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**Universal Mobile Telecommunications System (UMTS);
Services provided by the physical layer
(3GPP TS 25.302 version 17.0.0 Release 17)**

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1 Scope

The present document is a technical specification of the services provided by the physical layer of UTRA to upper layers.

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.
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- 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 TS 23.110: "UMTS Access Stratum; Services and Functions".

[2] 3GPP TS 25.301: "Radio Interface Protocol Architecture".

[3] 3GPP TS 25.212: "Multiplexing and channel coding (FDD)".

[4] 3GPP TS 25.222: "Multiplexing and channel coding (TDD)".

[5] 3GPP TS 25.224: "Physical Layer Procedures (TDD)".

[6] 3GPP TS 25.215: "Physical Layer – Measurements (FDD)".

[7] 3GPP TS 25.213: "Spreading and modulation (FDD)".

[8] 3GPP TS 25.214: "Physical layer procedures (FDD)".

[9] 3GPP TS 25.123: "Requirements for Support of Radio Resource Management (TDD)".

[10] 3GPP TS 25.133: "Requirements for Support of Radio Resource Management (FDD)".

[11] 3GPP TS 25.225: "Physical Layer – Measurements (TDD)".

[12] 3GPP TS 25.221: "Physical channels and mapping of transport channels onto physical channels (TDD)".

[13] 3GPP TS 25.331: "Radio Resource Control (RRC); protocol specification".

[14] 3GPP TS 25.346: "Introduction of the Multimedia Broadcast Multicast Service (MBMS) in the Radio Access Network (RAN); Stage 2".

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [3] and the following apply:

E-DCH active set (FDD only): The set of cells which carry the E-DCH for one UE. In CELL_FACH state and Idle mode, the E-DCH active set contains the Serving E-DCH cell only.

Serving E-DCH cell: Cell from which the UE receives Absolute Grants from the Node-B scheduler. A UE has one Serving E-DCH cell.

Serving E-DCH RLS or Serving RLS (FDD only): Set of cells which contains at least the Serving E-DCH cell and from which the UE can receive and combine one Relative Grant. The UE has only one Serving E-DCH RLS.

Non-serving E-DCH RL or Non-serving RL (FDD only): Cell which belongs to the E-DCH active set but does not belong to the Serving E-DCH RLS and from which the UE can receive one Relative Grant. The UE can have zero, one or several Non-serving E-DCH RL(s).

Primary downlink frequency: If a single downlink frequency is configured for the UE, then it is the primary downlink frequency. In case more than one downlink frequency is configured for the UE, then the primary downlink frequency is the frequency on which the Serving HS-DSCH cell is transmitted.

Secondary downlink frequency: In case more than one downlink frequency is configured for the UE, then a secondary downlink frequency is a frequency on which a secondary Serving HS-DSCH cell is transmitted.

Activated uplink frequency: For a specific UE, an uplink frequency is said to be activated if the UE is allowed to transmit on that frequency. The primary uplink frequency is always activated when configured while a secondary uplink frequency has to be activated by means of an HS-SCCH order in order to become activated.

Configured uplink frequency: For a specific UE, an uplink frequency is said to be configured if the UE has received all relevant information from higher layers in order to perform transmission on that frequency.

Primary uplink frequency: If a single uplink frequency is configured for the UE, then it is the primary uplink frequency. In case more than one uplink frequency is configured for the UE, then the primary uplink frequency is the frequency on which the E-DCH corresponding to the serving E-DCH cell associated with the serving HS-DSCH cell is transmitted. The association between a pair of uplink and downlink frequencies is indicated by higher layers.

Secondary uplink frequency: A secondary uplink frequency is a frequency on which an E-DCH corresponding to a serving E-DCH cell associated with a secondary serving HS-DSCH cell is transmitted. The association between a pair of uplink and downlink frequencies is indicated by higher layers.

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1st Secondary serving HS-DSCH cell: If the UE is configured with two uplink frequencies, the 1st secondary serving HS-DSCH cell is the secondary serving HS-DSCH cell that is associated with the secondary uplink frequency. If the UE is configured with a single uplink frequency, the 1st secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

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2nd Secondary serving HS-DSCH cell: If the UE is configured with more than two serving HS-DSCH cells, the 2nd secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

3rd Secondary serving HS-DSCH cell: If the UE is configured with four or more serving HS-DSCH cells, the 3rd secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

4th Secondary serving HS-DSCH cell: If the UE is configured with five or more serving HS-DSCH cells, the 4th secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

5th Secondary serving HS-DSCH cell: If the UE is configured with six or more serving HS-DSCH cells, the 5th secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

6th Secondary serving HS-DSCH cell: If the UE is configured with seven or more serving HS-DSCH cells, the 6th secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

7th Secondary serving HS-DSCH cell: If the UE is configured with eight serving HS-DSCH cells, the 7th secondary serving HS-DSCH cell is a secondary serving HS-DSCH cell whose index is indicated by higher layers.

