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Source: Lucent Technologies

Title: Downlink Model for HSDPA

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1 Introduction

In this paper, clarifications to comments and questions on Lucent's Downlink model proposal for HSDPA in TSG-RAN WG1#17, TSG-RAN WG1#18, and TSG-RAN WG2#18 are provided.

2 Downlink Transport Channel Multiplexing Structure

In [1], a new multiplex structure is proposed. Figure 1 shows the proposed structure with two HS-DSCH transport channels input from the MAC layer. The MAC HS-DSCH is a new entity proposed in [2] to support HSDPA and is terminated in Node B.

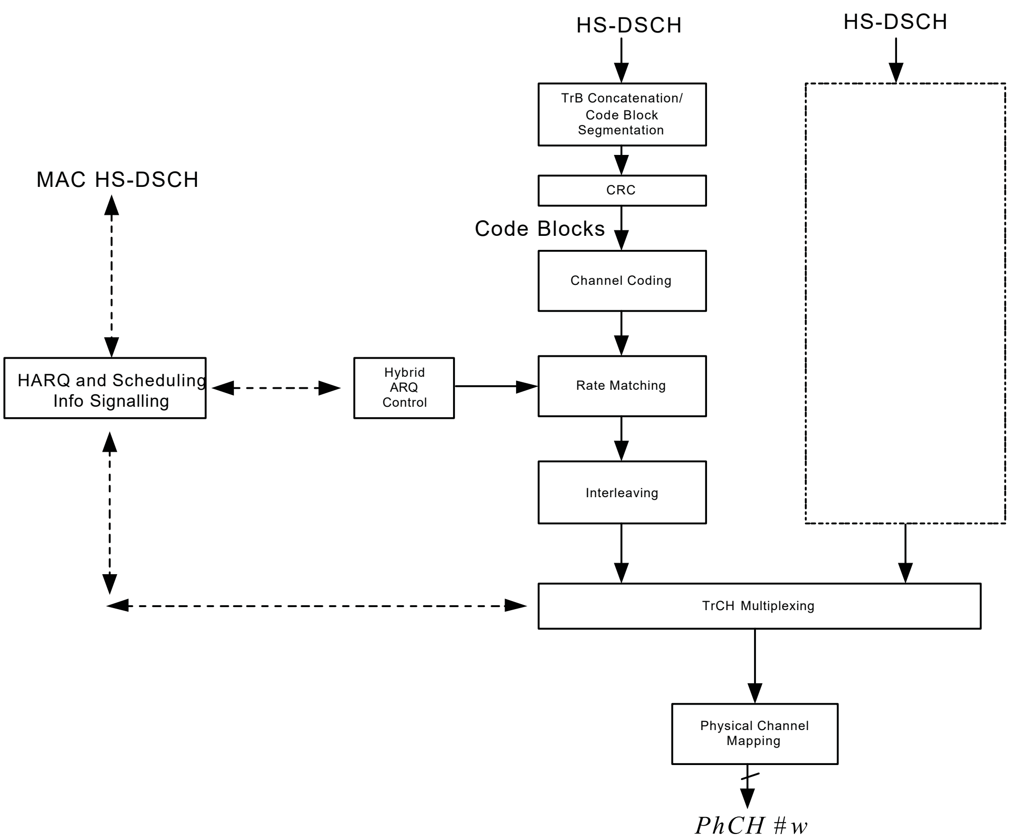

Figure 1: Proposed HSDPA Multiplex Structure [1]

2.1 Code Block or Transport Block Set

Transport Block Set is the entity exchanged between MAC and the Physical layer via the DSCH transport channel, every TTI. As shown in Figure 1, the transport blocks are concatenated and a CRC is appended to the concatenated transport blocks. This concatenated transport blocks with its CRC is termed *Code Block*. Similarly, the Transport Block Set sizes are referred to as Code Block Sizes as used [4].

Predefined Code Block sizes of values {640bits, 1280bits, 2560bits, 5120bits} assuming Transport Block size of 320bits are proposed in [5]. Support of Code Block sizes based on other Transport Block sizes as proposed for R99 is not precluded in this proposal.

As in R99, the Code Blocks sizes as defined above can change from one transmission time interval (TTI) to the next.

2.2 Single CRC Per Code Block

A single ACK/NACK bit per Code Block is proposed. Due to the smaller radio frame sizes as stated above, the overhead of using a CRC per transport block would be very high. To reduce the overhead, a single CRC is used for the concatenated transport blocks or the code block. This also allows for using a single bit to feedback the ACK/NACK back to the Node B.

2.3 Multiple TTI Values

The transmission time interval is defined as the inter-arrival time of Transport Block Sets and the MAC delivers one Transport Block Set to the Physical layer every TTI. Thus, the TTI is also the time interval for which the HSDPA radio resource is allocated to a UE.

In R99, the TTI is a multiple of the radio frame of 10ms, taking on values of {10ms, 20ms, 40ms, and 80ms}. A minimum TTI of 1 slot (0.667ms) was proposed in [3] and [4]. In [5], TTI values of {1, 2, 4, 8, 16} slots are proposed. In addition, the benefits of using variable TTI are discussed in [6].

