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Abstract of document:

This technical report captures the results of the work on the work item "High Speed Downlink Packet Access". The TR captures the working assumptions on various issues. In addition it captures the requirements to be considered in evaluating techniques for HSDPA and the open issues that need resolution. The document details the progress made so far on:

- UTRAN architecture (protocol model)
- The physical structure and attributes of the physical layer
- The HS-DSCH transport channel attributes
- The physical Layer model and downlink and uplink signalling approaches
- MAC architecture
- HARQ protocol considerations
- Signalling requirements for downlink and uplink

Changes since last presentation to TSG-RAN Meeting:

This is the first presentation of the TR to RAN.

Outstanding Issues:

The outstanding issues and progress made is fully captured in the TR.

Contentious Issues:

3GPP TR 25.855 V1.0.0 (2001-06)

Technical Report

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

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x the first digit:

1 presented to TSG for information;

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document captures the working assumptions and evaluation criteria of the different techniques being considered for HSDPA with regards to the overall support of UTRAN for HSDPA.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 25.950 (Release 4, version 4): "UTRA High Speed Downlink Packet Access".

3 Void

4 Background and Introduction

In the TSG-RAN #11 plenary meeting a work item was approved for High Speed Downlink Packet Access. The work item includes techniques such as adaptive modulation and coding, hybrid ARQ and fast scheduling with the goal to increase throughput, reduce delay and achieve high peak rates.

5 Requirements for the evaluation of techniques for High Speed Downlink Packet Access

The following considerations should be taken into account in the evaluation of the different techniques proposed for HSDPA.

1. The focus shall be on the streaming, interactive and background services. It should be noted that it might not be possible to simultaneously optimise the characteristics of HSDPA for all of the above traffic classes.
2. System performance improvement shall be obtained with the concomitant reduction in delay of service.
3. Priority shall be given to urban environments and then to indoor deployments. The techniques shall not be limited to these environments however.
4. The techniques accepted shall be optimised at speeds typical of urban environments but techniques should apply at other speeds also. Full mobility shall be supported, i.e., mobility should be supported for high-speed cases also, but optimisation should be for low-speed to medium-speed scenarios.
5. Features or group of features considered should demonstrate significant incremental gain.
6. Features accepted shall provide the benefit at reasonable cost to the operators. The value added per feature should be considered in the evaluation.

7. The techniques should be compatible with advanced antenna and receiver techniques.
8. The techniques should take into account the impact on R'99 networks both from a protocol and hardware perspective.
9. The choice of techniques (such as HARQ) shall take into account UE processing time and memory requirements.
10. The UE complexity shall be minimised for a given level of system performance.
11. An evolutionary philosophy shall be adopted as opposed to a revolutionary one in adopting new techniques and architectures.

6 Basic structure of HS-DSCH

6.1 Architecture Issues

Two architectures were considered as part of the original study item: an RNC-based architecture consistent with R'99 architecture and a Node B-based architecture for scheduling [1]. Moving the scheduling to the Node B enables a more efficient implementation of scheduling by allowing the scheduler to work with the most recent channel information. The scheduler can adapt the modulation to better match the current channel conditions and fading environment. Moreover, the scheduler can exploit the multi-user diversity by scheduling only those users in constructive fades. Furthermore, the HSDPA proposal has the additional potential to improve on the RNC-based HARQ architecture in both UE memory requirements and transmission delay. The scheduler for the HSDPA channel is therefore located in the Node B.

6.2 Protocol structure

Since the HSDPA functionality should be able to operate in an environment where certain cells are not updated with HSDPA functionality there is a need to as far as possible keep the R'99 functional split between layers. Furthermore, since the HSDPA functionality is intended for transport of dedicated logical channels, it is logical to keep the layers above MAC intact from R'99. Hence, it is proposed to keep the PDCP and RLC layers as is when using HSDPA functionality. This means that RLC can operate in either AM or UM mode (but not in TM mode due to ciphering) and PDCP can be configured either to do header compression or not. Furthermore, transport channel type switching is feasible if the MAC layer has similar functional split in UTRAN as for R'99, i.e. retaining MAC-d in S-RNC.

The new functionality of hybrid ARQ and HSDPA scheduling are proposed to be included in a MAC layer. In the UTRAN it is proposed to include them in a new entity called MAC-hs terminated in Node B. The transport channel that the HSDPA functionality will use is called HS-DSCH (High Speed Downlink Shared Channel). The MAC entity controlling the transport channel is called MAC-hs.

Furthermore, the physical layer will have to be updated with signalling support for hybrid ARQ and HS-DSCH scheduling. Figure 1 shows the proposed radio interface protocol architecture with termination points. MAC-hs in Node B is located below MAC-c/sh in CRNC. MAC-c/sh shall provide functions to HSDPA already included for DSCH in the R'99 version of MAC-c/sh. Note that the HS-DSCH FP (frame protocol) will handle the data transport from SRNC to CRNC (if the Iur interface is involved) and between CRNC and the Node B.

The proposed architecture supports both FDD and TDD modes of operation, though in the case of TDD, some details of the associated signalling for HS-DSCH are different.

