms to the first communication protocol, that the data unit includes VHT-SIG fields, etc. For data units that conform to the first communication protocol and have a bandwidth less than 80 MHz (e.g., 40 MHz or 20 MHz), such data units can utilize a similar preamble. For 40 MHz wide data units, the data unit preamble that conforms to the first communication protocol has an upper frequency and lower frequency duplication structure similar to or the same as described in the IEEE 802.11n Standard, according to an embodiment. <i>Id.</i> at Fig. 11:

Claim Elements	Disclosure in Zhang
	FIG. 11  <i>Id.</i>, ¶ [0116]: In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be repeated two or more times (e.g., for the purpose of more reliable channel estimation, frequency synchronization, automatic gain control (AGC) refinements, etc.). For example, in Greenfield mode data units, the VHT-STF and the first VHT-LTF symbol may be repeated two times each as shown in FIG. 13, which is preamble 300, according to an embodiment. The preamble 300 is similar to the preamble of FIG. 9, but includes two VHT-STFs 124-1, 124-2, two VHT-SIG1s, 128-1 a, 128-1 b, and M VHT-SIG fields, where M is an integer greater than or equal to two. <i>Id.</i> at Fig. 13:

Claim Elements	Disclosure in Zhang
	FIG. 13  <i>Id.</i>, ¶ [0117]: In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be extended beyond 4 μs. For example, in some embodiments, the VHT-STF is extended to 8 μs. FIG. 14 is a Fig diagram of an OFDM data unit 330 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. The data unit 330 is similar to the data unit 100 of FIG. 5, but with a VHT-STF field 334 that is extended to 8 μs. Additionally, in some embodiment, a cyclic prefix (CP) of one or more VHT-LTF symbols is extended to 1.6 μs. FIG. 15 is a diagram of an OFDM data unit 340 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. The data unit 340 is similar to the data unit 330 of FIG. 14, but with a first VHT-LTF field 344 that includes a CP extended to 1.6 μs. In some embodiments, repetition of VHT-STF and/or VHT-LTFs is similar to repetition of the L-LTF field as described in the IEEE 802.11n Standard. For example, a single CP (e.g. 0.8 μs) or double-length CP (1.6 μs) is followed by two repetitions of an OFDM symbol of VHT-STF or VHT-LTF. FIG. 16 is a diagram

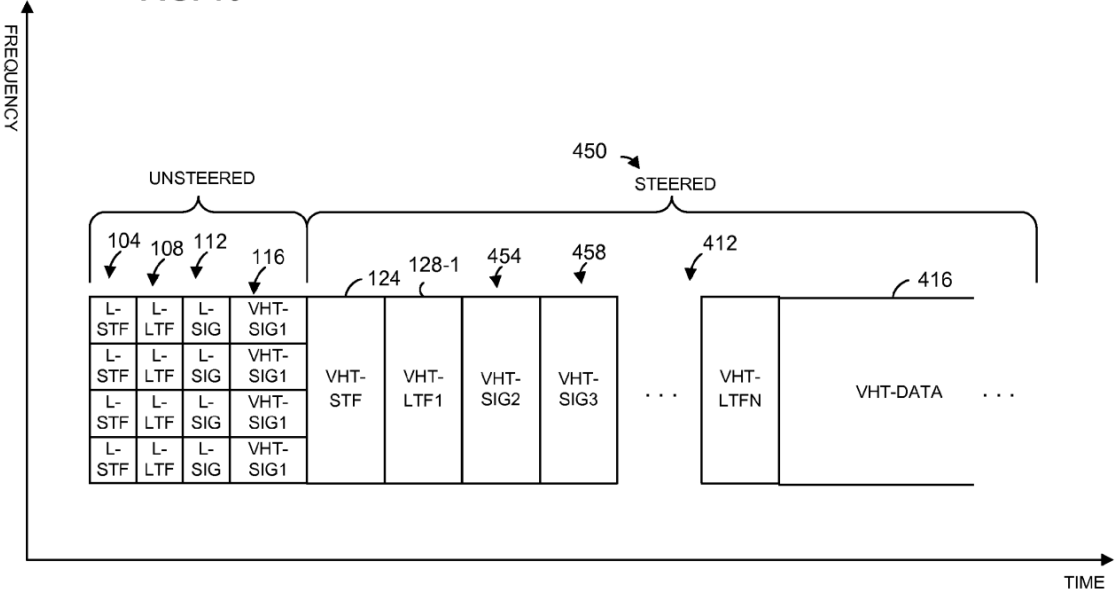
Claim Elements	Disclosure in Zhang
	illustrating repetition of two VHT-LTF symbols with a single CP for the two VHT-LTF symbols. The CP is 0.8 μs in some embodiments, and is 1.6 μs in other embodiments. <i>Id.</i> at Fig. 14: FIG. 14 <i>Id.</i> at Fig. 15:

Claim Elements	Disclosure in Zhang
	FIG. 15 <i>Id.</i>, ¶¶ [0121]-[0122]: Compared with the mixed mode preamble in the IEEE 802.11n Standard, the preamble of at least some data units conforming to the first communication protocol may be made shorter, but still backward compatible with the IEEE 802.11a and IEEE 802.11n Standards. In an embodiment, a Greenfield-like preamble is utilized, but with L-SIG fields inserted before the VHT-SIG fields. FIG. 17 is a diagram of an example preamble, according to an embodiment. L-SIG fields inserted before the three sets of VHT-SIG fields. In another embodiment, the VHT-SIG3 fields are omitted. In the data unit 350, the modulations of the VHT-SIG fields is the same as those described in FIGS. 5 and 6, e.g., as illustrated in FIGS. 7B-7E, in various embodiments. In an embodiment, the spatial mapping approach of L-SIG is in the same way as VHT-SIG field (e.g. the single stream L-SIG is mapped to NTX transmit antennas by a matrix QP1, where Q is the spatial mapping matrix applied to the VHT data, and P1 is the first column of the P matrix as introduced above or as in the IEEE

Claim Elements	Disclosure in Zhang
	802.11n Standard), and the modulation/coding of L-SIG is the same as the SIG field of the IEEE 802.11a Standard. In this embodiment, a receiver can use VHT-LTF1 as the channel estimation to demodulate the L-SIG field, as it does on demodulating VHT-SIG field for the example Greenfield mode preambles described above. In one embodiment, devices that transmit data units according to the first communication protocol utilize data unit preambles such as in FIG. 17 for Greenfield mode. In one embodiment, “spoofing” is applied by the duration T1 (determined according to rate and length fields in L-SIG, and the reserved bit of L-SIG is set to 1 to signal that the data unit conforms to the first communication protocol. In other embodiments, various modulation and numbers of OFDM symbols of VHT-SIG fields, and the format/length of VHT-STF and VHT-LTF fields such as described above are utilized. In embodiments utilizing a preamble such as in FIG. 17, and if the LTS symbol duplicates 20 MHz L-LTS symbols in each 20 MHz sub-band and non-zero values are utilized in the tones corresponding to IEEE 802.11n Standard legacy “DC/Guard tones” in each sub-band of L-LTS, then a receiver, when decoding L-SIG and VHT-SIG in one or more 20 MHz sub-bands will assume an IEEE 802.11a data unit of rate 6 Mbps (assuming the SIG fields set rate to 6 Mbps), and will determine worse channel estimation quality at tones around “DC” and “Guard band” in each sub-band, due to the non-zero values in “DC/Guard tones” at VHT-LTF1. In particular, the non-zero “DC” may be more problematic. <i>Id.</i> at Fig. 17:

Claim Elements	Disclosure in Zhang
	FIG. 17 <i>Id.</i>, ¶ [0125]: “FIG. 18 is a diagram of an example data unit 400 for use in embodiments in which the first communication protocol supports downlink SDMA (DL-SDMA). A first portion of the data unit 400 includes L-STF, L-LTF, L-SIG, VHT-SIG1, and VHT-SIG2 fields. The first portion is transmitted omni-directional and includes the same information for all client devices, in an embodiment. A second portion of the data unit 400 includes a VHT-STF field 401, a VHT-LTF1 field 402, a VHT-SIG3 field 404, a VHT-SIG4 field 408, VHT-LTF2 through VHT-LTFN fields 412, and a VHT data portion 416. At least some of the second portion includes different data for different client devices, wherein the different data is beamsteered to the different client devices.” <i>Id.</i> at Fig. 18:

Claim Elements	Disclosure in Zhang
	FIG. 18 <i>Id.</i>, ¶¶ [129]-[130]: FIG. 19 is a diagram of another example data unit 450 for use in embodiments in which the first communication protocol supports downlink SDMA (DL-SDMA). A first portion of the data unit 450 includes L-STF, L-LTF, L-SIG, and VHT-SIG1 fields. The first portion is transmitted omni-directional and includes the same information for all client devices, in an embodiment. A second portion of the data unit 400 includes VHT-STF, VHT-LTF1, a VHT-SIG2 field 454, a VHT-SIG3 field 458, the VHT-LTF2 through VHT-LTFN fields 412, and the VHT data portion 416. The second portion includes different data for different client devices, wherein the different data is beamsteered to the different client devices. The data unit 450 is similar to the data unit 400, but one symbol shorter before the VHT-STF. In an embodiment, the “reserved” bit in L-SIG is set to 1, permitting first communication protocol data unit detection. VHT-SIG1 can be modulated such as described above. If VHT-SIG1 is modulated using BPSK, this permits spoofing and first

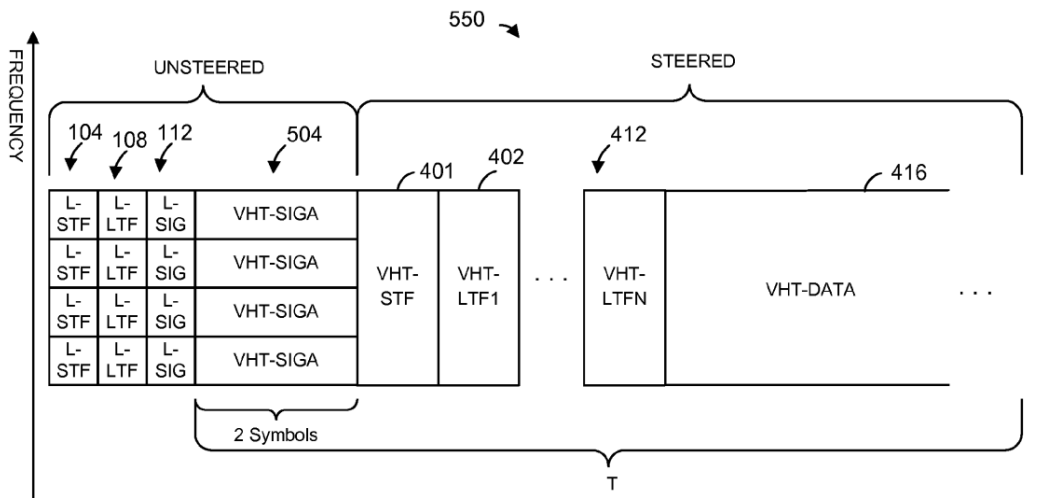
Claim Elements	Disclosure in Zhang
	communication protocol data unit detection. In an embodiment, content of VHT-SIG1 is a repetition of L-SIG, or any other suitable value. <i>Id.</i> at Fig. 19: FIG. 19  <i>Id.</i>, ¶¶ [131]-[134]: FIG. 20 is a diagram of another example data unit 470 for use in embodiments in which the first communication protocol supports downlink SDMA (DL-SDMA). A first portion of the data unit 470 includes L-STF, L-LTF, L-SIG, HT-SIG1, and HT-SIG2 fields. The first portion is transmitted omni-directional and includes the same information for all client devices, in an embodiment. A second portion of the data unit 400 includes VHT-STF, VHT-LTF1, a VHT-SIG1 field 474, a VHT-SIG2 field 478, the VHT-LTF2 through VHT-LTFN fields 412, and the VHT data portion 416. The second portion includes different data

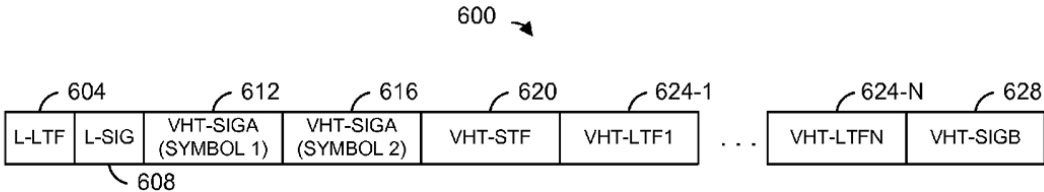
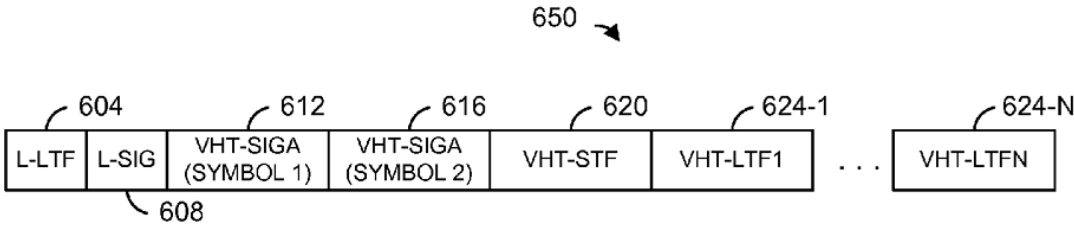
Claim Elements	Disclosure in Zhang
	for different client devices, wherein the different data is beamsteered to the different client devices. The data unit 470 is similar to the data unit 400, but includes HT-SIG fields in the first portion. In this embodiment, the length field in HT-SIG is used to indicate the length of the data unit 470 for IEEE 802.11n spoofing. In embodiments similar to those described above, the VHT-SIG blocks contain 3 OFDM symbols, conforming to all the previous cases where 3 OFDM symbols are needed for each VHT-SIG field. Also, in embodiments similar to those described above, the VHT-SIG placed after one VHT-LTF is applied regardless of DL-SDMA. In the above mentioned examples in which two VHT-SIG blocks are present (e.g., one after L-SIG and the other after one of the VHT-LTFs), in some embodiments the two VHT-SIG blocks have different numbers of OFDM symbols. For example, the first VHT-SIG block has 3 symbols and second VHT-SIG block has 2 or 1 symbols. In another example, the first VHT-SIG block has 2 symbols and the second VHT-SIG block has 1 symbol. <i>Id.</i> at Fig. 20:

Claim Elements	Disclosure in Zhang
	FIG. 20 <i>Id.</i>, ¶¶ [0135]-[0136]: In some embodiments that support DL-SDMA, the same preamble utilized regardless of DL-SDMA or not. In one embodiment of a non DL-SDMA case, the first VHT-SIG block signals the PHY information. In this embodiment, in the DL-SDMA case, the first VHT-SIG block delivers common PHY information for all the DL-SDMA users (e.g., bandwidth, short GI, etc.), and the second VHT-SIG block includes user-specific PHY information (e.g., MCS, length, etc.). In some embodiments, other fields are omitted in the second VHT-SIG block (e.g., sounding, extension, VHT-LTFs, etc.), so the second VHT-SIG block can be shorter than the first VHT-SIG block. In one embodiment, the first VHT-SIG block has 2 OFDM symbols, and the second VHT-SIG block has 1 OFDM symbol, and the same preamble is applied for both single user and SDMA. In this embodiment, the first VHT-SIG always signals common PHY information for all users regardless of single user or SDMA, and the second VHT-SIG block has user specific information in the case of SDMA. For example, the first VHT-SIG block includes

Claim Elements	Disclosure in Zhang
	Length, GI Length, Bandwidth, Coding Type, Non-Sounding, number of VHT-LTFs (or 1 bit for whether only single VHT-LTF is present for single user case), BCC Tail, CRC, according to an embodiment. On the other hand, the second VHT-SIG block includes MCS, STBC type, smoothing, BCC Tail, CRC, according to an embodiment. In other embodiment, some of the above listed subfields are not present. <i>Id.</i>, ¶ [0139]: FIG. 21A is a diagram of another example data unit 500, according to an embodiment, that can be used in both DL-SDMA and non DL-SDMA scenarios. A first portion of the data unit 470 includes L-STF, L-LTF, L-SIG fields, and VHT-SIGA fields 504. A second portion includes VHT-STF, VHT-LTF1, the zero or more VHT-LTF2 through VHT-LTFN fields 412, a VHT-SIGB field 508, and the VHT data portion 416. In the non DL-SDMA case, the VHT data portion 416 includes data for a single device. In the DL-SDMA case, VHT-STF, VHT-LTF1, the VHT-LTF2 through VHT-LTFN fields 412, the VHT-SIGB field 508, and the VHT data portion 416 include different information for different client devices. In non-DL-SDMA cases, the first portion of the data unit 500 need not be steered differently than the second portion of the data unit 500 (e.g., need not be unsteered vs. steered). <i>Id.</i> at Fig. 21A:

Claim Elements	Disclosure in Zhang
	FIG. 21A <i>Id.</i>, ¶ [0145]: In one embodiment, the first symbol of VHT-SIGA is modulated using BPSK, whereas the second symbol of VHT-SIGA is modulated using Q-BPSK, as illustrated in FIG. 21B. In one embodiment, a faster clock as compared to the IEEE 802.11n Standard is utilized for transmitting the preamble. In an embodiment, VHT-STF is longer as compared to HT-STF of the IEEE 802.11n Standard, and/or longer the GI of VHT-LTF1 is longer as compared to the GI of HT-LTF1 of the IEEE 802.11n Standard. This provides for better AGC performance especially at a transmit beamformee, in some implementations. In one embodiment, a different modulation of the first OFDM symbol of VHT-SIGA is utilized as compared to the IEEE 802.11n Standard, so the IEEE 802.11n Standard HT detection will still fail, but a client station configured according to the first communication protocol can determine that the data unit conforms to the first communication protocol. For VHT-SIGA and/or VHT-SIGB, 48 or 52 tones are utilized, depending on the implementation, according to some embodiments. <i>Id.</i>, ¶ [0156]:

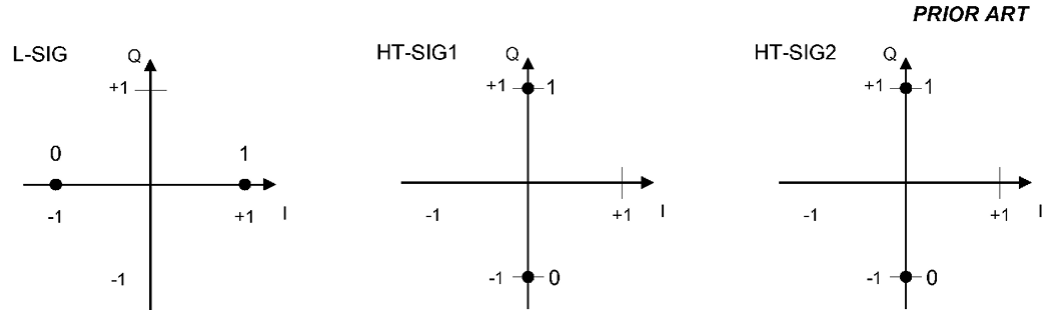
Claim Elements	Disclosure in Zhang
	FIG. 22 is a diagram of another example data unit 550, according to an embodiment, that can be used in both DL-SDMA and non DL-SDMA scenarios. The data unit 550 is similar to the data unit 500 of FIG. 21A, but omits the VHT-SIGB field 508. The L-SIG fields 112 and the VHT-SIGA fields 504 are modulated according to FIG. 21B, in an embodiment. The data unit 550 is an example data unit for an 80 MHz bandwidth transmission. The data unit 550 can be suitably modified for transmissions of different bandwidths as 20 MHz, 40 MHz, 160 MHz, etc. <i>Id.</i> at Fig. 22: FIG. 22  <i>Id.</i>, ¶ [0162]: FIG. 23 is a diagram of an example sounding data unit 600, according to an embodiment. The sounding data unit 600 omits a data portion. The sounding data unit 600 includes an L-LTF field 604, an L-SIG field 608, a VHT-SIGA field having a first symbol 612 and a second symbol 616. The sounding data unit 600 also includes a VHT-STF field 620, one or more VHT-LTF fields 624, and a VHT-SIGB field 628. In one embodiment, the L-SIG

