3GPP TSG-RAN2 meeting #6
Sophia Antipolis, 16-20 August 1999

***Document* R2-99908**

3G CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

TS 25.301 CR 008 Current Version: 3.1.0

3G specification number ↑ *↑ CR number as allocated by 3G support team*

For submision to TSG RAN#5 for approval [X] for information [ ]
list TSG meeting no. here ↑ *(only one box should be marked with an X)*

Form: 3G CR cover sheet, version 1.0 The latest version of this form is available from: ftp://ftp.3gpp.org/Information/3GCRF-xx.rtf

Proposed change affects: USIM [ ] ME [X] UTRAN [X] Core Network [ ]
(at least one should be marked with an X)

Source: BOSCH **Date:** 18/08/99

Subject: Introduction of Packet Data Convergence Protocol (PDCP) in the protocol architecture

3G Work item:

Category:
(only one category shall be marked with an X)

F	Correction	
A	Corresponds to a correction in a 2G specification	
B	Addition of feature	X
C	Functional modification of feature	
D	Editorial modification	

Reason for change: Following the decission to drop the LLC sublayer for UMTS a new sublayer (PDCP) is included in the access stratum u-plane (layer 2) to provide header compression for packet data.

Clauses affected:

Other specs affected:

Other 3G core specifications	[ ]	→ List of CRs:
Other 2G core specifications	[ ]	→ List of CRs:
MS test specifications	[ ]	→ List of CRs:
BSS test specifications	[ ]	→ List of CRs:
O&M specifications	[ ]	→ List of CRs:

Other comments:

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<--------- double-click here for help and instructions on how to create a CR.

3 Definitions and Abbreviations

3.1 Definitions

See [3] for a definition of fundamental concepts and vocabulary.

3.2 Abbreviations

ARQ	Automatic Repeat Request
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
C-	Control-
CC	Call Control
CCCH	Common Control Channel
CCH	Control Channel
CCTrCH	Coded Composite Transport Channel
CN	Core Network
CPCH	Common Packet channel
CRC	Cyclic Redundancy Check
CTCH	Common Traffic Channel
DC	Dedicated Control (SAP)
DCA	Dynamic Channel Allocation
DCCH	Dedicated Control Channel
DCH	Dedicated Channel
DL	Downlink
DRNC	Drift Radio Network Controller
DSCH	Downlink Shared Channel
DTCH	Dedicated Traffic Channel
FACH	Forward Link Access Channel
FAUSCH	Fast Uplink Signalling Channel
FCS	Frame Check Sequence
FDD	Frequency Division Duplex
GC	General Control (SAP)
HO	Handover
ITU	International Telecommunication Union

kbps	kilo-bits per second
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
LAC	Link Access Control
LAI	Location Area Identity
MAC	Medium Access Control
MM	Mobility Management
Nt	Notification (SAP)
OCCCH	ODMA Common Control Channel
ODCCH	ODMA Dedicated Control Channel
ODCH	ODMA Dedicated Channel
ODMA	Opportunity Driven Multiple Access
ORACH	ODMA Random Access Channel
ODTCH	ODMA Dedicated Traffic Channel
PCCH	Paging Control Channel
PCH	Paging Channel
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PU	Payload Unit
PHY	Physical layer
PhyCH	Physical Channels
RAB	Radio Access Bearer
RACH	Random Access Channel
RLC	Radio Link Control
RNC	Radio Network Controller
RNS	Radio Network Subsystem
RNTI	Radio Network Temporary Identity
RRC	Radio Resource Control
SAP	Service Access Point
SCCH	Synchronization Control Channel
SCH	Synchronization Channel
SDU	Service Data Unit
SRNC	Serving Radio Network Controller

SRNS	Serving Radio Network Subsystem
TCH	Traffic Channel
TDD	Time Division Duplex
TFCI	Transport Format Combination Indicator
TFI	Transport Format Indicator
TMSI	Temporary Mobile Subscriber Identity
TPC	Transmit Power Control
U-	User-
UE	User Equipment
UE_R	User Equipment with ODMA relay operation enabled
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
USCH	Uplink Shared Channel
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

4 Assumed UMTS Architecture

Figure 1 shows the assumed UMTS architecture as outlined in TS 23.110 [1]. The figure shows the UMTS architecture in terms of its entities User Equipment (UE), UTRAN and Core Network. The respective reference points Uu (Radio Interface) and Iu (CN-UTRAN interface) are shown. The figure illustrates furthermore the high-level functional grouping into the Access Stratum and the Non-Access Stratum.