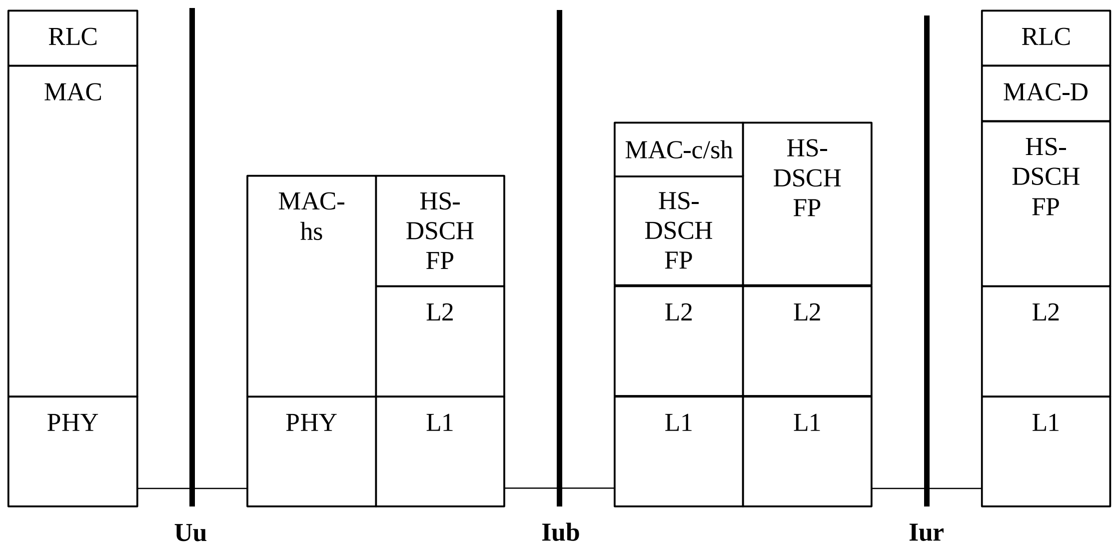

Figure 1: Radio Interface Protocol Architecture of HSDPA

6.3 Basic physical structure

6.3.1 DL HSDPA Physical layer model

6.3.1.1 FDD Downlink Physical layer Model

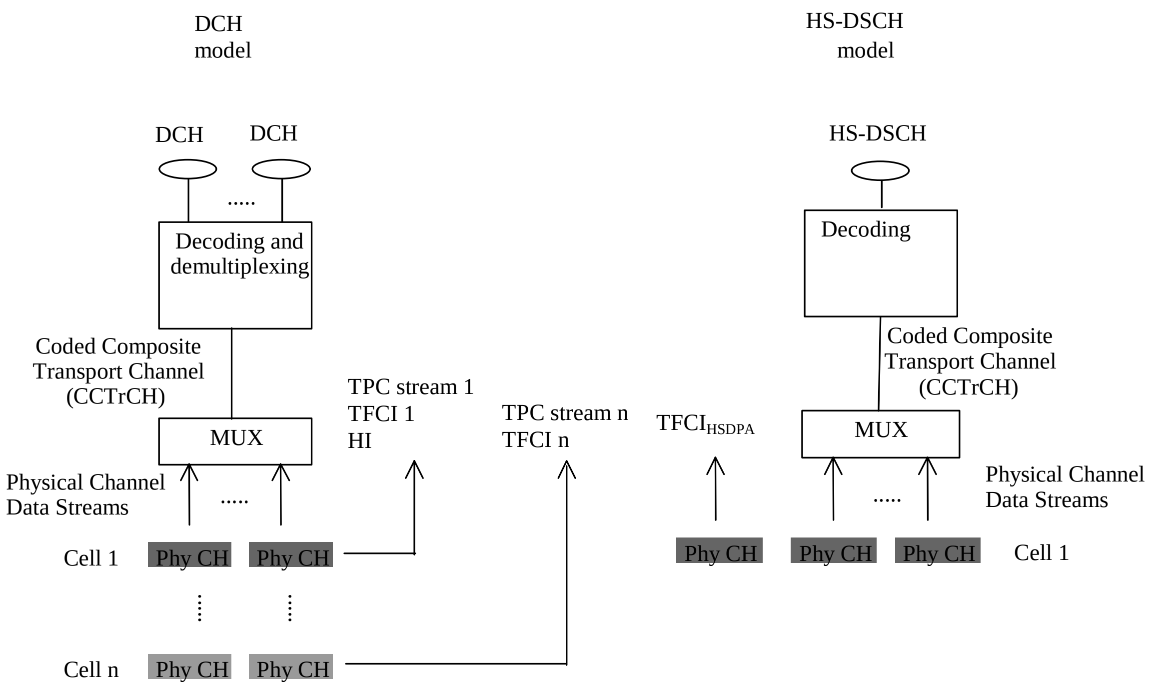

Figure 2: Model of the UE's Downlink physical layer - HS-PDSCH with associated DPCH. HS-PDSCH is transmitted from cell 1 in this figure.

NOTE: In Figure 2 above the model for the DCH is included for completeness and to be consistent with the approach in TS 25.302.

A HS-DSCH transport channel is processed and decoded from one CCTrCH. The CCTrCH can be mapped to one or several physical channels.

There is only one CCTrCH of HS-DSCH type per UE. If there are several HS-DSCH transport channels in a HS-DSCH CCTrCH, the transport format combinations are configured in such a way that for any transport format combination, there is a maximum of one transport channel having a transport format with one or more transport blocks. The possibility to have multiple HS-DSCH per CCTrCH is FFS.

The basic downlink channel configuration proposed is a DPCH combined with a separate shared physical control channel in combination with the HS-PDSCH.

It is FFS whether the L1 signalling on the DPCH (i.e. carried by the DPCCH) relates to the HS-PDSCH or not. Two possibilities exist:

- the two-step approach - a pointer exists which in turn directs the UE to a shared control channel;
- the one-step approach - the UE monitors only the shared control channel that carries all the necessary HS-DSCH control information.

Both of the above possibilities have been proposed for both FDD and TDD modes.

6.3.1.1.1 One-step signalling approach

A one-step approach results by mapping all the control information related to the HS-PDSCH on the shared control physical channel. The DPCH does not in this case carry any HS-PDSCH information (for example HI). UEs assigned to the HS-PDSCH must therefore monitor the shared control physical channel continuously. The upper layer signalling on the DCCH can be mapped to the associated DPCH or the HS-PDSCH as in the case of R'99 PDSCH.

Another one-step proposal for the downlink signalling configuration consists of a new dedicated physical channel that is operated in a combined time-division and code-division multiplexing fashion and which carries the necessary power control information for the uplink. The information necessary for the UE to read the data on the HS-PDSCH is carried on a shared physical control channel as in the case of the other one-step approach described above (and also the two-step approach described later below). Here as well, UEs assigned to the HS-PDSCH must monitor the shared control physical channel continuously. In this instance, the higher layer signalling on the DCCH is mapped to the HS-PDSCH. The possibility to map the higher layer signalling on the DCCH on to the new physical channel is FFS.

6.3.1.1.2 Two-step signalling approach

The two-step approach to signalling using the pointer technique is described below.

The model for the associated dedicated physical channel is almost identical to that of a stand-alone DCH. The difference is that a HI (HS-DSCH Indicator) is additionally carried on the DPCH. The DPCH therefore has a slot format different from that used for the DPCH in R'99 and Rel-4.

The HI in turn carries information indicating to the UE to read the HS-DSCH TFCI carried on a separate shared control physical channel, and also to read the HS-PDSCH. The upper layer signalling on the DCCH is mapped to the associated DPCH. The possibility to map the DCCH carrying upper layer signalling to the HS-DSCH, as in the case of R'99 PDSCH, remains.

The timing offsets between the various channels in the two-step approach are FFS.

NOTE: Several UEs can simultaneously get addressed using independent HIs to read $TFCI_{HSDSCH}$. This envisages the use of multiple shared control physical channels; the specific shared control channel assigned to the UE is identified on the associated dedicated control channel. Other methods which allow for a single shared control channel carrying multiple records for individual UEs all simultaneously addressed on the respective associated dedicated physical channel are also possible.

In summary there are four possibilities for configuring the downlink physical channels to provide the necessary signalling support. These are indicated in the table below. The four cases are distinguished based on the mapping of the DCCH carrying higher layer signalling and the structure of the physical channel(s). All configurations rely on a shared control physical channel - the differences relate to what the shared control channel carries in each configuration and what if any information is carried by a dedicated physical channel if associated with the HS-PDSCH.

NOTE: Cases 2,3 and 4 are FFS.

Table 1: Possibilities for downlink signalling

	DL Physical Channel	DCCH mapping onto DPCH	New Requirements for HSDPA
1	DPCH	DPDCH has a DCH for DCCH	Requires new slot formats
2	DPCH	DPDCH has no DCH for DCCH, DCCH mapped to HS-PDSCH.	Requires new slot formats
3	DPCH/N	DPDCH has no DCH for DCCH, DCCH mapped to HS-PDSCH. Sub-rate TDM multiplexed DPCH	Requires new physical channel (CDM + TDM channel) Minimises downlink code usage
4	*DPCH/N*	*DPDCH has DCH for DCCH,* *Sub-rate TDM multiplexed DPCH*	*Requires new physical channel* *(CDM + TDM channel)* *Minimises downlink code usage*