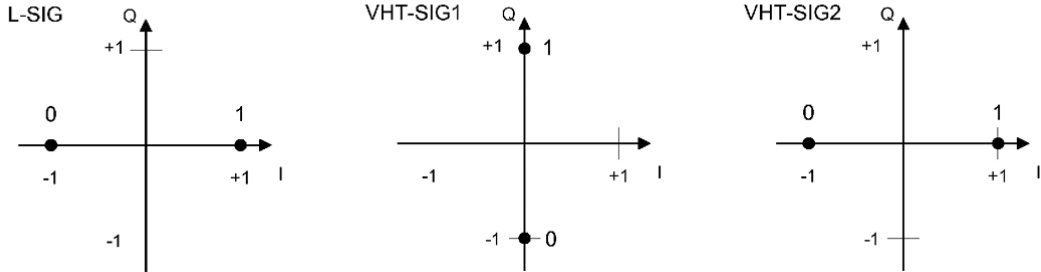
Claim Elements	Disclosure in Zhang
	field 604 and/or the VHT-SIGA field 612, 616 and/or the VHT-SIGB field 628 indicates that the data unit does not have a data portion. In another embodiment, the L-SIG field 604 and/or the VHT-SIGA field 612, 616 and/or the VHT-SIGB field 628 additionally or alternatively include “non-sounding” information (i.e., a “non-sounding” bit) that indicates that the data unit 600 is a sounding data unit. <i>Id.</i> at Fig. 23: FIG. 23  <i>Id.</i>, ¶ [0163]: FIG. 24 is a diagram of another example sounding data unit 650, according to an embodiment. The sounding data unit 650 is similar to the sounding data unit 600, but omits VHT-SIGB 628. <i>Id.</i> at Fig. 24: FIG. 24 

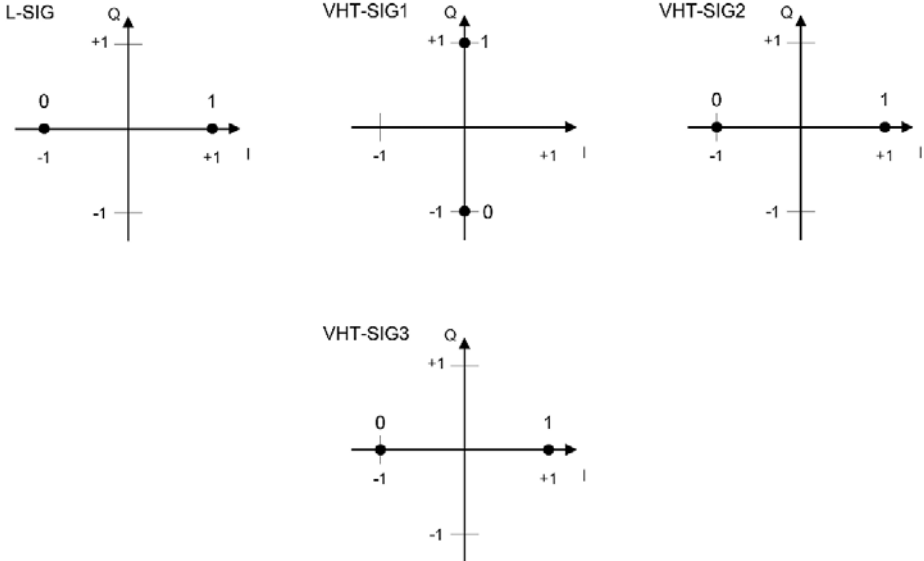
Claim Elements	Disclosure in Zhang
[1.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second plurality of header bits,	Zhang discloses a demodulator to demodulate the second number of OFDM symbols to determine the second plurality of header bits. For example, the reference discloses the following: <i>See, e.g., Zhang, ¶¶ [0121]-[0123]:</i> Compared with the mixed mode preamble in the IEEE 802.11n Standard, the preamble of at least some data units conforming to the first communication protocol may be made shorter, but still backward compatible with the IEEE 802.11a and IEEE 802.11n Standards. In an embodiment, a Greenfield-like preamble is utilized, but with L-SIG fields inserted before the VHT-SIG fields. FIG. 17 is a diagram of an example preamble, according to an embodiment. L-SIG fields inserted before the three sets of VHT-SIG fields. In another embodiment, the VHT-SIG3 fields are omitted. In the data unit 350, the modulations of the VHT-SIG fields is the same as those described in FIGS. 5 and 6, e.g., as illustrated in FIGS. 7B-7E, in various embodiments. In an embodiment, the spatial mapping approach of L-SIG is in the same way as VHT-SIG field (e.g. the single stream L-SIG is mapped to NTX transmit antennas by a matrix QP_1, where Q is the spatial mapping matrix applied to the VHT data, and P_1 is the first column of the P matrix as introduced above or as in the IEEE 802.11n Standard), and the modulation/coding of L-SIG is the same as the SIG field of the IEEE 802.11a Standard. In this embodiment, a receiver can use VHT-LTF1 as the channel estimation to demodulate the L-SIG field, as it does on demodulating VHT-SIG field for the example Greenfield mode preambles described above. In one embodiment, devices that transmit data units according to the first communication protocol utilize data unit preambles such as in FIG. 17 for Greenfield mode. In one embodiment, “spoofing” is applied by the duration T1 (determined according to rate and length fields in L-SIG, and the reserved bit of L-SIG is set to 1 to signal that the data unit conforms to the first communication protocol. In other embodiments, various modulation and numbers of OFDM symbols of VHT-SIG fields, and the format/length of VHT-STF and VHT-LTF fields such as described above are utilized. In embodiments utilizing a preamble such as in FIG. 17, and if the LTS symbol duplicates 20 MHz L-LTS symbols in each 20 MHz sub-band and non-zero values are utilized in the tones corresponding to IEEE 802.11n Standard legacy “DC/Guard tones” in each sub-band of L-LTS, then a receiver, when decoding L-SIG and VHT-SIG in one or more 20 MHz

Claim Elements	Disclosure in Zhang
	sub-bands will assume an IEEE 802.11a data unit of rate 6 Mbps (assuming the SIG fields set rate to 6 Mbps), and will determine worse channel estimation quality at tones around “DC” and “Guard band” in each sub-band, due to the non-zero values in “DC/Guard tones” at VHT-LTF1. In particular, the non-zero “DC” may be more problematic. In some embodiments, to improve the detection of SIG fields, zero values are kept at the “DC” tones and/or “Guard” tones in each of the sub-bands of the LTS symbols in each of the VHT-LTF fields, and also not to transmit data in these tones in the Data field (VHT portion). In these embodiments, SIG field decoding quality will tend to be improved, at the expense of a lower data rate. On the other hand, a benefit of a short mixed mode preamble compared with the other embodiments is obtained. . . . If a VHT-SIG occurs after VHT-LTF_n, then it can be spatially mapped the same way as VHT-LTF_n (e.g., by vector QP_n) or the same way as VHT-LTF1 (e.g. by vector QP1) so the receiver can use the channel estimation from VHT-LTF_n or VHT-LTF1 to decode this VHT-SIG block after VHT-LTF_n. <i>Id.</i>, ¶ [0148]: Whenever a first communication protocol receiver detects that there are signals on these 4 tones, and/or the detected symbols (after demodulation and slicing) matches the predefined symbols on these 4 tones, then the receiver determines that the data unit conforms to the first communication protocol. <i>Id.</i>, ¶ [0020]: The preamble includes a first field having information that indicates a duration of the data unit, the first field being formatted such that the first field is decodable by a receiver device that conforms to a second communication protocol but does not conform to the first communication protocol to determine the duration of the data unit based on the first field. Additionally, the preamble is formatted such that a portion of the preamble is decodable by a receiver device that conforms to a third communication protocol but does not conform to the first communication protocol. <i>Id.</i>, ¶ [0022]:

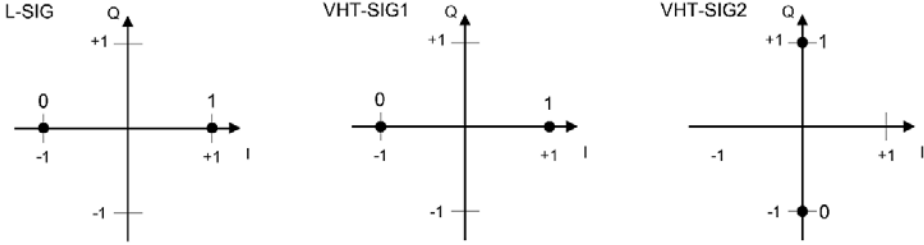
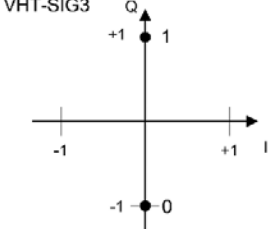
Claim Elements	Disclosure in Zhang
	A portion of the data unit that is decodable by the receiver device that conforms to the third communication protocol but does not conform to the first communication protocol includes the first field, and wherein the first field is formatted such that the first field is decodable by the receiver device that conforms to the third communication protocol but does not conform to the first communication protocol to determine the duration of the data unit based on the first field. <i>Id.</i>, ¶ [0026]: A second field of the preamble includes information that indicates the duration of the data unit, and wherein the portion of the preamble that is decodable by the receiver device that conforms to the third communication protocol but does not conform to the first communication protocol includes the second field. <i>Id.</i>, ¶ [0068]: On the other hand, the legacy client station 25-4 is enabled to receive and fully decode and transmit data units according to the second communication protocol and/or the third communication protocol. <i>Id.</i>, ¶¶ [0079]-[0081]: For example, a modulation and coding scheme (MCS) field in VHT-SIG1 and/or VHT-SIG2 is the same as the MCS field in HT-SIG, but applied to an 80 MHz band. In one embodiment, MCS 32 is disallowed for VHT data units such as the data unit 100. In other embodiments, MCS 32 is allowed for VHT data units such as the data unit 100. In some embodiments, the format and/or modulation of VHT-SIG1 and/or VHT-SIG2 is at least different to cause a legacy device operating according to the IEEE 802.11n Standard to detect an error, such as a cyclic redundancy check (CRC) error. Further according to the IEEE 802.11n Standard, the legacy client device will wait until the energy of the data unit 100 drops out before switching to CCA idle mode. In some embodiments, the modulation of the VHT-SIG1s and/or the VHT-SIG2s in the different 20 MHz sub-bands signals is rotated by different angles.

Claim Elements	Disclosure in Zhang
	<i>Id.</i>, ¶ [0086]: FIG. 7A is a set of diagrams illustrating modulation of the L-SIG, HT-SIG1, and HT-SIG2 fields as defined by the IEEE 802.11n Standard. The L-SIG field is modulated according to binary phase shift keying (BPSK), whereas the HT-SIG1 and HT-SIG2 fields are modulated according to BPSK, but on the quadrature axis (Q-BPSK). In other words, the modulation of the HT-SIG1 and HT-SIG2 fields is rotated by 90 degrees as compared to the modulation of the L-SIG field. FIG. 7A  <i>Id.</i>, ¶¶ [0087]-[0088]: FIG. 7B is a set of diagrams illustrating modulation of the L-SIG, VHT-SIG1, and VHT-SIG2 fields of the data unit 100 of FIG. 5, according to an embodiment. Similar to the HT-SIG1 field in FIG. 7A, the VHT-SIG1 field is rotated by 90 degrees as compared to the modulation of the L-SIG field. On the other hand, unlike the HT-SIG2 field of FIG. 7A, the VHT-SIG2 field is the same as the modulation of the L-SIG field. In an embodiment, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will cause a legacy device configured according to the IEEE 802.11n Standard to detect an error, such as a CRC error, upon receiving a VHT-SIG2 field. Additionally, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will permit a device configured according to the first

Claim Elements	Disclosure in Zhang
	communication protocol to determine that the data unit 100 conforms to the first communication protocol. In other embodiments, the VHT-SIG2 field is rotated by 90 degrees as compared to the modulation of the L-SIG field, similar to the HT-SIG2 field of FIG. 7A. <i>Id.</i> at Fig. 7B: FIG. 7B  <i>Id.</i>, ¶ [0089]: FIG. 7C is a set of diagrams illustrating modulation of the L-SIG, VHT-SIG1, VHT-SIG2, and VHT-SIG3 fields of the data unit 150 of FIG. 6, according to an embodiment. Similar to the HT-SIG1 field in FIG. 7A, the VHT-SIG1 field is rotated by 90 degrees as compared to the modulation of the L-SIG field. On the other hand, unlike the HT-SIG2 field of FIG. 7A, the VHT-SIG2 field is the same as the modulation of the L-SIG field. Additionally, the VHT-SIG3 field is the same as the modulation of the L-SIG field. In an embodiment, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will cause a legacy device configured according to the IEEE 802.11n Standard to detect an error, such as a CRC error, upon receiving a VHT-SIG2 field. Additionally, the different modulation of the VHT-SIG2 field and the HT-SIG2 field defined in the IEEE 802.11n Standard will permit a device configured according to the first

Claim Elements	Disclosure in Zhang
	communication protocol to determine that the data unit 150 conforms to the first communication protocol. <i>Id.</i> at Fig. 7C: FIG. 7C  <i>Id.</i>, ¶ [0094]: For example, in one embodiment, all of the VHT-SIG symbols are modulated using BPSK. As another example, the first VHT-SIG symbol is BPSK, and the remaining symbols are modulated using Q-BPSK. FIG. 7D is a set of diagrams illustrating modulation of the L-SIG, VHT-SIG1, and VHT-SIG2 fields of the data unit 100 of FIG. 5, according to an embodiment. Unlike the HT-SIG1 field in FIG. 7A, the VHT-SIG1 field is not rotated by 90 degrees as compared to the modulation of the L-SIG field (i.e., the VHT-SIG1 field is BPSK modulated). On the other hand, like the HT-SIG2 field of FIG. 7A, the VHT-SIG2 field is rotated by 90 degrees as compared to the modulation of the L-SIG field. In the