The Access Stratum offers services through the following Service Access Points (SAP) to the Non-Access Stratum:

- General Control (GC) SAPs,
- Notification (Nt) SAPs and
- Dedicated Control (DC) SAPs

The SAPs are marked with circles in Figure 1. The services provided to the non-access stratum by the GC, Nt, and DC SAPs, from a radio interface protocol perspective, are assumed to be provided by the Radio Resource Control (RRC) to the higher protocol layer. It is however assumed that at the network side, the RRC layer terminates in the UTRAN (cf. Sec. 5.1).

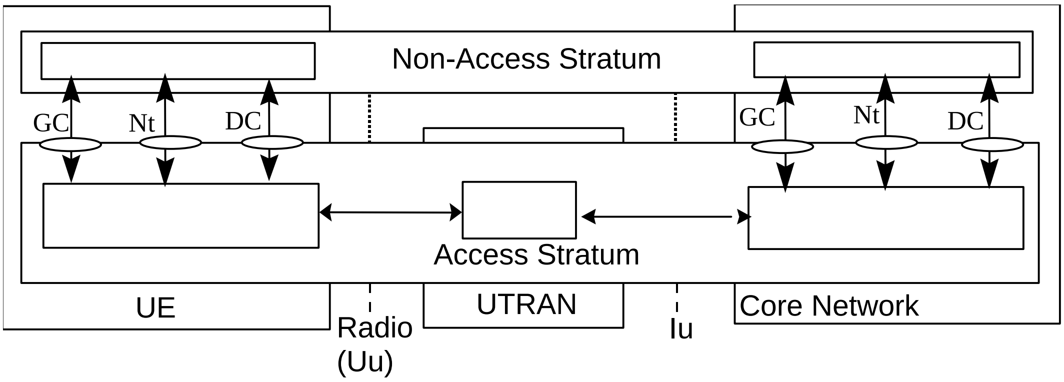


Figure 1: Assumed UMTS Architecture

5 Radio interface protocol architecture

5.1 Overall protocol structure

The radio interface is layered into three protocol layers:

- the physical layer (L1),
- the data link layer (L2),
- network layer (L3).

Layer 2 is split into two sublayers in the control plane, Radio Link Control (RLC) and Medium Access Control (MAC) and into three sublayers in the user plane, Packet Data Convergence Protocol (PDCP), RLC and MAC.

Layer 3 and RLC are divided into Control (C-) and User (U-) planes.

In the C-plane, Layer 3 is partitioned into sublayers where the lowest sublayer, denoted as Radio Resource Control (RRC), interfaces with layer 2. The higher layer signalling such as Mobility Management (MM) and Call Control (CC) are assumed to belong to the non-access stratum, and therefore not in the scope of 3GPP TSG RAN. On the general level, the protocol architecture is similar to the current ITU-R protocol architecture, ITU-R M.1035.

Figure 2 shows the radio interface protocol architecture. Each block in Figure 2 represents an instance of the respective protocol. Service Access Points (SAP) for peer-to-peer communication are marked with circles at the interface between sublayers. The SAP between MAC and the physical layer provides the transport channels (cf. Sec5.2.1.1). The SAPs between RLC and the MAC sublayer provide the logical channels (cf. Sec.5.3.1.1.1). In the C-plane, the interface between RRC and higher L3 sublayers (CC, MM) is defined by the General Control (GC), Notification (Nt) and Dedicated Control (DC) SAPs.

Also shown in the figure are connections between RRC and MAC as well as RRC and L1 providing local inter-layer control services. An equivalent control interface exists between RRC and the RLC sublayer and between RRC and the PDCP sublayer. These interfaces allow the RRC to control the configuration of the lower layers. For this purpose separate Control SAPs are defined between RRC and each lower layer (PDCP, RLC, MAC, and L1). It is assumed that for RLC and MAC one Control SAP each is provided per UE.

[Note: Control of RLC entities in C and U planes needs to be clarified further. Also, the multiplicity of Control SAPs (necessity of one SAP per UE) at the UTRAN side may need to be reconsidered.]

The RLC sublayer provides ARQ functionality closely coupled with the radio transmission technique used. There is no difference between RLC instances in C and U planes.