6.3.1.2 TDD Downlink Physical layer model

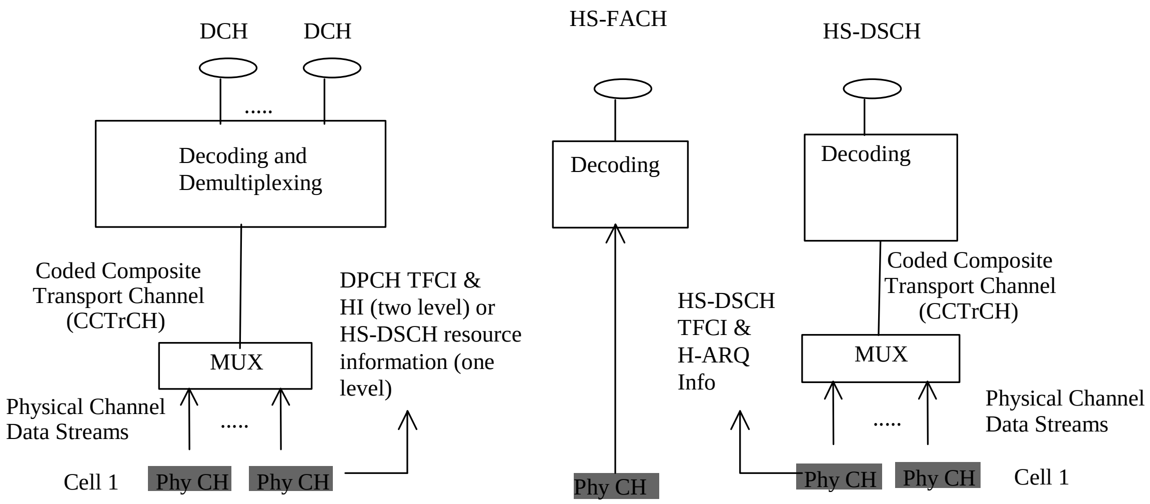

Figure 3: Model of the UE's physical layer (TDD)

In the case of TDD as well there are multiple possibilities - depending on whether a dedicated control channel or a common control channel approach is used. Furthermore, both one-step and two-step signalling approaches are possible. Figure 3 shows the physical layer model for both cases.

6.3.1.2.1 One-step approach

In the associated dedicated control channel configuration, the associated DPCH carries all the necessary information for resource allocation on the HS-DSCH.

In the common control channel configuration, a common control channel (HS-FACH) to carry all the necessary downlink signalling information for support of the HS-DSCH. There is no associated dedicated control channel and the UE continuously monitors the common control channel for allocation of the HS-DSCH.

6.3.1.2.2 Two-step approach

In case of the two-step approach, an indicator (HI) on the associated dedicated control channel provides information to the UE about the need to read the HS-FACH and HS-DSCH. The downlink signalling information for support of HS-DSCH is carried by a HS-FACH transport channel mapped to a physical channel (either a S-CCPCH or a newly defined physical channel), different from the S-CCPCH carrying FACH and PCH. HS-FACH is different from release 99 FACH due to the fact that its starting point is in Node B and not in CRNC. HS-FACH does not support any logical channels. HS-FACH is not multiplexed with other transport channels.

It is FFS whether a separate S-CCPCH is used to carry HS-FACH or whether it is required to introduce HS-PDCCH (High Speed Physical Downlink Control Channel) as new physical channel.

Whether TFCI is needed on the physical channel carrying HS-FACH or not is FFS.

Whether the TFCI information for a UEs HS-DSCH is carried within the HS-DSCH itself or in some other way is FFS.

6.3.2 UL HSDPA Physical layer model

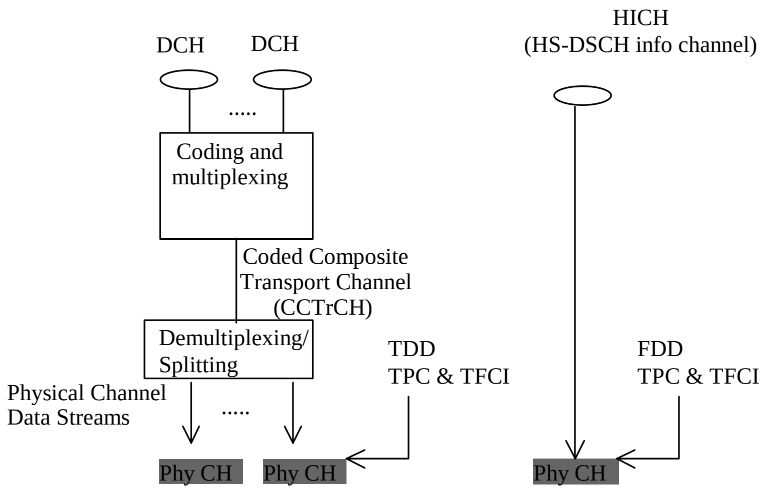

Figure 4: Model of the UE's Uplink physical layer

The HS-DSCH information that is needed in the uplink is higher layer information from the H-ARQ entity in the MAC -hs and possible measurements for MCS selection and scheduling. This information is carried on the HICH (HS-DSCH Information CHannel).

In FDD the current working assumption is to use the R'99 DPCCH structure with a SF=256. Since there are no bits left on the current R'99 DPCCH for the new information required and there is a need for backwards compatibility with R'99 and REL-4 Node Bs, the proposal is to have the HS-DSCH information carried on a new DPCCH (DPCCH-2) code-multiplexed with the DPCCH, currently defined in the specifications, and the DPDCH.

In TDD it is FFS if the HICH information is carried on the physical channel carrying the DCHs along with TPC and TFCI or on a new uplink physical channel, the HS-PUCCH (High Speed Physical Uplink Control Channel).

6.3.3 HSDPA physical-layer structure in the code domain

In the code domain, it has been proposed that HSDPA transmission would use a fixed spreading factor and multi-code transmission. The working assumption is a SF=16. Furthermore, the support of code multiplexing of UEs, as in the case of R'99 DSCH, is a working assumption.

6.3.4 HSDPA physical-layer structure in the time domain

In the time domain, the support of HSDPA TTI shorter than one radio frame (10 ms) has been proposed. In addition there are proposals for dynamic TTI. The length of such shorter HSDPA TTI should be selected from the set $\{T_{slot}, 3\times T_{slot}\}$ where T_{slot} is equal to 0.67 ms. In addition it is proposed to have mandatory support for 10 ms TTI as well - this is FFS.

6.4 Transport channel structure

The HS-DSCH transport channel is characterised by the following:

- existence in downlink only;
- possibility to use beam forming;
- possibility of applying link adaptation techniques other than power control;
- possibility to be broadcast in the entire cell;
- always associated with a DPCH, S-CCPCH, new to-be-defined (FFS) physical channels (TDD) or standalone. The approaches to be adopted are FFS.

The following is a list of transport channel attributes:

1. Transport block size - semi-static or dynamic
2. Transport block set size - dynamic for 1st transmission. Restriction for retransmission is for further study.
3. Transmission Time Interval (TTI). The working assumption is a semi-static TTI. The choice of one fixed, two semi-static or multiple semi-static values is FFS.

   Dynamic TTI has also been proposed. Its merits compared to the semi-static case would need to be shown as an incremental gain in WG1 and WG2 before it would be considered.
4. Coding parameters
   a. Type of error protection - fixed turbo coding (working assumption is to maintain the R'99 turbo code block size of 5114 bits)
   b. Coding rate - for further study
   c. Rate matching parameters - for further study
5. Modulation - dynamic for 1st transmission. Restriction for retransmission is for further study. The working assumption is for mandatory support for QPSK and 16 QAM and optional support for 64 QAM. Need for 8PSK is FFS.
6. Redundancy version - dynamic
7. CRC size - semi-static. The working assumption is for a CRC per TTI.

7 MAC Architecture

7.1 HSDPA MAC architecture– UE side

This section describes the architecture of the MAC and functional split required to support the features being considered for HSDPA on the UE side.

