TSG-RAN Working Group 2 (Radio L2 and Radio L3) ***R2-001762***
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Agenda item: 7.1
Source: Nokia
Title: Fast Hybrid ARQ description
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The HARQ mechanisms presented for inclusion to the technical report on HARQ in RAN WG2 before meeting #15 assume termination of the retransmission protocol at the serving RNC. According to simulation results provided by Nokia (R2-001419), the block error rate of the first transmission has to be rather high (> 50%) before significant capacity increase is experienced. The influences of the increased error rate and roundtrip delay can be experienced in total acknowledged-mode transmission delay, UE buffering requirements and Iub interface load.

Due to these concerns it is felt that a mechanism, which allows to terminate the HARQ in Node B, is necessary to be included in the comparison of different methods.

This contribution incorporates a proposal for inclusion of a "Fast Hybrid ARQ" mechanism into the technical report. To stay consistent with the protocol termination model of release '99, the mechanism is proposed to be incorporated into the Node B terminated part of the physical layer. No changes for higher user plane air interface protocol layers are necessary.

5 Overview of Hybrid ARQ Type II/III

Two alternative approaches to realize hybrid ARQ are presented in this document for consideration.

Option 1 is based on the present termination of retransmission protocols, i.e. utilizing the retransmission mechanism defined in release '99 with the current termination points and adding Type II functionality as an add-on to the current protocol. Option one is described in chapter 6.

Option 2 is to add fast hybrid ARQ functionality to Node B. With this approach the release '99 RLC and MAC are not affected. Option 2 is described in chapter 7.

6 Option 1: Hybrid ARQ Type II/III in UTRAN Layer 2 and Layer 3

7 Option 2: Fast Hybrid ARQ

The fast HARQ operates with an n-channel stop-and-wait protocol. Dual channel, which can be considered the default operation mode, is illustrated in Figure 1. A continuous transmission flow is separated in time into two subchannels, both of which independently execute a stop-and-wait retransmission protocol. The dual-channel structure guarantees continuous transmission, i.e. the protocol doesn't get stalled waiting for acknowledgements, as long as the roundtrip delay for the acknowledgements is short enough so that the response is always available when the slot for the same subchannel occurs again.

Using a dual-channel approach brings benefits in receiver buffering requirements and decreases error probability in combining retransmissions with earlier received blocks:

- Only the amount of data corresponding to two TTI:s needs to be buffered in the receiver: One for each subchannel. If the transmission is not succesful the retransmission takes place in the next TTI for the respective subchannel.
- For the received data there is only two possibilities: It is either a new transmission or a retransmission of the previously transmitted block. Consequently, the soft combining of data can be done reliably.

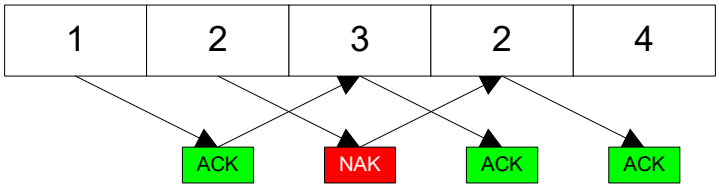

Figure 1 Dual channel stop-and-wait protocol principle.

To perform the fast HARQ operation the physical layer requires some additional side information, e.g. FHARQ sequence number, and redundancy version. The selection of these parameters should be under the control of MAC but the actual parameter values are generated at L1. The physical layer can encode the data and the side information separately, and map them on one, or possibly even different physical channels. At the receiver the buffering and recombining of the data is performed.

7.1 Protocol architecture

This section gives a general overview of function split for fast HARQ in the UE, the Node B, the Controlling or Drift RNC, and the Serving RNC in the DL direction. Fast HARQ is employed in DSCH only.

Table 1 shows which functions should be fulfilled in the DL direction in the entities.

	UE	Node B	CRNC / DRNC	SRNC
TX buffering of RLC-PDUs for AMD service	-			RLC
TX buffering for fast HARQ		Layer 1		
Redundancy selection and Parameter setting	-	Layer 1	-	
RX soft decision buffering for combining	Layer 1	-	-	-
RX buffering for RLC-SDU reassembly	RLC	-	-	-
Combining of retransmissions	Layer 1	-	-	-

Table 1: Functional split for fast hybrid ARQ type II/III in the UE, NodeB, CRNC/DRNC, and SRNC in DL direction

Dotted lines in Figure 2 visualise the transport of necessary side information for fast hybrid ARQ operation. Solid lines show the transport of user data that is to utilize fast hybrid ARQ.