The UTRAN can be requested by the CN to prevent all loss of data (i.e. independently of the handovers on the radio interface), as long as the Iu connection point is not modified. This is a basic requirement to be fulfilled by the UTRAN retransmission functionality as provided by the RLC sublayer.

However, in case of the Iu connection point is changed (e.g. SRNS relocation, streamlining), the prevention of the loss of data may not be guaranteed autonomously by the UTRAN but would rely on some functions in the CN. In this case, a mechanism to achieve the requested QoS may require support from the CN. Such mechanisms to protect from data loss due to SRNS relocation or streamlining are for further study.

[Note: Such mechanisms need to be specified jointly with 3GPP TSGs CN and SA. The implied functionality would be applied in the U plane. Applicability in the C plane is for further study.]

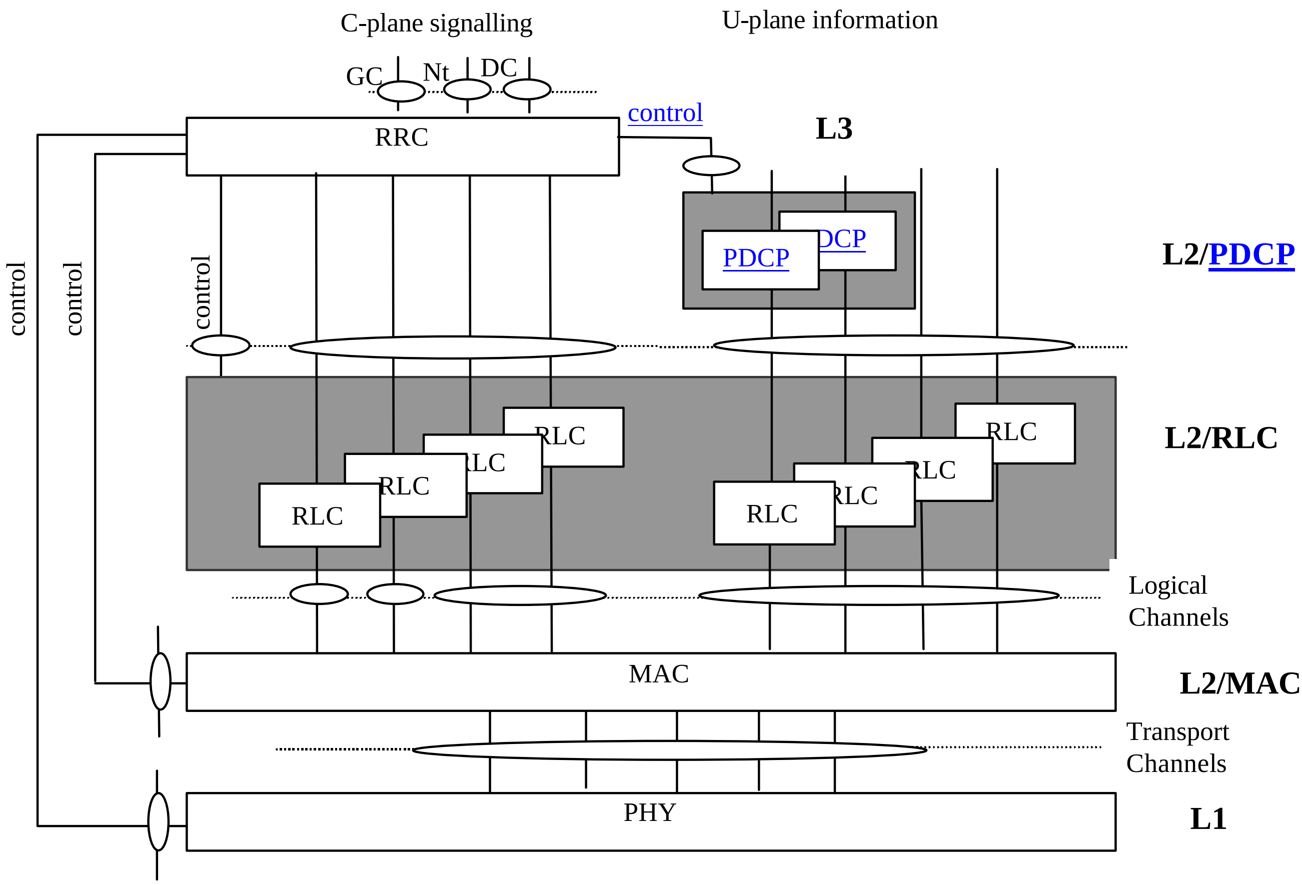


Figure 2: Radio Interface protocol architecture (Service Access Points marked by circles)

5.1.1 Service access points and service primitives

Each layer provides services at Service Access Points (SAPs). A service is defined by a set of service primitives (operations) that a layer provides to upper layer(s).

