TSG-RAN Working Group 1
Sweden
November 21-24

TSGR1#16(00) 1383

Agenda item: HSDPA

Source: Lucent Technologies

Title: Downlink Transport Channel Multiplexing Structure for HSDPA

Document for: Discussion and decision

1 Introduction

This contribution provides an approach for time division multiplexing of transport channel in the HSDPA downlink. The considerations made in this design are

1 Simplicity: Since the shared channel is intended for packet data services, the design here tries to simplify many of the elements of the Release 99 Transport Channel Multiplexing Structure for Downlink (TS25.212 V3.4.0, Figure 2). In particular, the proposed design uses time division multiplexing of transport channels to achieve significant simplification of the rate matching procedures compared to Release 99. Here rate matching (coding, repetition, puncturing) is handled per transport channel.

2 Efficiency: The proposed structure is optimised for transport channels with requirements that are suitably multiplexed into a HS-PDSCH rather than a dedicated channel. The single-slot granularity ensures high frame-fill efficiency compared to frames that span many slots. This eliminates the need for multiplexing of multiple transport channels within a single frame. Instead, different transport channels each having separate delay-throughput requirements are multiplexed using time division multiplexing. In addition to simple rate matching, scheduling flexibility is used to achieve QoS requirements. This approach maximizes system throughput while meeting transport channel QoS requirements.

3 Low Overheads: Since the frame granularity could be as small as a slot, the overhead in carrying TFCI information on the downlink or acknowledgement (ACK) information for multiple transport channels on the uplink would be excessive. The time division multiplexing of transport channels, outlined here limits the overhead due to TFCI (downlink) as well as that from ACK information (uplink).

The design is particularly well suited for efficient transport of high-speed packet data on the HS-DSCH.

2 Proposed Multiplexing Structure

The positioning of the proposed multiplex structure with respect to the current specified structure in TS25.212 V3.4.0 is shown in Figure 1.

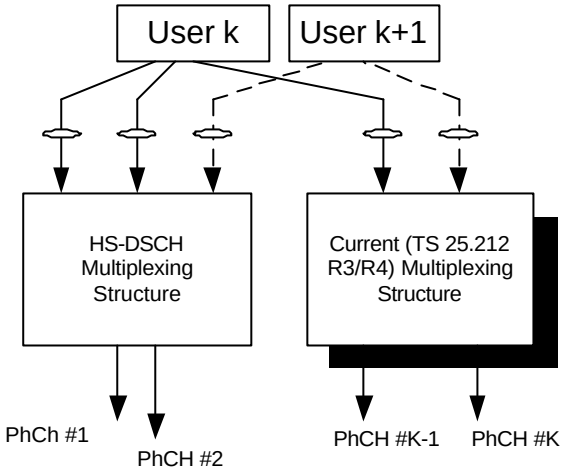

Figure 1: Positioning of HS-DSCH multiplexing structure

The two structures exist and can operate in parallel. The HS-DSCH structure accepts information from a number of transport channels, one or more of which belong to different users, time multiplexes/schedules those into a single Coded Shared (or Scheduled) Transport Channel (CSTrCH). The CSTrCH is then mapped into a number of Physical Channels each corresponding to an channelization code. All HS-PDSCH codes have the same spreading factor and are known to the UE via the mechanism that allows dynamic code-sharing as outlined in [2]

The RRC layer determines the user ids (denoted by k and h) and/or TrCH ids (denoted by l and i in the subsequent discussion) that are multiplexed via the HS-DSCH structure and those that will be multiplexed in the currently specified UMTS R3/R4 structure. The RRC layer would make this determination based on the required QoS.

The signal flow diagram of the proposed HS-DSCH structure is shown in Figure 2.