7.1.1 Overall architecture

Figure 4 shows the overall MAC architecture where the newly defined MAC-hs has been added to the R'99 model. In case of HSDPA the data received on HS-DSCH is mapped to the MAC-c/sh. The MAC-hs is configured via the MAC Control SAP by RRC similar to the MAC-c/sh and MAC-d, to set the parameters in the MAC-hs like allowed transport format combinations for the HS-DSCH and so on.

The associated Downlink Signalling carries information for support of HS-DSCH while the associated Uplink Signalling carries feedback information.

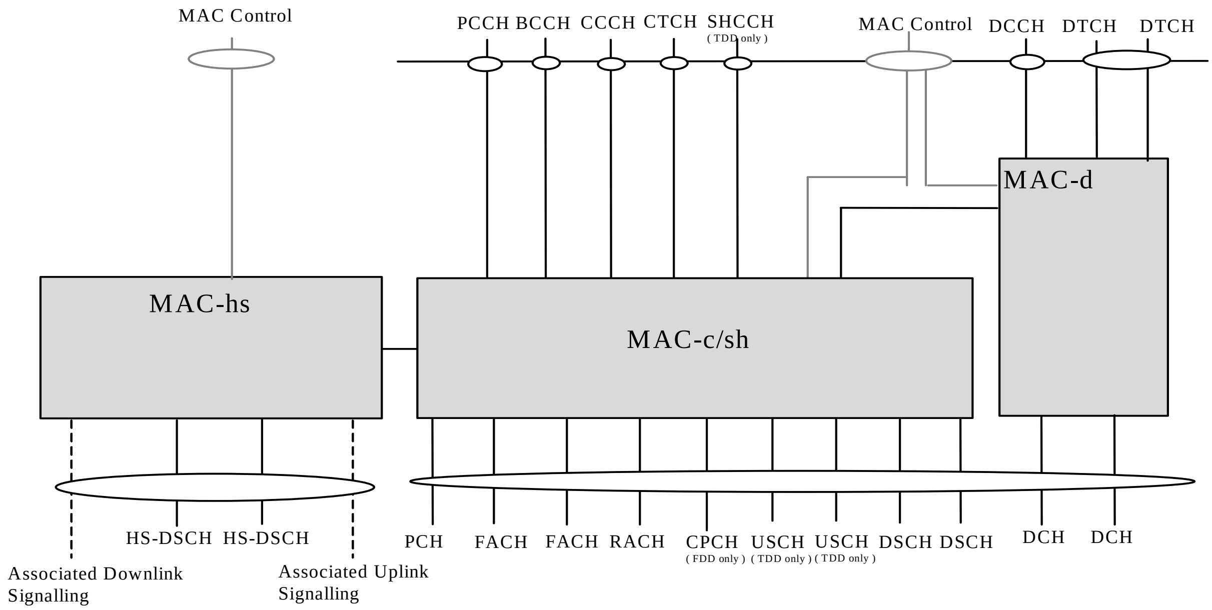

Figure 6: UE side MAC architecture with HSDPA

NOTE: The support of more than one HS-DSCH per UE is FFS.

7.1.2 Details of MAC-c/sh

The MAC-c/sh on the UE side retains its functionality as defined in R'99 with minor additions HSDPA.

NOTE: Newly defined parts are shown distinguished from R'99 architecture in red.

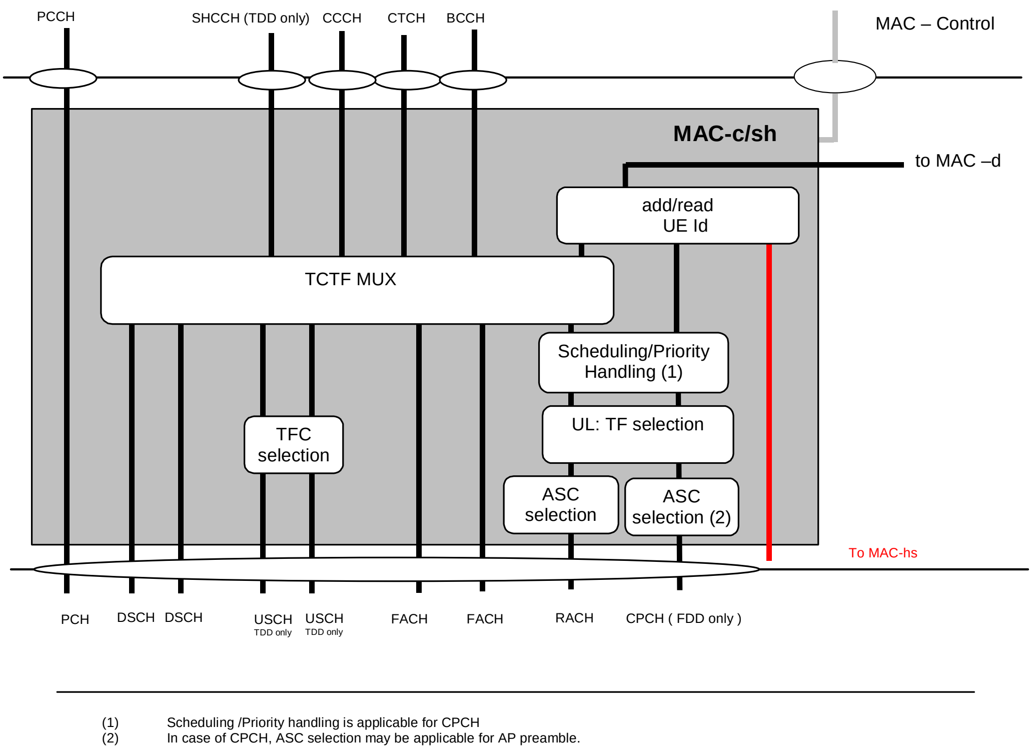

Figure 7: UE side MAC architecture / MAC-c/sh details

NOTE: The need for evaluation of the UE-Id within MAC-c/sh for HS-DSCH is FFS. The current working assumption is that there is sufficient reliability on the downlink signalling for the scheduling and thus the UE-Id is not required additionally on the HS-DSCH and its presence on the associated signalling channel is sufficient.

7.1.3 Details of MAC-hs

The MAC-hs handles the HSDPA specific functions. In the proposed model below the MAC-hs comprises the following entity:

- HARQ:
  The HARQ entity is responsible for handling the HARQ protocol. It is for example responsible for generating ACKs and/or NACKs. It should be noted that the HARQ functional entity handles all the tasks that are required for hybrid ARQ. The detailed configuration of the hybrid ARQ protocol is provided by RRC over the MAC-Control SAP.
  The details of the HARQ protocol are FFS.

NOTE: It is FFS whether a separate functional entity within MAC-hs needs to be added in order to model the handling of measurement results provided by physical layer, management of uplink resources (in case of TDD), etc., or whether these functions are described within HARQ functional entity.