Because the TTI is also the interval for the radio resources that are allocated to an UE, minimum TTI of 1 slot also corresponds to radio sub-frame of 1 slot.

2.4 Variable TTI

In R99, the TTI can be changed in the Transport Format and is an attribute in the semi-static part of the Transport Format. However, this TTI variation is controlled through control signalling from the RRC and it varies at a slow rate.

Multiple TTI values are proposed in [5], and explained in the previous section. In addition, it has been proposed that the TTI be varied during a connection based on the user's channel condition and data backlog [5]. This variation of the TTI is controlled and signalled from the MAC HSDPA which is proposed to be resident in Node B [2] to ensure very fast channel response and adaptation.

2.5 Rate Matching

In R99, the rate matching function (dynamic rate matching per CCTrCH) is primary to balance the resource between the different transport channels by matching the bit rate of the transport channel to one of the limited set of bit rates of the downlink (or uplink) physical channels. In addition, more than one transport channel can be multiplexed within a single radio frame of 10ms.

A simplification to perform the rate matching per transport channel is proposed in [3]. Minimum TTI of 1 slot or radio sub-frame of 1 slot ensures high frame-fill efficiency compared to radio frames with frame duration that is of multiple 10ms. The small radio sub-frame of single slot avoids the need to multiplex multiple transport channels into a single radio frame. Hence, rate matching on a single transport channel is proposed. The rate matching proposed would be part of the HARQ function with control entity that resides in the proposed MAC HSDPA.

2.6 Transport Channel Multiplexing

As explained in the previous section, the proposed radio sub-frame of 1 slot allows for rate matching operation over a single transport channel. As a result, the second intra-frame interleaver that performs 10ms radio frame interleaving will not be needed and thus is not proposed in the downlink model.

Data stream from other transport channels would be sent serially and the QoS of each of transport channels is provision through smart scheduling and the rate matching function.

2.7 One or Multiple HS-DSCH Transport Channels

In TS 25.321, more than one HS-DSCH transport channels are defined. If only a single HS-DSCH transport channel is used, the Coded Composite Transport Channel (CCTrCh) would then be unnecessary for thus will not be supported for HSDPA.

Flexibility in scheduling leading to better source adaptation could be achieved when more than one HS-DSCH transport channel is used. These are due to the small packets sent during connection set up and tear down of the TCP link and HTTP traffic. These packets may only require a small portion of the full 10ms frame to transmit, resulting in high frame overhead. To alleviate this problem, more than one HS-DSCH can be used with one or multiple users on the different HS-DSCH transport channels, adding flexibility into the system and thus improving the frame fill efficiency. With multiple HS-DSCH transport channels, the CCTrCH frame is thus a composite of all the transport channels for one UE or for different UEs.

The alternative solution would be by providing flexibility through the use of smaller radio frame, such as the proposed sub-frame of 1 slot. Efficient frame filling is possible because of the smaller frame sizes and the smaller frame sizes also facilitate fast scheduling among the different UEs onto the CCTrCH.

The proposed downlink model supports the use of single and multiple HS-DSCH transport channels.

3 Summary: Comparison with R99 DL Model

The table below summarises the similarity and differences between Lucent's HSDPA proposal and the R99 Downlink Shared Channels.

	R99 DSCH Model	**Lucent Proposed DSCH Model**
TTI	10ms, 20ms, 40ms, and 80ms	Variable TTI with smallest TTI of 1 slot (0.667ms)
Frame Size	Radio frame of 10ms	Radio Sub-frame with minimum duration of 1 slot (0.667ms)
Physical Channels	Multiple physical channels per TTI	Multiple physical channels per TTI
SF	SF can vary every TTI	Fixed SF is proposed
DSCH Transport Channels	Multiple DSCH Transport Channels are defined. However, the need to support more than one DSCH Transport Channels has been proposed for further study.	Proposal supports use of multiple DSCH Transport Channels
Rate Matching	Performed on the CCTrCH level or across multiple Transport Channels.	Performed per Transport Channel
DSCH CCTrCH	Single or multiple DSCH CCTrCh could be defined.	Single or multiple DSCH CCTrCh could be defined.
UEs sharing Time and Code space	Both in Time and Codes. More than one DSCH CCTrCH must be supported	Both in Time and Codes. More than one DSCH CCTrCH must be supported for

	for Codes sharing among UEs.	Codes sharing among UEs.

Table 1: Comparison of the Proposed DL Model and the R99 DL Model

4 References

[1] "Downlink Transport Channel Multiplexing Structure for HSDPA", TSG-RAN #17(00) 1383 Lucent Technologies.

[2] "HSDPA Radio Interface Protocol Architecture", R2A010023, Ericson, Motorola.

[3] "Downlink and Uplink Channel Structures for HSDPA", TSG-RAN#17(00) 1383, Lucent Technologies.

[4] "Physical layer aspects of HSDPA and text proposals for HSDPA TR", TSG-RAN1#16(00) 1193, Ericsson.

[5] "A^2IR – An asynchronous and adaptive Hybrid ARQ scheme for HSDPA", TSG-RAN1#18, R1-01-0080, Lucent Technologies.

[6] "Variable TTI proposal for HSDPA", TSG-RAN1#18 (00), R1-01-0079, Lucent Technologies.