Control services, allowing the RRC layer to control lower layers locally (i.e. not requiring peer-to-peer communication) are provided at Control SAPs (C-SAP). Note that C-SAP primitives can bypass one or more sublayers, see Figure 2.

In the radio interface protocol specifications, the following naming conventions for primitives shall be applicable:

- Primitives provided by SAPs between adjacent layers shall be prefixed with the name of the service-providing layer, i.e. PHY, MAC, ~~or~~ RLC or PDCP.
- Primitives provided by Control SAPs, in addition to the name of the service-providing layer, shall be prefixed with a "C", i.e. CPHY, CMAC, ~~or~~ CRLC or CPDCP.

This principle leads to the following notations, where <Type> corresponds to request, indication, response or confirm type of primitives:

Primitives between PHY and MAC:
PHY- <Generic name> – <Type>

Primitives between PHY and RRC (over C-SAP):
CPHY- <Generic name> - <Type>

Primitives between MAC and RLC:
MAC- <Generic name> - <Type>

Primitives between MAC and RRC (over C-SAP):
CMAC- <Generic name> - <Type>

Primitives between RLC and non-access stratum, ~~and~~ between RLC and RRC for data transfer and between RLC and PDCP:
RLC- <Generic name> - <Type>

Primitives between RLC and RRC for control of RLC (over C-SAP):
CRLC- <Generic name> – <Type>

Primitives between PDCP and non-access stratum:
PDCP- <Generic name> - <Type>

Primitives between PDCP and RRC (over C-SAP):
CPDCP- <Generic name> - <Type>

5.3.3 PDCP Services and Function

This section provides an overview on services and functions provided by the Packet Data Convergence Protocol (PDCP). A detailed description of the PDCP is given in 3GPP TS 25.3xx

5.3.3.1 PDCP Services provided to upper layers

- Transmission and reception of Network PDUs in acknowledged, unacknowledged and transparent RLC mode.

5.3.3.2 PDCP Functions

- Mapping of Network PDUs from one network protocol to one RLC entity.
- Compression in the transmitting entity and decompression in the receiving entity of redundant Network PDU control information (header compression/ decompression). This may include TCP/IP header compression and decompression.

5.3.35.3.4 Data flows through Layer 2

5.6 Protocol termination

This section specifies in which node of the UTRAN the radio interface protocols are terminated, i.e. where within UTRAN the respective protocol services are accessible. Dashed lines indicate those protocols whose presence is dependant on the service provided to upper layers.

5.6.1 Protocol termination for DCH

Figure 12 and Figure 13 show the protocol termination for DCH for the control and user planes, respectively. The part of physical layer terminating in the Serving RNC is the topmost macro-diversity combining and splitting function for the FDD mode. If no macrodiversity applies, the physical layer is terminated in Node B.