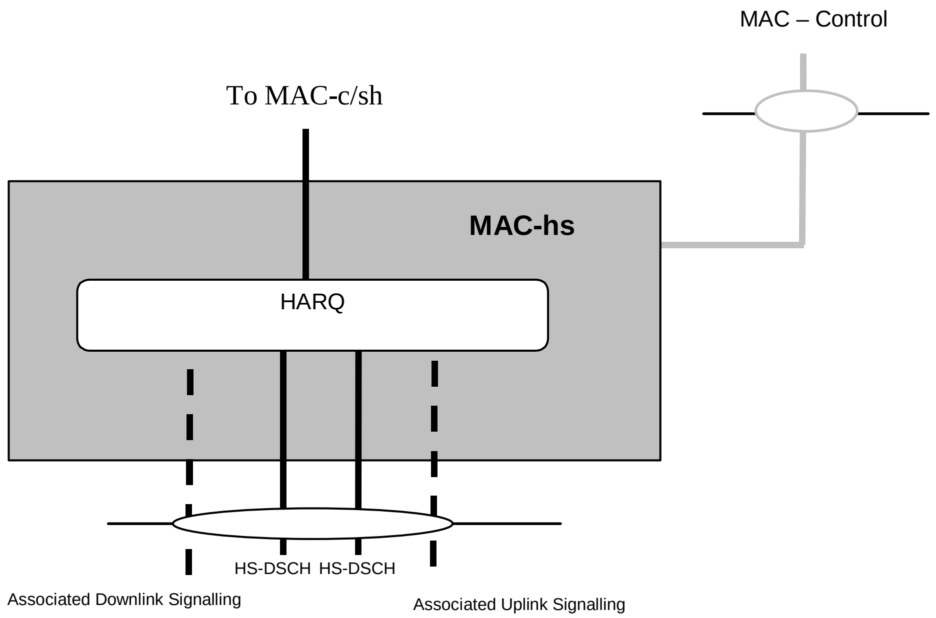

Figure 8: UE side MAC architecture / MAC-hs details

NOTE: The support of more than one HS-DSCH per UE is FFS.

7.2 HSDPA MAC architecture – UTRAN side

This section describes the changes that are required to the MAC model to support the features for HSDPA on the UTRAN side

7.2.1 Overall architecture

One new MAC functional entity, the MAC-hs, is added to the R'99 MAC architecture. The MAC-hs is located in the Node B. If one or more HS-DSCHs are in operation the MAC-hs SDUs to be transmitted are transferred from MAC-c/sh to the MAC-hs via the Iub interface. Details of the impacts on the Iub interface are FFS.

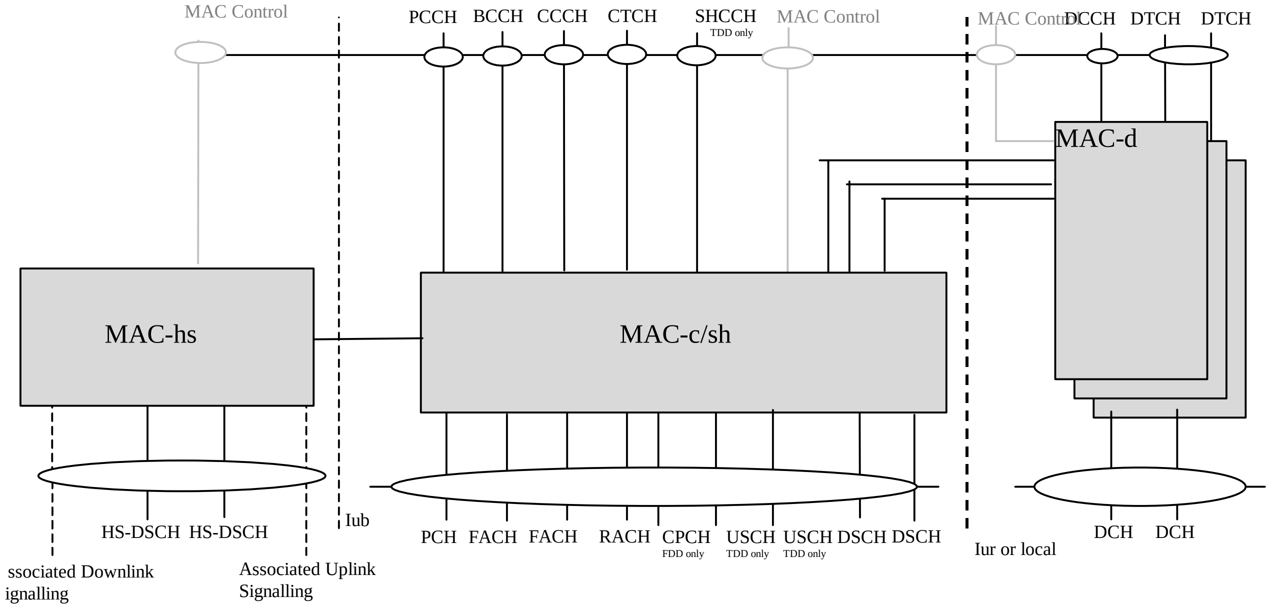

Figure 9: UTRAN side overall MAC architecture

7.2.2 Details of MAC-c/sh

Also on the UTRAN side the additions to the MAC-c/sh functional part are rather limited. The data for the HSDPA are also subject to flow control between the serving and the drift RNC. The impacts on the Iur are FFS.

A new flow control function is included to support the data transfer between MAC-d and MAC-hs. Details of this function are FFS.

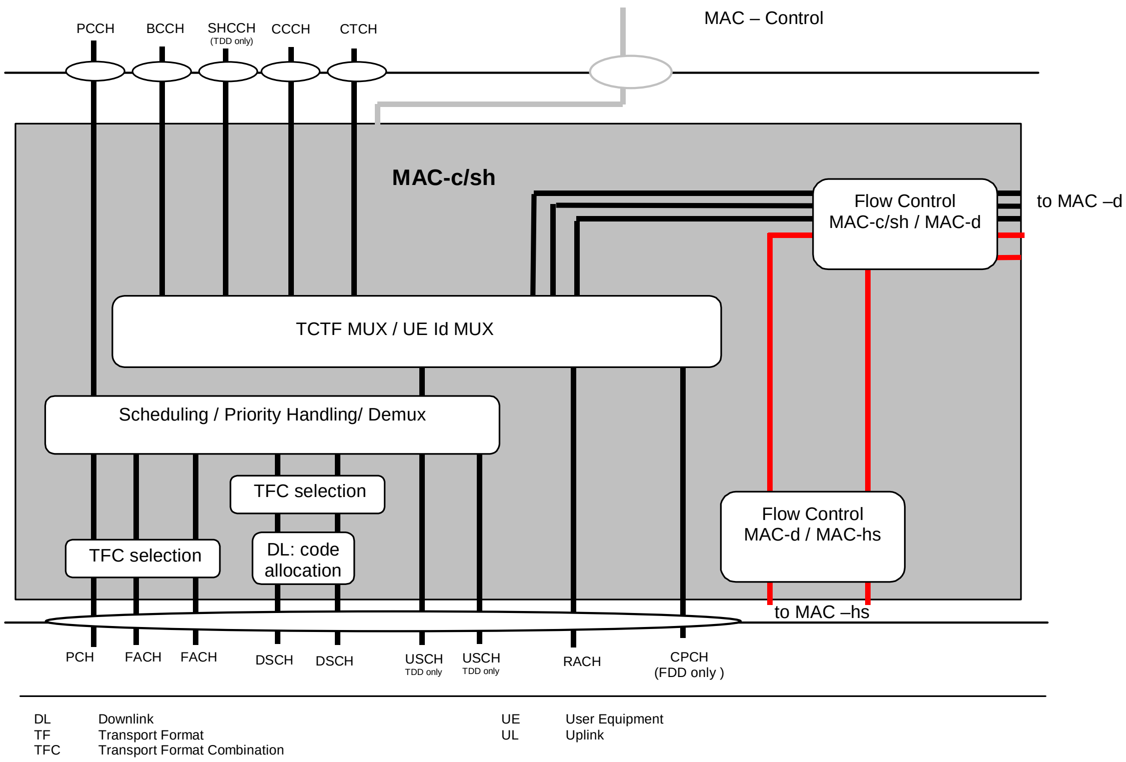

Figure 10: UTRAN side MAC architecture / MAC-c/sh details

NOTE: The need for insertion of the UE Id within MAC-c/sh for the HS-DSCH is FFS. The current working assumption is that there is sufficient reliability on the downlink signalling for the scheduling and thus the UE-Id is not required additionally on the HS-DSCH and its presence on the associated signalling channel is sufficient

7.2.3 Details of MAC-hs

The MAC-hs is responsible for handling the data transmitted on the HS-DSCH. Furthermore it is its responsibility to manage the physical resources allocated to HSDPA. MAC-hs receives configuration parameters from the RRC layer via the MAC-Control SAP.