Claim Elements	Disclosure in Zhang
	embodiment of FIG. 7D, devices conforming to the IEEE 802.11n Standard will treat the data unit as an IEEE 802.11a data unit, because the modulation of the VHT-SIG1 field is not BPSK, as specified by the IEEE 802.11n standard. In this embodiment, the device conforming to the IEEE 802.11n Standard will set the CCA idle duration according to L-SIG. The modulation of FIG. 7D can also be used with the data unit 150 of FIG. 6, and FIG. 7E is a diagram of modulation for the VHT-SIG3 field of FIG. 6, according to an embodiment. In another embodiment, all or the first or some of the VHT-SIG symbols are modulated with neither BPSK, nor Q-BPSK. For example, VHT-SIG1 or VHT-SIG2 or all the VHT-SIGs are modulated with 45-deg rotated BPSK. As another example, VHT-SIG1 or VHT-SIG2 or all the VHT-SIGs are modulated with $R \times 45$-deg rotated BPSK, wherein $R=1, 2$, or 3. As another example, VHT-SIG1 or VHT-SIG2 or all the VHT-SIGs are modulated with BPSK and Q-BPSK alternatively or not alternatively but in a predetermined manner (e.g. any N tones using Q-BPSK, the other $52-N$ tones using BPSK) across the data and pilot tones (52 tones in each 20 MHz sub-band) i.e., a predetermined mapping of the tones for BPSK and Q-BPSK modulations. <i>Id.</i> at Figs. 7D, 7E:

Claim Elements	Disclosure in Zhang
	FIG. 7D  FIG. 7E  <i>Id.</i> at Figs. 12A, 12B, 21B. <i>Id.</i>, ¶ [0111]: In embodiments in which signaling in VHT-SIG2 is utilized, after a station that conforms to the first communication protocol detects that the data unit conforms to the first communication protocol at VHT-SIG2 (e.g., with the modulation of FIG. 7D, in an embodiment), the device combines VHT-SIG1 and VHT-SIG2 decoded bits to check CRC and get PHY parameters, according to an embodiment. <i>Id.</i>, ¶ [0137]: In this embodiment, an IEEE 802.11n Standard compliant station, when decoding the L-SIG and finding Rate is not 6 Mbps, will automatically treat the packet as a legacy IEEE 802.11a packet, and set CCA according to the “Rate” and “Length” subfields in L-SIG.

Claim Elements	Disclosure in Zhang
	<i>Id.</i>, ¶ [0151]: In embodiments in which VHT-SIG-B is placed after VHT-LTF_n (e.g., after the last VHT-LTF, as in FIG. 21A), VHT-SIG-B is spatially mapped the same way as VHT-LTF_n (e.g. by vector Q_{Pn}) so a receiver can use the channel estimation from VHT-LTF_n to decode VHT-SIG-B. In another embodiment, VHT-SIG-B is spatially mapped the same way as VHT-LTF₁ (e.g. by vector Q_{P1}), so a receiver can use the channel estimation from VHT-LTF₁ to decode VHT-SIG-B.
[1.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	Zhang discloses wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions. For example, the reference discloses the following: <i>See, e.g.</i>, Zhang, ¶¶ [0074]-[0075]: FIG. 5 is a diagram of an OFDM data unit 100 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 100 to the AP 14. The data unit 100 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 100 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 100 is suitable for “mixed mode” situations, i.e., when the WLAN 10 includes a client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 100 can be utilized in other situations as well. The data unit 100 includes a preamble having four L-STFs 104, four L-LTFs 108, four L-SIGs 112, four first very high throughput signal fields (VHT-SIG1) 116, four second very high throughput signal fields (VHT-SIG2) 120, a very high throughput short training field (VHT-STF) 124, and N very high throughput long training fields (VHT-LTFs) 128, where N is an integer. The data unit 100 also includes a data portion 140. The L-STFs 104, the L-LTFs 108, and the L-SIGs 112 form a legacy portion. The VHT-STF 124, the VHT-LTFs 128, and the data portion 140 form a very high throughput (VHT) portion.

Claim Elements	Disclosure in Zhang
	In the embodiment of FIG. 5, each of the L-STFs 104, each of the L-LTFs 108, each of the L-SIGs 112, each of the VHT-SIG1s, and each of the VHT-SIG2s occupy a 20 MHz band. In the present disclosure, several example data units, including the data unit 100, having an 80 MHz contiguous bandwidth are described for the purposes of illustrating embodiments of frame formats, but these frame format embodiments and other embodiments are applicable to other suitable bandwidths (including noncontiguous bandwidths). For instance, although the preamble of FIG. 5 includes four of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s, in other embodiments in which the OFDM data unit occupies a cumulative bandwidth other than 80 MHz, such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, etc., a different suitable number of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s is utilized accordingly (e.g., one of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s for an OFDM data unit occupying 20 MHz, two of each of the fields for a 40 MHz bandwidth OFDM data unit, six of each of the fields for a 120 MHz bandwidth OFDM data unit, and eight of each of the fields for a 160 MHz bandwidth OFDM data unit). Also in 80 MHz and 160 MHz bandwidth OFDM data units, for example, the band is not contiguous in frequency, in some embodiments and situations. Thus, for example, the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s occupy two or more bands that are separated from each other in frequency, and adjacent bands are separated in frequency by at least one MHz, at least five MHz, at least 10 MHz, at least 20 MHz, for example, in some embodiments. In the embodiment of FIG. 5, each of the STF 124, the VHT-LTFs 128, and the data portion 140 occupy an 80 MHz band. If the data unit conforming to the first communication protocol is an OFDM data unit that occupies a cumulative bandwidth such as 20 MHz, 40 MHz, 120 MHz, or 160 MHz OFDM, the VHT-STF, VHT-LTFs and VHT data portion occupy the corresponding whole bandwidth of the data unit, according to an embodiment. <i>Id.</i>, ¶ [0077]: The frequency domain symbols of the legacy portion are repeated over four 20 MHz sub-bands of the 80 MHz band. Legacy client devices that are configured according to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard with 20 MHz bandwidth will