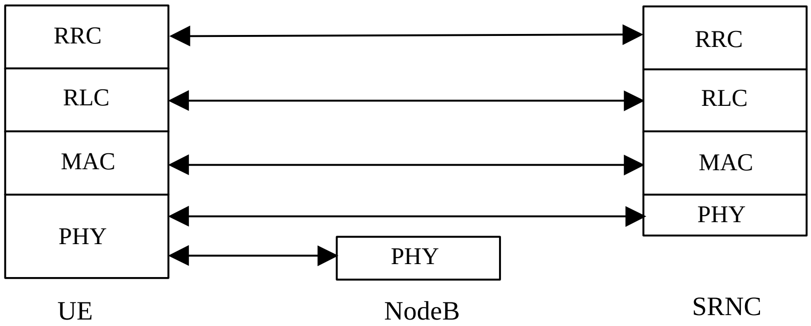


Figure 12: Protocol Termination for DCH, control plane

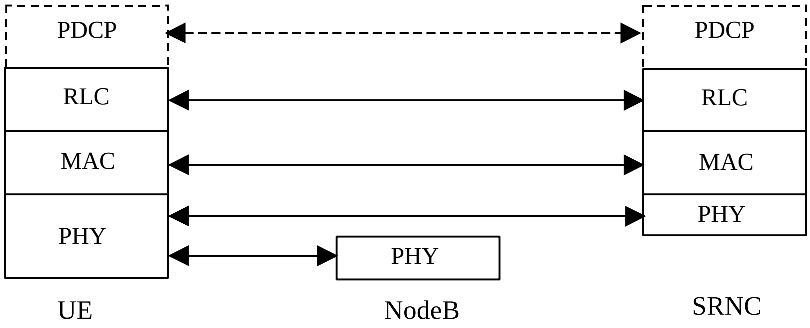


Figure 13: Protocol Termination for DCH, user plane

5.6.2 Protocol termination for RACH/FACH

Figure 14 and Figure 15 show the protocol termination for RACH/FACH for the control and user planes, respectively. Control plane termination refers to the case where RACH/FACH carry dedicated or common control information (i.e. CCCH or DCCH). User plane termination refers to the case where RACH/FACH carry user data (DTCH) (two alternatives cases, referred to as case B and C, are described in the Annex).

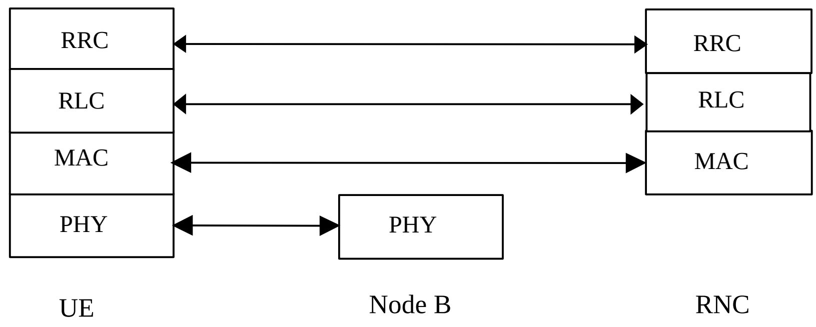
It is assumed that macrodiversity/soft handover is not applied for RACH/FACH. Therefore, the physical layer terminates in Node B. For RACH/FACH carrying DCCH, MAC is split between Controlling and Serving RNC. RLC, and in the C plane also RRC terminate in the Serving RNC. Since Iur can support common channel data streams, the users of that common channel can depend on different SRNCs. However, they depend on the same Controlling RNC. Therefore, for a given user, the Controlling RNC and the Serving RNC can be separate RNCs.

For RACH/FACH carrying CCCH, MAC, RLC and RRC are terminated in the RNC.

[Note: It is currently an open issue whether or not there are CCCH messages that need to be routed between Controlling and Serving RNC over Iur. If it is only the initial access message that is defined for CCCH, C-RNC and S-RNC are always identical and no routing would be needed. If messages such as "URA update", "Cell update" and

"RRC connection re-establishment" would be signalled on CCCH, routing of these messages on RRC level would need to be performed]

CCCH:



DCCH:

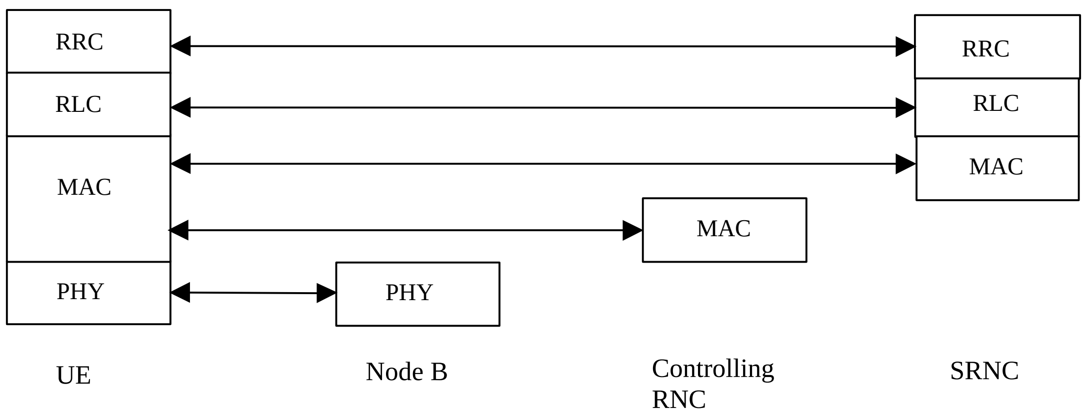


Figure 14: Protocol Termination for RACH/FACH, control plane

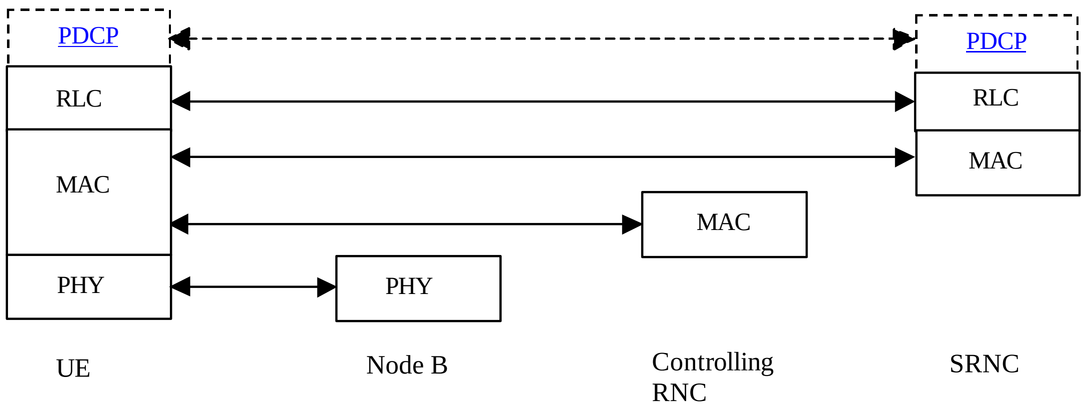


Figure 15: Protocol Termination for RACH/FACH, user plane

5.6.3 Protocol termination for FAUSCH

Protocol termination for the FAUSCH is the same as for the RACH in the control plane (see Figure 14), since FAUSCH is for control purposes only.

5.6.4 Protocol termination for CPCH

The protocol termination for CPCH is identical to the termination for RACH. Figure 14 (for DCCH) presents the control plane protocol termination. Figure 15 presents the user plane protocol termination.

5.6.5 Protocol termination for DSCH

5.6.5.1 DSCH definition

The DSCH is a resource that exists in downlink only. It has only impact on the physical and transport channel levels, so there is no definition of shared channel in the logical channels provided by MAC.

The DSCH is a transport channel shared dynamically between several UEs. The DSCH is mapped to one or several physical channels such that a specified part of the downlink code tree is employed. For the DSCH no macrodiversity is applied, i.e. a specific DSCH is transmitted in a single cell only.

The following two DSCH cases are presently considered, in the following denoted as cases A and B:

Case A: The DSCH is defined is an extension to DCH transmission. DSCH related resource allocation is signalled utilizing the transport format indication field (TFI) that will be mapped to the TFCI of the associated DCH.

Case B: The DSCH is defined as a shared downlink channel for which resource allocation, including UE identification, is signalled on another common downlink channel, referred to as DSCH Control Channel.

[Note: It is considered ffs. whether the DSCH Control Channel requires a new type of transport channel or whether a specific FACH transport channel can be used for this purpose. It is assumed that the DSCH control channel is supported on the PSCCCH (Physical Shared Common Control Channel) if it carries TPC information. It needs to be confirmed by TSG RAN WG1 that this channel will be specified.]

Note: For case B it is assumed that DSCH and DSCH Control Channel employ individual channelization codes each. Time multiplexing of user data (DSCH) and control information (DSCH Control Channel) is not considered.

Note also that a third case of DSCH definition, where the DSCH was defined as a stand-alone channel providing in-band UE identification is not considered any more. This case has been identified as being equivalent to a FACH and is as such already included in the radio interface specification.

Interleaving for the DSCH may be applied over a multiplicity of radio frames. Nevertheless, here the basic case is considered where the interleaving is rectangular for a given MAC PDU, and equal to one radio frame (10 ms). The framing is synchronised on the SCH.

In every radio frame, one or several codes can be used in the downlink. Therefore, the DSCH supports code multiplexing. MAC multiplexing shall not be applied within a radio frame, i.e. the whole radio frame for one code is assigned to a single UE. However, MAC multiplexing is allowed on a frame by frame basis, i.e. one code may be allocated to different UEs at each frame.

Transport blocks on the DSCH may be of constant size, so that the Transport Block Set may be derived from the code allocated to each UE on the DSCH.