The MAC-hs in the proposed model is comprised of four different functional entities:

- Flow Control:
  This is the companion flow control function to the flow control in the MAC-c/sh. Both entities together provide a controlled data flow between the MAC-c/sh and the MAC-hs taking the transmission capabilities of the air interface into account in a dynamic manner.

- HARQ:
  One HARQ entity handles the hybrid ARQ functionality for one user. One HARQ entity is capable of supporting multiple instances of stop and wait HARQ protocols. Details of the HARQ functionality require further study.

- Scheduling/Priority Handling

  Due to the restrictions in the physical layer combining process, it is not permitted to schedule new transmissions, including retransmissions originating in the RLC layer, within the same TTI, along with retransmissions originating from the HARQ layer.

- TFC selection:
  Selection of an appropriate transport format combination for the data to be transmitted on HS-DSCH.

NOTE: It is FFS whether a separate functional entity within MAC-hs needs to be added in order to model the handling of feedback information, MCS selection, allocation of uplink resources (in case of TDD), provisioning of flow control information, etc., or whether these functions are described within the above-mentioned functional entities.

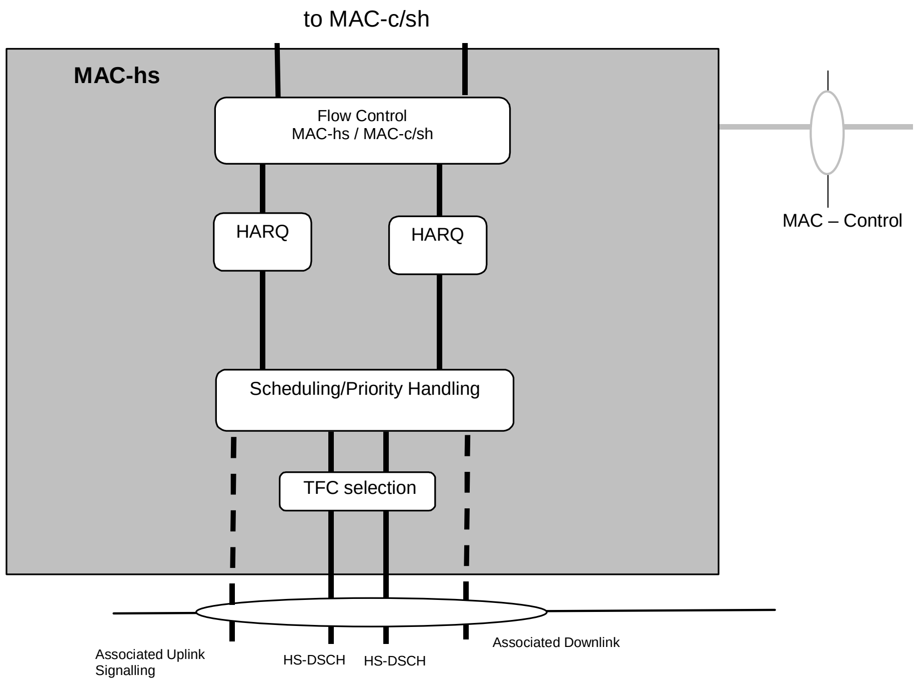

Figure 11: UTRAN side MAC architecture / MAC-hs details

8 HARQ Protocol Considerations

Several potential retransmission schemes exist for the HARQ operation for HSDPA. One example is the N-channel stop and wait protocol described in [1]. The N-channel stop and wait protocol have several variations, e.g. synchronous, asynchronous and partly asynchronous operation. Other alternatives include variations of selective repeat and go-back-N schemes. In order to conclude on an appropriate HARQ protocol, it would be beneficial to agree on a set of requirements and relevant comparison criteria for the HARQ protocol retransmission scheme.

The following are the agreed requirements and criteria for comparison of HARQ protocols.

8.1 Requirements and Comparison criteria for HARQ protocols

8.1.1 In-sequence delivery

If the HARQ receiver deliver each correctly received data block to the RLC receiver, the data blocks will not be delivered to the RLC receiver in the same order as the data blocks was originally transmitted, due to retransmissions by the HARQ layer. An RLC PDU delivered to the RLC layer before another RLC PDU with lower sequence number is here denoted *out-of-sequence PDU*.

The current R'99 RLC protocol layer is not designed for reception of out-of sequence PDUs. In UM RLC, the reception of an out-of sequence RLC PDU will cause the corresponding higher layer SDU to be discarded. In AM RLC, the reception of out-of-sequence RLC PDUs will cause gaps in the received sequence numbers. When a status report is triggered, the out-of sequence PDUs will be requested for retransmission by the RLC receiver, even if these RLC PDUs are not lost, only delayed due to HARQ retransmissions. These unnecessary retransmissions will lead to poor protocol performance.

In-sequence delivery can be achieved either in the HARQ protocol or through modifications of the RLC protocol; but this needs to be considered in the protocol design.

8.1.2 Memory requirement

The buffer memory requirement in both the transmitter (Node B) and the receiver (UE) entity of the HARQ protocol should be considered. In the receiver entity, it is important to distinguish between two different requirements:

The number of received data blocks that needs to be stored to provide in-sequence delivery

The number of received data blocks from which soft samples need to be stored while the data blocks are retransmitted by the HARQ layer.

The latter is parameter requires significantly more memory for each data block. Note that these values are also dependent on the method used for soft combining, which is however not targeted here.

8.1.3 Robustness

The HARQ protocol needs to be robust towards various protocol error situations, like lost signalling (e.g. read flags, sequence numbers or status information) and corrupt signalling due to undetected bit errors. The ability to recover from these error situations needs to be considered.

8.1.4 Protocol overhead

The protocol overhead required to signal sequence numbers, status information (positive and negative acknowledgements), read flags and other data fields should be considered for both uplink and downlink transmission.

The resources required to transfer a given protocol variable depends e.g. on the amount of information that needs to be transferred, the reliability required for the information (error correcting coding and transmit power), and the frequency of the transmission of the information. Thus, a potential parameter for comparison could be the power needed to transmit the information.

8.1.5 Complexity

The complexity in terms of both processing requirements and implementation complexity should be considered. The implementation complexity may be difficult to calculate accurately but estimations could be sufficient for a comparison.

8.1.6 SDU delay

An important performance measure is the SDU delay caused by the HARQ protocol. The average delay for an SDU calculated from the point the SDU is submitted to the HARQ transmitter until it is delivered to the RLC layer at the receiver should be used to compare the performance between HARQ retransmission schemes. The SDU delay would implicitly include aspects such as scheduling flexibility, since a HARQ scheme with limited scheduling flexibility would experience a higher average SDU delay.

In addition the SDU delay variation should be considered.

8.1.7 Link Throughput

The link throughput could be considered as an additional performance measure.

9 Signalling Requirements

9.1 Downlink Signalling Parameters

9.1.1 UE identification

This identifies the UE (or UEs) for which data is transmitted in the corresponding HS-DSCH TTI.