Claim Elements	Disclosure in Zhang
	recognize a legacy IEEE 802.11a Standard preamble in any of the 20 MHz sub-bands. In some embodiments, the modulation of different 20 MHz sub-bands signals is rotated by different angles. For example, in one embodiment, a first subband is rotated 0-degrees, a second subband is rotated 90-degrees, a third sub-band is rotated 180-degrees, and a fourth sub-band is rotated 270-degrees. In other embodiments, different suitable rotations are utilized. As just one example, a first sub-band is rotated 45-degrees, a second sub-band is rotated 90-degrees, a third sub-band is rotated -45-degrees, and a fourth sub-band is rotated -90-degrees. <i>Id.</i>, ¶ [0122]: In embodiments utilizing a preamble such as in FIG. 17, and if the LTS symbol duplicates 20 MHz L-LTS symbols in each 20 MHz sub-band and non-zero values are utilized in the tones corresponding to IEEE 802.11n Standard legacy “DC/Guard tones” in each sub-band of L-LTS, then a receiver, when decoding L-SIG and VHT-SIG in one or more 20 MHz sub-bands will assume an IEEE 802.11a data unit of rate 6 Mbps (assuming the SIG fields set rate to 6 Mbps), and will determine worse channel estimation quality at tones around “DC” and “Guard band” in each sub-band, due to the non-zero values in “DC/Guard tones” at VHT-LTF1. In particular, the non-zero “DC” may be more problematic.
[2] The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	Zhang discloses at least one repeated header bit increases reliability of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Zhang</i>, ¶ [0116]: In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be repeated two or more times (e.g., for the purpose of more reliable channel estimation, frequency synchronization, automatic gain control (AGC) refinements, etc.). For example, in Greenfield mode data units, the VHT-STF and the first VHT-LTF symbol may be repeated two times each as shown in FIG. 13, which is preamble 300, according to an embodiment. The preamble 300 is similar to the preamble of FIG. 9, but includes two VHT-STFs 124-1, 124-2, two VHT-SIG1s, 128-1 a, 128-1 b, and M VHT-SIG fields, where M is an integer greater than or equal to two.

Claim Elements	Disclosure in Zhang
	<i>Id.</i>, ¶ [0124]: In some embodiments, a benefit is that SDMA downlink transmissions can differentiate VHT-SIG fields for different users by beam-steering, while keeping the legacy portion of mixed mode packet unsteered (e.g., “omni-directional”). <i>Id.</i>, ¶¶ [0145]-[0146]: In one embodiment, the first symbol of VHT-SIGA is modulated using BPSK, whereas the second symbol of VHT-SIGA is modulated using Q-BPSK, as illustrated in FIG. 21B. In one embodiment, a faster clock as compared to the IEEE 802.11n Standard is utilized for transmitting the preamble. In an embodiment, VHT-STF is longer as compared to HT-STF of the IEEE 802.11n Standard, and/or longer the GI of VHT-LTF1 is longer as compared to the GI of HT-LTF1 of the IEEE 802.11n Standard. This provides for better AGC performance especially at a transmit beamformee, in some implementations. In one embodiment, a different modulation of the first OFDM symbol of VHT-SIGA is utilized as compared to the IEEE 802.11n Standard, so the IEEE 802.11n Standard HT detection will still fail, but a client station configured according to the first communication protocol can determine that the data unit conforms to the first communication protocol. For VHT-SIGA and/or VHT-SIGB, 48 or 52 tones are utilized, depending on the implementation, according to some embodiments. In an embodiment, Q-BPSK is utilized on MQ data tones in the first symbol of VHT-SIG-A or both of the symbols of VHT-SIG-A, and BPSK is utilized on the remaining MI=48–MQ data tones. As just two examples, the (MQ, MI) tuple equals (24, 24) or (16, 32). In an embodiment, the different modulations are spread across the whole band to explore frequency diversity, e.g. by equal or substantially equal separations. The specific tone indices with the different modulations can be specified by the first communication protocol.
[3] The wireless transceiver of claim 1, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of	Zhang discloses at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g.</i>, Zhang, ¶ [0116]:

Claim Elements	Disclosure in Zhang
correctly decoding header information of the first packet in the first narrower frequency band.	In some embodiments, the VHT-STF and/or one or more VHT-LTF symbols may be repeated two or more times (e.g., for the purpose of more reliable channel estimation, frequency synchronization, automatic gain control (AGC) refinements, etc.). For example, in Greenfield mode data units, the VHT-STF and the first VHT-LTF symbol may be repeated two times each as shown in FIG. 13, which is preamble 300, according to an embodiment. The preamble 300 is similar to the preamble of FIG. 9, but includes two VHT-STFs 124-1, 124-2, two VHT-SIG1s, 128-1 a, 128-1 b, and M VHT-SIG fields, where M is an integer greater than or equal to two. <i>Id.</i>, ¶ [0124]: In some embodiments, a benefit is that SDMA downlink transmissions can differentiate VHT-SIG fields for different users by beam-steering, while keeping the legacy portion of mixed mode packet unsteered (e.g., “omni-directional”). <i>Id.</i>, ¶¶ [0145]-[0146]: In one embodiment, the first symbol of VHT-SIGA is modulated using BPSK, whereas the second symbol of VHT-SIGA is modulated using Q-BPSK, as illustrated in FIG. 21B. In one embodiment, a faster clock as compared to the IEEE 802.11n Standard is utilized for transmitting the preamble. In an embodiment, VHT-STF is longer as compared to HT-STF of the IEEE 802.11n Standard, and/or longer the GI of VHT-LTF1 is longer as compared to the GI of HT-LTF1 of the IEEE 802.11n Standard. This provides for better AGC performance especially at a transmit beamformee, in some implementations. In one embodiment, a different modulation of the first OFDM symbol of VHT-SIGA is utilized as compared to the IEEE 802.11n Standard, so the IEEE 802.11n Standard HT detection will still fail, but a client station configured according to the first communication protocol can determine that the data unit conforms to the first communication protocol. For VHT-SIGA and/or VHT-SIGB, 48 or 52 tones are utilized, depending on the implementation, according to some embodiments. In an embodiment, Q-BPSK is utilized on MQ data tones in the first symbol of VHT-SIG-A or both of the symbols of VHT-SIG-A, and BPSK is utilized on the remaining MI=48–MQ data tones. As just two examples, the (MQ, MI) tuple equals (24, 24) or (16, 32). In an

Claim Elements	Disclosure in Zhang
	embodiment, the different modulations are spread across the whole band to explore frequency diversity , e.g. by equal or substantially equal separations. The specific tone indices with the different modulations can be specified by the first communication protocol.
[4] The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.	Zhang discloses that the second wider frequency band is two times wider than the first narrower frequency band. For example, the reference discloses the following: <i>See, e.g., Zhang, ¶¶ [0074]-[0075]:</i> FIG. 5 is a diagram of an OFDM data unit 100 that the AP 14 is configured to transmit to the client station 25-1, according to an embodiment. In an embodiment, the client station 25-1 is also configured to transmit the data unit 100 to the AP 14. The data unit 100 conforms to the first communication protocol and occupies an 80 MHz band. In other embodiments, data units similar to the data unit 100 occupy different bandwidths such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, or any suitable bandwidth. Additionally, the 80 MHz band need not be contiguous, but may include two or more smaller bands, such as two 40 MHz bands, separated in frequency. The data unit 100 is suitable for “mixed mode” situations, i.e., when the WLAN 10 includes a client station (i.e., the legacy client station 25-4) that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard, but not the first communication protocol. The data unit 100 can be utilized in other situations as well. The data unit 100 includes a preamble having four L-STFs 104, four L-LTFs 108, four L-SIGs 112, four first very high throughput signal fields (VHT-SIG1) 116, four second very high throughput signal fields (VHT-SIG2) 120, a very high throughput short training field (VHT-STF) 124, and N very high throughput long training fields (VHT-LTFs) 128, where N is an integer. The data unit 100 also includes a data portion 140. The L-STFs 104, the L-LTFs 108, and the L-SIGs 112 form a legacy portion. The VHT-STF 124, the VHT-LTFs 128, and the data portion 140 form a very high throughput (VHT) portion. In the embodiment of FIG. 5, each of the L-STFs 104, each of the L-LTFs 108, each of the L-SIGs 112, each of the VHT-SIG1s, and each of the VHT-SIG2s occupy a 20 MHz band. In the present disclosure, several example data units, including the data unit 100, having an 80 MHz contiguous bandwidth are described for the purposes of illustrating