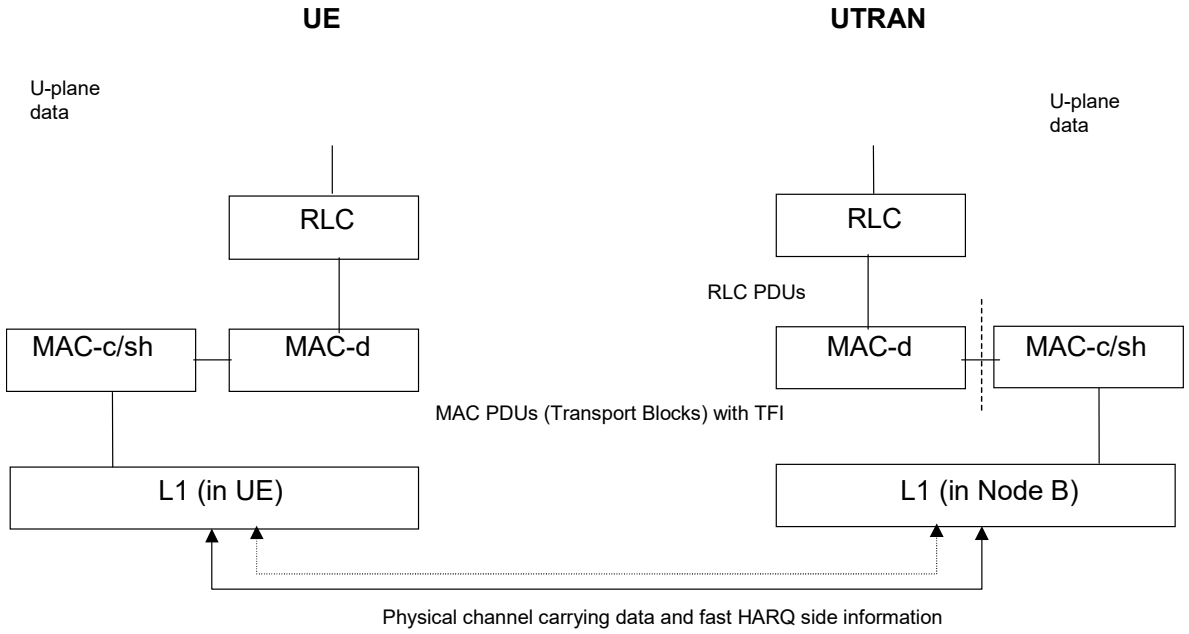

Figure 2 Protocol stack overview for fast hybrid ARQ type II/III.

7.2 Usage of transport channels and physical channels

If fast HARQ is operated as a dual-channel model, the side information must be available very quickly since the retransmission interval is only one frame. The receiver reads the sequence number and redundancy version after which the packet is decoded. The integrity of the packet is checked and an acknowledgement is sent in the current uplink frame. Fast HARQ is planned to be employed on DSCH. Side information and sequence number are added by Layer 1 to facilitate fast decoding at the receiver end.

The fast HARQ feedback information is transmitted once for every TTI. This feedback information can be e.g. inserted into uplink DPDCH frame by reserving a few slots in advance or use some of the dedicated physical control channel (DPCCH) bits in the given slots.

7.3 Services provided by the physical layer

7.3.1 Functions of Layer 1

The main functions of the physical layer are listed in [1]. The following additional functions have to be performed for fast HARQ operation:

- redundancy selection, TX buffering, retransmission control, RX soft decision buffering and combining for data
- encoding/decoding, transmission, and error detection on fast HARQ side information (including fast acknowledgements)
- generation of Acknowledgement PDU & Side Information

7.3.2 Interface to Layer 1

According to the functional split, major parts of the functionality for fast HARQ have to be performed in the physical layer. Some fast HARQ parameters are passed from higher layers, the required changes are FFS.

7.4 MAC protocol

For the basic functionality presented in this document no changes are anticipated to the MAC protocols.

7.5 RLC protocol

No changes to RLC protocols have been identified. As with release '99, RLC can operate in transparent mode, UM or AM independent of whether the fast HARQ is being used.

7.6 RRC protocol

Some additional parameters for the configuration of fast HARQ will be required.

8 Physical Layer impacts