

Support for dynamic and semi-static resource allocation

Random Access Channel (RACH)

- Supports transmission of limited control information
- Possible risk of collision

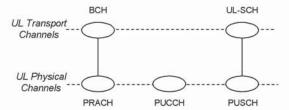
3.2.6 Mapping Uplink Physical Channels to Transport Channels

Transport channels are mapped to physical channels as shown in Figure 3.2.6-1.

3.2.7 Coding

The UL-SCH uses the same rate 1/3 turbo encoding scheme (two 8-state constituent encoders and one internal interleaver) as the DL-SCH.

Figure 3.2.6-1 Mapping of UL Transport Channels to UL Physical Channels



3.3 MB-SFN

Multimedia Broadcast Multicast Services (MBMS) are performed either in a single cell or multi-cell mode. In single cell transmissions, MBMS traffic is mapped to the DL-SCH. In multi-cell mode, transmissions from cells are carefully synchronized to form a Multicast/Broadcast – Single Frequency Network (MB-SFN).

MB-SFN is an elegant application of OFDM for cellular broadcast. The principle of operation is quite simple. Identical transmissions are broadcast from closely coordinated cells simultaneously on a common frequency. Signals from adjacent cells arrive at the receiver and are dealt with in the same manner as multipath delayed signals. In this manner, UE can combine the energy from multiple transmitters with no additional receiver complexity.

If the UE is at a cell boundary, the relative delay between the two signals is quite small. However, if the UE is close to one base station and relatively distant from a second base station, the amount of delay between the two signals can be quite large. For this reason, MB-SFN transmissions are supported using a 7.5 kHz subcarrier spacing and a longer CP. MB-SFN networks also use a common reference signal from all transmitters within the network to facilitate channel estimation.

As a consequence of the MB-SFN transmission scheme, UE can roam between cells with no handoff procedure required. Signals from various cells will vary in strength and in relative delay, but in aggregate the received signal is still dealt with in the same manner as a conventional single channel OFDM transmission.

4 Conclusions

Although incomplete, the LTE specifications do contain a great deal of useful information. It is entirely possible to construct a reasonably accurate picture of the LTE physical layer at this time. This discussion has hopefully provided the reader with a reasonably complete description of the LTE PHY. In some cases, material has been omitted for the sake of brevity. In other instances, the LTE specifications do not contain much detail at this time. As mentioned above, work on the 3GPP LTE specification is on going at this time and will not be complete before late this year or possibly early 2008.





5 References

- 3GPP TR 25.913 v7.3.0, <u>Requirements for EUTRA and EUTRAN</u>, http://www.3gpp.org/ftp/Specs/archive/25%5Fseries/25.913/
- Van Nee and Prasad, <u>OFDM for Wireless Multimedia Communications</u>, <u>Artech House Publishers</u>, ISBN 0-890006-530-6, 2000
- 3. T Doc #R1-060023, Cubic Metric in 3GPP-LTE, Motorola, Helsinki, January 2006
- 3GPP TS 36.300 v8.0.0, <u>E-UTRA and E-UTRAN Overall Description</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.300/
- 3GPP TS 36.201 v1.0.0, <u>LTE Physical Layer General Description</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.201/
- 3GPP TS 36.211 v1.0.0, <u>Physical Channels and Modulation</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.211/
- 3GPP TS 36.212 <u>Multiplexing and Channel Coding</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.212/
- 3GPP TS 36.213 v1.0.0, <u>Physical Layer Procedures</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.213/
- 3GPP TS 36.214 v0.1.0, <u>Physical Layer Measurements</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.214/
- 3GPP TS 36.300 v8.0.0, <u>E-UTRA and E-UTRAN Overall Description; Stage 2</u>, http://www.3gpp.org/ftp/Specs/archive/36%5Fseries/36.300/





6 Acronyms and Abbreviations

| 16QAM | 16 point quadrature amplitude modulation | MBMS | Multimedia broadcast multicast service |
|-----------------------------|--|---------|--|
| 3GPP | Third Generation Partnership Project | MB-SFN | Multicast/broadcast - single frequency |
| 64QAM | 64 point quadrature amplitude modulation | | network |
| ACK | Acknowledgement | MCH | Multicast channel |
| AGC | Automatic gain control | MIMO | Multiple Input Multiple Output |
| AP | Access point | MRC | Maximal ratio combining |
| ARQ | Automatic repeat request | NACK | Not acknowledgement |
| BCH | Broadcast channel | OFDM | Orthogonal Frequency Division |
| BPSK | Binary phase shift keying | | Multiplexing |
| BW | Bandwidth | PAPR | Peak-to-average power ratio |
| CCPCH | Common control physical channel | PCH | Paging channel |
| CDD | Cyclic delay diversity | PDCCH | Physical downlink control channel |
| CDMA | Code Division Multiple Access | PDSCH | Physical downlink shared channel |
| CIR | Channel impulse response | PHY | Physical layer |
| CP | Cyclic prefix | PRACH | Physical random access channel |
| CQI | Channel quality indication | PRB | Physical resource block |
| CSMA | Carrier sense multiple access | PRN | Pseudo random numerical sequence |
| DC | Direct current | PSK | Phase shift keying |
| DFT | Discrete Fourier transform | PUCCH | Physical uplink control channel |
| DL | Downlink | PUSCH | Physical uplink shared channel |
| DL-SCH | Downlink-shared channel | QAM | Quadrature amplitude modulation |
| DRX | Discontinuous receive | QPSK | Quadrature phase shift keying |
| eNodeB | Enhanced Node B (enhanced base | RACH | Random access channel |
| | station) | RFE | Radio front end |
| FDD | Frequency division duplexing | RFPA | Radio frequency power amplifier |
| FFT | Fast Fourier transform | S/P | Serial-to-parallel |
| GMSK | Gaussian minimum shift keying | SAP | Service access point |
| GT | Guard time | SC-FDMA | Single Carrier - Frequency Division |
| HARQ | Hybrid automatic repeat request | | Multiple Access |
| HSDPA | High Speed Downlink Packet Access | SNR | Signal-to-noise ratio |
| HSUPA | High Speed Uplink Packet Access | STA | Station |
| ICI | Inter carrier interface | TDD | Time Division Duplexing |
| IDFT | Inverse discrete Fourier transform | UE | User equipment |
| IEEE | Institute of Electrical and Electronics | UL | Uplink |
| atvace r z c z e | Engineers | UL-SCH | Uplink – shared channel |
| IFFT | Inverse fast Fourier transform | XCVR | Transceiver |
| ISI | Inter symbol interface | | |
| LO | Local oscillator | | |
| | | | |



LTE

Long Term Evolution



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