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	embodiments of frame formats, but these frame format embodiments and other embodiments are applicable to other suitable bandwidths (including noncontiguous bandwidths). For instance, although the preamble of FIG. 5 includes four of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s, in other embodiments in which the OFDM data unit occupies a cumulative bandwidth other than 80 MHz, such as 20 MHz, 40 MHz, 120 MHz, 160 MHz, etc., a different suitable number of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s is utilized accordingly (e.g., one of each of the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s for an OFDM data unit occupying 20 MHz, two of each of the fields for a 40 MHz bandwidth OFDM data unit, six of each of the fields for a 120 MHz bandwidth OFDM data unit, and eight of each of the fields for a 160 MHz bandwidth OFDM data unit). Also in 80 MHz and 160 MHz bandwidth OFDM data units, for example, the band is not contiguous in frequency, in some embodiments and situations. Thus, for example, the L-STFs 104, the L-LTFs 108, the L-SIGs 112, the VHT-SIG1s, and the VHT-SIG2s occupy two or more bands that are separated from each other in frequency, and adjacent bands are separated in frequency by at least one MHz, at least five MHz, at least 10 MHz, at least 20 MHz, for example, in some embodiments. In the embodiment of FIG. 5, each of the STF 124, the VHT-LTFs 128, and the data portion 140 occupy an 80 MHz band. If the data unit conforming to the first communication protocol is an OFDM data unit that occupies a cumulative bandwidth such as 20 MHz, 40 MHz, 120 MHz, or 160 MHz OFDM, the VHT-STF, VHT-LTFs and VHT data portion occupy the corresponding whole bandwidth of the data unit, according to an embodiment.
[8] The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.	Zhang discloses that the wireless transceiver supports one or more wireless standards. For example, the reference discloses the following: <i>See, e.g., Zhang, ¶ [0019]:</i> When operating in an infrastructure mode, wireless local area networks (WLANs) typically include an access point (AP) and one or more client stations. WLANs have evolved rapidly over the past decade. Development of WLAN standards such as the Institute for Electrical and Electronics Engineers (IEEE) 802.11a, 802.11b, 802.11g, and 802.11n Standards has

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	improved single-user peak data throughput. For example, the IEEE 802.11b Standard specifies a single-user peak throughput of 11 megabits per second (Mbps), the IEEE 802.11a and 802.11g Standards specify a single-user peak throughput of 54 Mbps, and the IEEE 802.11n Standard specifies a single-user peak throughput of 600 Mbps. Work has begun on a new standard, IEEE 802.11ac, that promises to provide even greater throughput.”
[9.PRE] A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim 1, preamble above.
[9.A] a wireless OFDM communications receiver operable to receive a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim 1, limitation 1.A above.
[9.B] a demodulator, connected to the wireless OFDM communications receiver, operable to demodulate the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a	<i>See, e.g.</i> , claim 1, limitation 1.B above.

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plurality of OFDM subcarriers;	
[9.C] the wireless OFDM communications receiver further operable to receive a second packet in a second wider frequency band, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion.	<i>See, e.g.</i> , claim 1, limitation 1.C above.
[9.D] the demodulator further operable to demodulate the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim 1, limitation 1.D above.
[9.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim 1, limitation 1.E above.
[10] The wireless transceiver of claim 9, wherein the at least one repeated header bit increases reliability of the first	<i>See, e.g.</i> , Claim 2 above.

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packet in the first narrower frequency band.	
[11] The wireless transceiver of claim 9, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 3 above.
[12] The wireless transceiver of claim 9, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[16] The wireless transceiver of claim 9, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[17.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[17.A] receiving, in a first narrower frequency band, by a receiver using wireless OFDM	<i>See, e.g.</i> , claim limitation 1.A above.

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communications, a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits;	
[17.B] demodulating, by a demodulator connected to the receiver, the first number of OFDM symbols to determine the first plurality of header bits, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers,	<i>See, e.g.</i> , claim limitation 1.B above.
[17.C] receiving, in a second wider frequency band, by the receiver using wireless OFDM communications, a second packet comprising second number of OFDM symbols, less than the first number of OFDM symbols, that carry a second plurality of header bits, different from the first plurality of header bits.	<i>See, e.g.</i> , claim limitation 1.C above.
[17.D] demodulating, by the demodulator, the second number of OFDM symbols to	<i>See, e.g.</i> , claim limitation 1.D above.

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determine the second plurality of header bits,	
[17.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[21] The method of claim 17, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , Claim 8 above.
[22] The wireless transceiver of claim 17, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , Claim 4 above.
[23] The method of claim 17, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , Claim 2 above.
[24] The method of claim 17, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly decoding header information	<i>See, e.g.</i> , Claim 3 above.

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of the first packet in the first narrower frequency band.	
[25.PRE] A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:	<i>See, e.g.</i> , claim preamble 1.PRE above.
[25.A] receiving, by a wireless OFDM communications receiver, a first packet in a first narrower frequency band, wherein the first packet comprises a first header portion received on a first number of OFDM symbols;	<i>See, e.g.</i> , claim limitation 1.A above.
[25.B] demodulating, by a demodulator connected to the wireless OFDM communications receiver, the first number of OFDM symbols to determine the first header portion, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;	<i>See, e.g.</i> , claim limitation 1.B above.
[25.C] receiving, a second packet in a second wider frequency band, by the	<i>See, e.g.</i> , claim limitation 1.C above.

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wireless OFDM communications receiver, wherein the second packet comprises a second header portion received on a second number of OFDM symbols, less than the first number of OFDM symbols, and wherein the second header portion is different than the first header portion;	
[25.D] demodulate, by the demodulator, the second number of OFDM symbols to determine the second header portion,	<i>See, e.g.</i> , claim limitation 1.D above.
[25.E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.	<i>See, e.g.</i> , claim limitation 1.E above.
[26] The method of claim 25, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.	<i>See, e.g.</i> , claim 2 above.
[27] The method of claim 25, wherein the at least one repeated header bit provides	<i>See, e.g.</i> , claim 3 above.

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additional diversity to increase a likelihood of correctly decoding header information of the first packet in the first narrower frequency band.	
[28] The method of claim 25, wherein the second wider frequency band is two times wider than the first narrower frequency band.	<i>See, e.g.</i> , claim 4 above.
[32] The method of claim 25, wherein the wireless transceiver supports one or more wireless standards.	<i>See, e.g.</i> , claim 8 above.