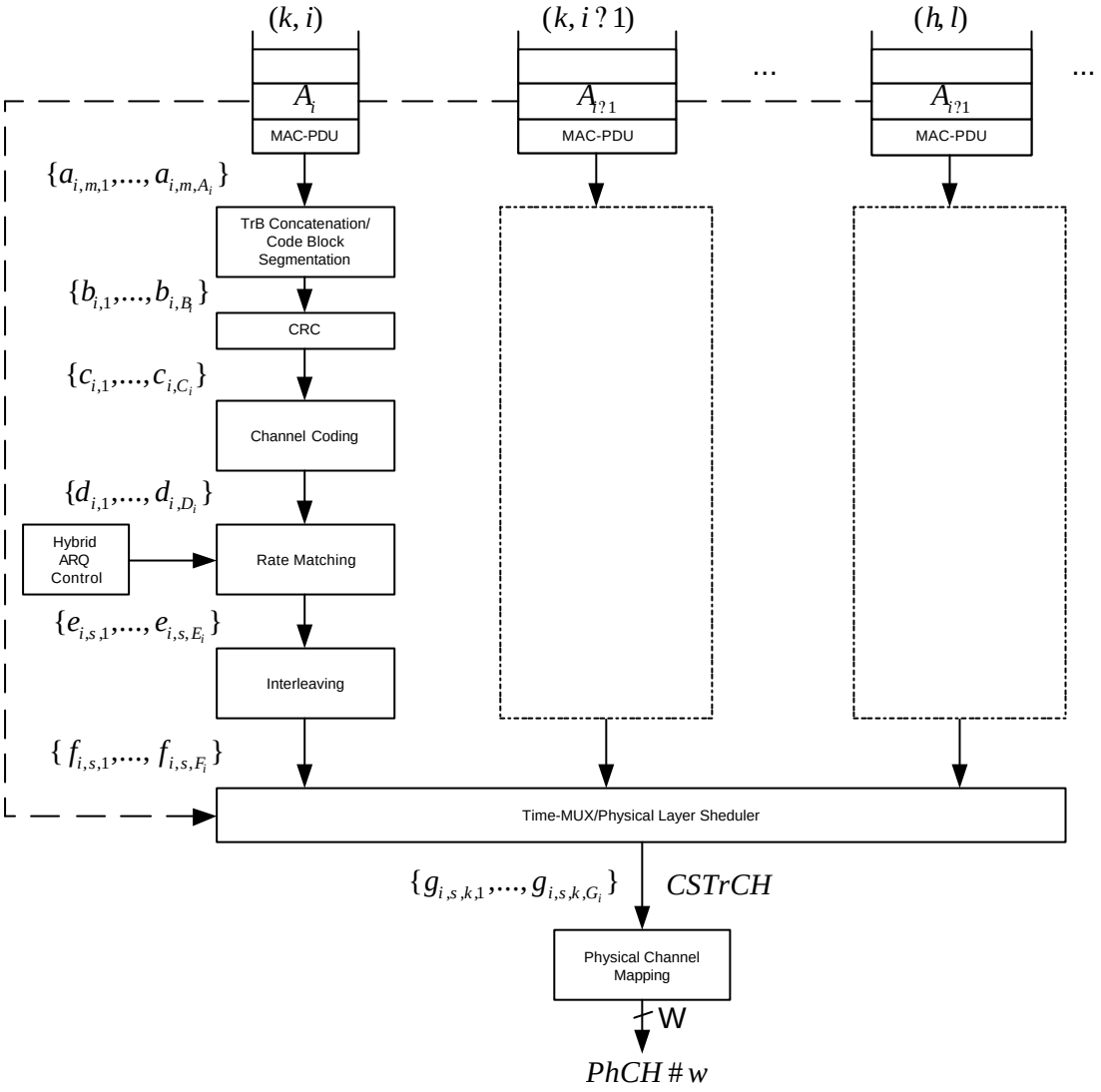

Figure 2: Proposed HSDPA Multiplex Structure (k, h are user ids, i, l are TrCH ids)

The Transport Channel i injects into the HSDPA physical layer multiplex structure, information formatted in MAC-PDU units. Each MAC PDU consists of $A(i)$ bits and is represented as $\{a_{i,m,1},...,a_{i,m,A_i}\}$. The index m, identifies one of the M MAC-PDUs that are injected into the physical layer to be transmitted within a Transmission Time Interval (TTI) that is given by,

$$TTI ? n ? T_{slot}$$

where n depends on HSDPA scheduling, hybrid ARQ state and rate information provided by the mobile (see accompanying contribution [2].

In the current multiplexing structure, the presence of multiple transport channels into the physical layer and the multitude of configuration possibilities, mandate explicit Transport Format Combination Indication signalling to the UE.

In HSDPA though, it is the UE that sends via the proposed UL DPCCH channel's RAI field [2], the required Rate Information (RI) to the Node-B. In this respect, the TFCI signalling can be significantly reduced by mapping the RI and the TrCH id (index i) scheduled by the Physical Layer Scheduler (PLS) entity, into the number of PDUs that are transmitted to the UE i.e.

$$M ? ? (RI, i).$$

where the function $?(.)$ is known to both the Node-B and the UE. The only information that is required by the UE to allow HS-DSCH demultiplexing, is the TrCH id, as in general more than one TrCH are time multiplexed by the PLS. At any instant in time only one TrCH will be transmitted to one of the UEs.

The UE upon decoding the TrCH id, can determine the number M of PDUs and can de-multiplex the HS-DSCH channel. Inefficiencies may arise in the following scenario: when the channel conditions are favourable, the UE indicates a Rate Information that corresponds to an $M ?? M_{actual}$ where M_{actual} is the number of PDUs that are actually waiting in the Node-B buffer. Consequently, another option would be the explicit signalling to the UE of $M ? \{M_{\min},...,M_{\max}\}$ in order to avoid excessive padding. The set of allowed values for M are communicated to the UE via higher layer signalling.

After the concatenation of the M PDUs and Code Block segmentation, a CRC code is appended to each Code Block Segment CBS of $B(i)$ bits resulting in a block of

$$C(i) ? B(i) ? CRC(i)$$

bits that is encoded by a Turbo encoder with nominal code rate r. The resulting $D(i)$ bits are punctured to a code rate $r*(i,RI) ? r$ that is a deterministic function of the decoded Rate Information (RI) received in the UL-DPCCH. A coded sub-block (denoted by the index s) is defined as a rate-matched block of size $E(RI,i)$ bits that is submitted to the block interleaver with memory $E(RI,i)$ and finally via the Time-Multiplexer/Physical Layer Scheduler (PLS) entity forms a Coded Shared Transport Channel (CSTrCH). The mapping from CSTrCH to a number of physical channels is performed using the number of W-ary OVSF codes (W is a system constant) that are available at the point of time of the actual transmission.

3 References

[1] “Control Channel Structure for High Speed DSCH (HS-DSCH)”, TSG-RAN #16(00) 1242, Motorola.

[2] “Downlink and Uplink Channel Structures for HSDPA”, TSG-RAN #17(00)1381, Lucent Technologies.