5.6.5.2 Resource allocation and UE identification on DSCH

The principles of capacity allocation and UE identification on the DSCH are described in more detail below.

[Note: The two resource allocation methods of the cases A and B might be used simultaneously for one DSCH, i.e. some UEs may use an associated DSCH Control Channel and some UEs may use an associated DCH for resource allocation while transmitting data on the same DSCH. This option is ffs.]

5.6.5.2.1 Case A (UE requires a downlink TFCI on a DPCCH)

The TFCI of the dedicated physical channel may carry the information that a given code of the DSCH must be listened to by the UE. Fast power control can be applied per code based on the dedicated physical control channel, DPCCH.

Alternatively, a UE may be requested on the DCH to listen to a DSCH for a given period of time, and to decode the data so that the address of the destination UE can be decoded. This does not require more TFCI values because signalling is done in layers 2 and 3.

5.6.5.2.2 Case B (UE requires a downlink DSCH Control Channel)

The information which DSCH code to listen to and when is sent on an additional downlink channel to the UE (essentially a broadcast channel). This channel, is referred to as *DSCH Control Channel*. It is code multiplexed on the downlink and should convey the following information, which is modified every radio frame:

- Layer 1 information
    - TPC bits for each UE which would have an uplink DCH without downlink DCH. The location of TPC bits on the PSCCCH of each cell is allocated to each UE when a RAB is mapped onto a DSCH.
    - Channelisation code allocated to each UE indicated relatively to the DSCH code entry point
- Layer 2 information
    - Identity of the UEs who should receive information on the DSCH. The UE ID is allocated when a RAB is mapped onto a DSCH. Which UE ID is used to identify UE on the DSCH of each cell is ffs.

This concept allows to perform power control on the DSCH, whereas the DSCH Control Channel would be less efficient in terms of power control efficiency (need to power control on the farthest UE).

5.6.5.3 Model of DSCH in UTRAN

Figure 16 captures the working assumption on the Downlink Shared Channel (DSCH). The two RLCs point to logical channel (DTCH) specific RLC-entities of specific users while MAC refers to the provision of MAC sublayer functions for all users.

The MAC sublayer of a DSCH is split between the Controlling RNC and SRNC. For a given user, the RLC sublayer is terminated in its SRNC. Since Iur can support DSCH data streams, the users on that DSCH can depend on different SRNCs. For a given user, the Controlling RNC and the Serving RNC can be separate RNCs. The MAC in the network takes care of mapping downlink data either to a common channel (FACH, not shown in this figure), DCH or the DSCH.

Figure 16 also includes the DSCH Control Channel, needed for case B of DSCH definition only. See 3GPP TS 25.321 [8] for details on MAC architecture. In this example, the resource allocation on the DSCH is signalled on the DSCH control channel for UE 1 and on the associated DCH for UE 2.