NOTE: The current working assumption is that there is sufficient reliability on the downlink signalling for the scheduling and thus the UE-Id is not required additionally on the HS-DSCH and its presence on the associated signalling channel is sufficient.

NOTE: For TDD, UE identification is not needed for the one step associated dedicated physical channel approach. In a two- step associated dedicated physical channel approach, UE Ids are FFS, depending on the possibility to address more than one UE on HS-FACH.

9.1.2 MCS used

This defines what MCS is used in the corresponding HS-DSCH TTI.

9.1.3 HS-DSCH power level

For FDD, this defines the relationship of HS-PDSCH and CPICH code power level. The UE may need to know this in order to perform N-QAM demodulation. The need for this parameter is FFS.

NOTE: An offset to the CPICH may not be sufficient in case of for e.g. beam forming.

The need of this parameter for TDD defining the P-CCPCH to HS-PDSCH power ratio is FFS.

9.1.4 Code channels in case of code multiplexing (FDD only)

This identifies the UE (or UEs) the codes it (they) should receive and decode.

9.1.5 HS-DSCH physical channel configuration or resource ID (TDD only)

This identifies for a UE (or UEs) the timeslots and codes it (they) should receive and decode.

The method of signalling TDD HS-DSCH resources (either with resource IDs or physical channel configuration parameters) is FFS.

9.1.6 FHARQ

- FHARQ process number (= subchannel number for N-channel SAW structure)

  This info is needed by the UE, in order to know which received packets should be combined and decoded together.

- FHARQ redundancy version

  This info is also needed by the UE in order to know how the received packets should be combined and decoded together.

- FHARQ sequence number, including the idea of aborting failed attempts

  The sequence number is needed by the UE to know, what packets should be combined together by the Hybrid ARQ entity. It is assumed that only one sequence number is needed per TTI. E.g. the number could be somehow tied or mapped to the RLC PDU number of the first TrCH block in the TTI.

  There may be also a need for some mechanism for aborting the current ARQ attempt, e.g. in order to limit the maximum number of attempts per frame and instruct the UE to flush the previous attempts from its receiver's buffers Here it is assumed that these two methods can be combined to one signalling parameter.

NOTE: The HARQ technique is FFS and the above applies only for the N-channel SAW scheme. For the selective repeat HARQ scheme different parameters would be signalled.

9.1.7 Power offset for uplink control channel

This informs the UE what kind of power offset it should use in the uplink, when sending e.g. ACK during soft handover. Node B could estimate the SIR from the uplink, and calculate the needed power offset in the uplink, in order to make sure that an ACK can be decoded reliably. This information may be sent at a much lower rate than the other parameters described in this section.

In TDD, it is FFS whether a power level needs to be signalled for the uplink shared control channel and / or for 1.28 Mcps TDD SYNC1 ACK/NACK signalling.

9.1.8 Measurement feedback rate (FDD only)

This identifies the feedback rate for downlink quality measurement. It is FFS what measurements need to be fed back to the UTRAN. This information may be sent at a much lower rate than the other parameters described in this section.

9.1.9 UL Resource ID or physical channel configuration for uplink shared control channel (TDD only)

This identifies for a UE the timeslot and code to be used by the UE on uplink shared control channel for HS-DSCH H-ARQ acknowledgements and measurement reports. The method of signalling these resources (either with resource IDs or physical channel configuration parameters) is FFS.

NOTE: This signalling element is needed in the common control channel approach. For the associated dedicated physical channel approach, its applicability is FFS.

9.1.10 Resource Allocation Information for PUSCH (TDD only)

NOTE: The possibility of assigning PUSCH resources by HSDPA signalling is required in the common control channel concept. For the associated dedicated physical channel approach its usage is FFS.

a. HS UE-ID- Identifies the UE that is allocated uplink resource allocation on PUSCH

b. UL Resource Id or physical channel configuration for PUSCH - PUSCH resources to be used by the UE

c. Synchronisation Shift (1.28 Mcps TDD only) - Adaptation of Uplink Synchronisation for 1.28 Mcps TDD UEs

d. Frame duration of PUSCH allocation – need of this parameter is FFS

9.1.11 Request for Measurement Reports and Related Resource Allocation for Uplink Shared Control Channel (TDD only)

NOTE: The possibility of explicitly requesting measurement reports on uplink shared control channel is needed in the common control channel concept. For the associated dedicated physical channel approach, its usage is FFS.

a. HS UE-Id - Identifies UE that is informed about request for measurement report

b. Request for traffic volume measurement report on the uplink shared control channel- for UL buffer occupancy it is necessary to know what RBs / TrCHs to report. The need for this parameter is FFS.

c. UL Resource ID or physical channel configuration for uplink shared control channel - Resources to be used by the UE on uplink shared control channel for sending the measurement report

d. Power offset for uplink shared control channel - need of this parameter is FFS

e. Synchronisation Shift (1.28 Mcps TDD only) - Adaptation of Uplink Synchronisation for 1.28 Mcps TDD UEs

f. Request for DL channel quality measurement report on the uplink shared control channel - This parameter indicates which DL timeslots to measure. The need for this parameter is FFS.

9.1.12 Message Type

If several independent signalling messages exist in TDD, explicate identities are required.

NOTE: The need of this parameter is FFS.

Table 2: Parameters and range for consideration in signalling approach evaluation

Parameter		Before the HSDSCH data packet			Simultaneously with HSDSCH data packet		
		Min	Prop	Max	Min	Prop	Max
UE identification							
MCS							
HS-DSCH power level							
Code channels							
FHARQ process #							
FHARQ redundancy version							
FHARQ packet number							
Power offset for uplink							
Measurement feedback rate							
UL Resource ID for HS-PUSCH (TDD)							
Resource Allocation Information for PUSCH (TDD)							
	HS UE-Id						
	UL Resource ID for PUSCH						
	Synchronisation shift (Low chip rate TDD)						
Resource Allocation Information for PUCCH (TDD)							
	HS UE-Id						
	UL Resource ID for PUCCH						
	UL Resource ID for PUCCH						
	Synchronisation shift (Low chip rate TDD)						
Total							

The current working assumption is a range of 10-20 bits for FDD for the various downlink signalling fields irrespective of the precise final list of parameters and their placement or splitting of the parameters across the various downlink signalling channels (i.e. dedicated control channel and shared control channel).

For TDD, Table 3 below captures the present status; details need to be verified by both RAN WG1 and RAN WG2 along with a comparison of the work on FDD.

NOTE: Numbers of signalling bits that are FFS are in []. The numbers in ( ) are values for the case that certain physical configuration information is signalled simultaneously with HS-DSCH transmission. For parameters written in italics, their usage in the regarded concept is FFS.