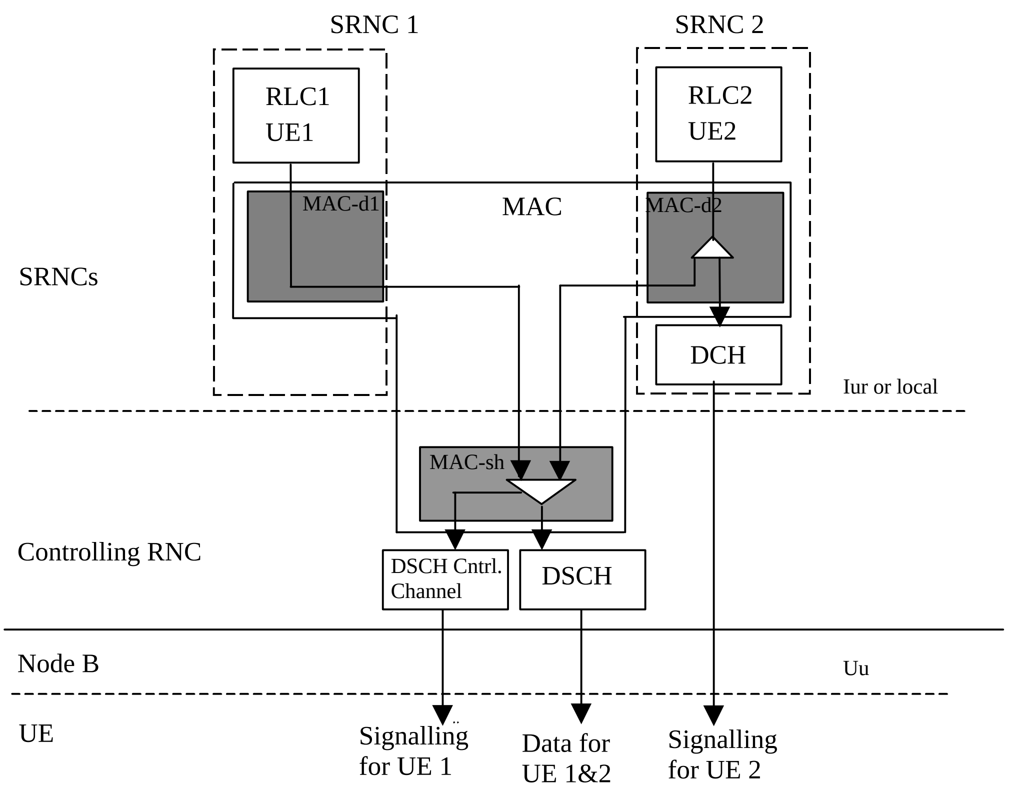


Figure 16: Model of downlink shared channel (DSCH) in UTRAN

5.6.5.4 Protocol termination

The protocol termination points for DSCH in control and user planes are presented in Figure 17 and Figure 18, respectively.

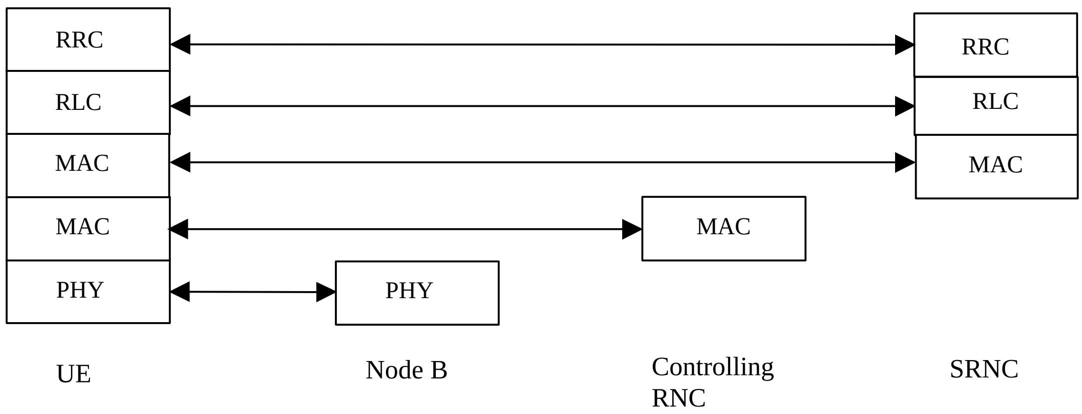


Figure 17: Protocol termination points for DSCH, control plane.

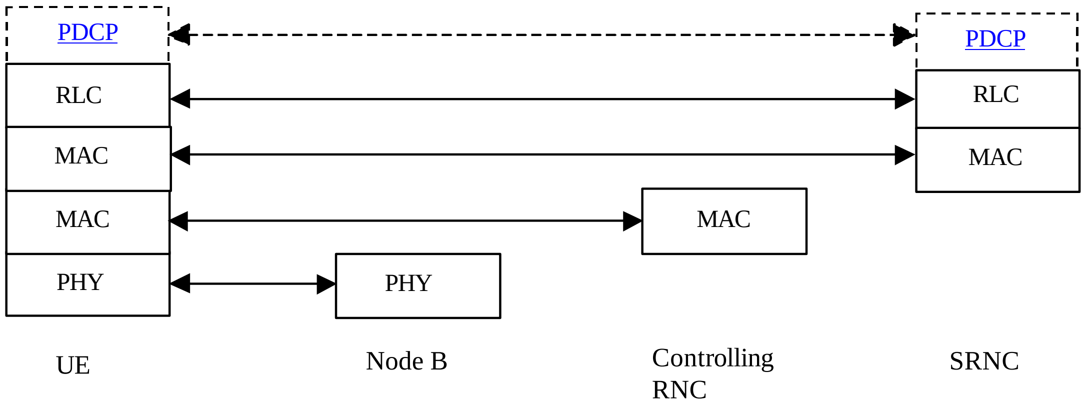


Figure 18: Protocol termination points for DSCH, user plane.