Table 3: Summary of downlink signalling for TDD

TDD Resource Allocation Information for HS-DSCH:	Before the HSDSCH data packet			Simultaneously with HSDSCH data packet		
	Min	**Prop**	**Max**	**Min**	**Prop**	**Max**
UE identification	[7]	[8]	[16]			
Message Type	[2]	[2]	[4]			
MCS	[2]	[3]	[3]			
HS-DSCH power level	[0]	[3opt]	[4opt]			
HS-DSCH physical channel configuration or resource ID	[4]	[20 (16)]	[96]		[(10)]	
FHARQ process #				[0]	[2]	[2]
FHARQ redundancy version				[0]	[2]	[2]
FHARQ packet number				[2]	[6]	[12]
Power offset for uplink	[0]	[6 (0)]	[6+6opt]		[(6opt)]	
Uplink Shared Control Channel Resource ID or physical channel configuration	[5]	[8 (0)]	[8]		[(8)]	
Total TrCH Bits (Note2)	[20]	[47+3opt]	[133+10opt]	N/A	N/A	N/A
Total TrCH Bits with Simultaneous Signalling (Note2)		(29+3opt)		N/A	N/A	N/A
Total Physical Control Bits	N/A	N/A	N/A	[2]	[11]	[21]
Total Physical Control Bits with Simultaneous Signalling	N/A	N/A	N/A		[(31+ 6 opt)]	

TDD Resource Allocation Information for PUSCH (Note1)						
- HS UE-Id	[7]	[8]	[16]			
- Message Type	[2]	[2]	[4]			
- UL Resource ID or physical channel configuration for PUSCH	[4]	[20]	[96]			
- Synchronisation shift (Low chip rate TDD)	[FFS]	[FFS]	[FFS]			
- PUSCH frame duration	[0]	[5]	[8]			
Total TrCH Bits	[13 + FFS bits]	[35 + FFS bits]	[138 + FFS bits]			

TDD Measurement Request and Allocation Information for Uplink Shared Control Channel (Note1)						
- HS UE-Id	[7]	[8]	[16]			
- Message Type	[2]	[2]	[4]			
- Request for Traffic Volume Measurement Report	[FFS]	[FFS]	[FFS]			
- UL Resource ID or physical channel configuration for Uplink Shared Control Channel	[5]	[8]	[8]			
- Power offset for uplink	[0]	[6]	[6+6opt]			
- Synchronisation shift (Low chip rate TDD)	[FFS]	[FFS]	[FFS]			
- DL Channel Quality Measurement Request	[0]	[12opt]	[14opt]			
Total TrCH Bits	[13 + FFS bits]	[24+12opt +FFS bits]	[34+20opt+ FFS bits]			

NOTE 1: The ability to allocate PUSCH resources and explicitly request measurement reports is needed in the common control channel approach. For the associated dedicated physical channel approach, the applicability is FFS.

NOTE 2: In the associated dedicated one step approach, it is FFS whether all parameters are physical control field bits or whether a signalling transport channel exists.

9.2 Uplink Signalling Parameters

9.2.1 ACK/NACK

This will be used by the HARQ technique for indicating a successful/unsuccessful transmission on the HS-DSCH. There are proposals that utilize more advanced acknowledgement schemes, such as a CACK - cumulative ACK; this is FFS.

9.2.2 Measurement Report

It is FFS what measurements need to be included in the measurement report. This may be used in the choice of AMC by the network. The rate of the measurement report to the network can be configured by higher layer signalling. In TDD, measurement reports may be specifically requested in DL signalling, and downlink channel quality measurements may be reported for specifically requested timeslots.

9.2.3 Buffer status (TDD only)

This is included to assist in USCH scheduling in Node B.

NOTE: This element is required in the TDD common control channel approach. Its applicability for the associated dedicated physical channel approach is FFS.

Table 4 contains the summary of the uplink signalling parameters for the TDD common control channel approach and the associated dedicated physical channel (one or two step) approach.

Table 4: Summary of parameters and suggested range for uplink signalling in TDD

UL Acknowledgement/Measurement Report			
Parameter			
	Min	Prop	Max
H-ARQ ack/nack	[1]	[1]	[FFS]
Downlink channel quality	[7]	[38]	[60]
Buffer Status	[FFS]	[FFS]	[FFS]
Total Bits → (Note1)	[8 + FFS bits]	[39 + FFS bits]	[60 + FFS bits]

NOTE 1: UL signalling parameters are optional in individual UL acknowledgement/measurement reports.

10 Open Issues to be considered in the evaluation of HSDPA functionality

In order to aid the discussion regarding the introduction of HSDPA into UTRA a number of issues need to be carefully considered.

10.1 General Impacts

10.1.1 Mobility in HSDPA

10.1.1.1 Interaction between compressed mode and HSDPA

Compressed mode is used by UE in order to handover to an inter-frequency carrier. How is the scheduling handled between the compressed mode and the scheduler within the Node B for the HS-DSCH?

10.1.1.2 Speed and HSDPA

In order to assess the services that may be provided using HSDPA, an understanding is required for which user mobility speeds are best suited and applicable. Can HSDPA be used for user at 0 km/h, 3 km/h, 50km/h, 120km/h, 250km/h?

10.1.2 Interactions between RNC and Node B scheduler

10.1.2.1 Allocation of power to the HS-DSCH scheduler

What feedback is required in the RNC in order that the "outer loop" allocation of power for the "inner loop" HS-DSCH can be made in an efficient manner? How frequently can this be expected to change?

10.1.2.2 Impacts of high mobility and handovers in HSDPA

What feedback is required in the RNC and NodeB in the case that not all packets that have been moved to a Node B can be delivered?

10.1.2.3 Admission/Load control between all RNC resources and channels

What interactions are envisaged in the case of load sharing between the RNC and standard DCH/DSCH users? How will the power budget be handled?

10.1.3 Uplink channel used for feedback

A clear definition is required of the uplink feedback information that is used in order to perform link adaptation.

10.1.4 Measurements

Which parameter measurements are made that can be used to perform the fast link adaptation? What type of accuracy can be expected for these channel condition measurements?

10.1.5 Others

The interaction of HSDPA with IPDL needs to be considered i.e. can both of them be operational simultaneously?

10.2 Network Infrastructure Impact

10.2.1 Impact of existing infrastructure hardware

10.2.1.1 Estimate the impact on the current interfaces due to the introduction of HSDPA.

In order to ensure interoperability between existing and future features, the issue of interoperability needs to be considered so that ubiquitous service may be provided. Further clarification is required of the handling of HS-DSCH traffic across the Iub FP.

10.2.1.2 Impact on the Node B hardware

What will be the overall impact on the Node B cell hardware? Is a new power amplifier required?

10.2.1.3 Impact on the RNC hardware

Does the introduction of HSDPA require substantial upgrades to existing R'99 RNCs?

10.3 Impacts on User Equipment

10.3.1 Impact of existing User Equipment

10.3.1.1 Increase in UE memory/buffering

Given the potential high data rate transmissions, what is the impact in terms of UE memory/buffering.

10.3.1.2 Impact of receiving multiple codes

Is there a significant increase in the complexity of the UE hardware and processing required in order to be able to receive 20 simultaneous codes?

Annex A: Change history

Document history		
Date	**Version**	**Comment**
April 6, 2001	0.0.1	Text based on joint WG1/WG2 AdHoc
April 12, 2001	0.0.2	Modifications based on e-mail comments
May 7, 2001	0.0.3	Updates from RAN WG2#20; addition of section 10.
May 21, 2001	0.0.4	Modifications based on comments on reflectors
May 21, 2001	0.0.5	Comments from RAN WG2#21
May 30, 2001	0.0.6	Updates reflecting latest status in RAN WG1#20 and RAN WG1/WG2 joint HSDPA AdHoc meeting
June 05, 2001	0.0.7	Updated following comments on RAN WG1 and RAN WG2 reflectors on v0.0.6.
June 06, 2001	0.0.8	Updated for presentation to RAN plenary.
June 08, 2001	1.0.0	Application of correct styles and other editorial corrections throughout the document, for presentation to TSG-RAN plenary
Rapporteur for 3GPP TR 25.855 is: Ravi Kuchibhotla		
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This document is written in Microsoft Word 2000.		

NOTE: The table above will be deleted when this TR is presented to the TSG-RAN plenary in version 2.0.0 (i.e., for approval) and be replaced by the table below.

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**