Multiflow (FDD only): A mode of operation with two simultaneous HS-DSCH transport channels per carrier frequency, where the HS-DSCH transport channels may belong to the same or different Node Bs.

Assisting serving HS-DSCH Cell: In addition to the serving HS-DSCH cell, a cell in the same frequency, where the UE is configured to simultaneously monitor a HS-SCCH set and receive HS-DSCH if it is scheduled in that cell.

Assisting secondary serving HS-DSCH Cell: In addition to the serving HS-DSCH cell, a cell in the secondary downlink frequency, where the UE is configured to simultaneously monitor a HS-SCCH set and receive HS-DSCH if it is scheduled in that cell.

Serving E-DCH cell decoupling (FDD only): An E-DCH operation mode in which the Serving HS-DSCH cell and the Serving E-DCH cell are different.

Radio links without DPCH/F-DPCH (FDD only): An operation mode in which UE supports to not receive both DPCH and F-DPCH downlink channels from the indicated Non-serving E-DCH cell(s).

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

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
CLTD	Closed Loop Transmit Diversity
CN	Core Network
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
DC	Dedicated Control (SAP)
DCA	Dynamic Channel Allocation
DCCH	Dedicated Control Channel
DCH	Dedicated Channel
DL	Downlink
DPCCH2	Dedicated Physical Control Channel 2
DRNC	Drift Radio Network Controller
DSCH	Downlink Shared Channel
DTCH	Dedicated Traffic Channel
E-AGCH	E-DCH Absolute Grant Channel
E-DCH	Enhanced DCH
E-DPCCH	E-DCH Dedicated Physical Control Channel (FDD only)
E-DPDCH	E-DCH Dedicated Physical Data Channel (FDD only)
E-HICH	E-DCH HARQ Acknowledgement Indicator Channel
E-PUCH	E-DCH Physical Uplink Channel (TDD only)
E-RGCH	E-DCH Relative Grant Channel (FDD only)
E-ROCH	E-DCH Rank and Offset Channel (FDD only)
E-RUCCH	E-DCH Random access Uplnk Control Channel (TDD only)
E-TFC	E-DCH Transport Format Combination
E-UCCH	E-DCH Uplink Control Channel (3.84 Mcps and 7.68 Mcps TDD only)
FACH	Forward Link Access Channel
FCS	Fame Check Sequence
FDD	Frequency Division Duplex
F-DPCH	Fractional Dedicated Physical Channel (FDD only)
F-TPICH	Fractional Transmitted Precoding Indicator Channel
GC	General Control (SAP)
GANSS	Galileo and Additional Navigation Satellite Systems
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HARQ	Hybrid Automatic Repeat Request
HS-DPCCH	High Speed Dedicated Physical Control CHannel
HS-DSCH	High Speed Downlink Shared CHannel
HS-SCCH	High Speed Shared Control CHannel
HS-SICH	High Speed Shared Information CHannel
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

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MAC	Medium Access Control
MBMS	Multimedia Broadcast Multicast Service
MCCH	MBMS point-to-multipoint Control Channel
MICH	MBMS notification Indicator Channel
MM	Mobility Management
MSCH	MBMS point-to-multipoint Scheduling Channel
MTCH	MBMS point-to-multipoint Traffic Channel
Nt	Notification (SAP)
PCCH	Paging Control Channel
PCH	Paging Channel
PDU	Protocol Data Unit
PHY	Physical layer
PhyCH	Physical Channels
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
S-DPCCH	Secondary Dedicated Physical Control Channel
SDU	Service Data Unit
S-E-DPCCH	Secondary E-DPCCH (FDD only)
S-E-DPDCH	Secondary E-DPDCH (FDD only)
SRNC	Serving Radio Network Controller
SRNS	Serving Radio Network Subsystem
SS	Synchronisation Shift
TCH	Traffic Channel
TDD	Time Division Duplex
TFCI	Transport Format Combination Indicator
TFI	Transport Format Indicator
TFRI	Transport Format and Resource Indicator
TMSI	Temporary Mobile Subscriber Identity
TPC	Transmit Power Control
TSN	Transmission Sequence Number
U-	User-
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

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4 Interfaces to the physical layer

The physical layer (layer 1) is the lowest layer in the OSI Reference Model and it supports all functions required for the transmission of bit streams on the physical medium.

The physical layer interfaces the Medium Access Control (MAC) Layer and the Radio Resource Control (RRC) Layer as depicted in figure 1.

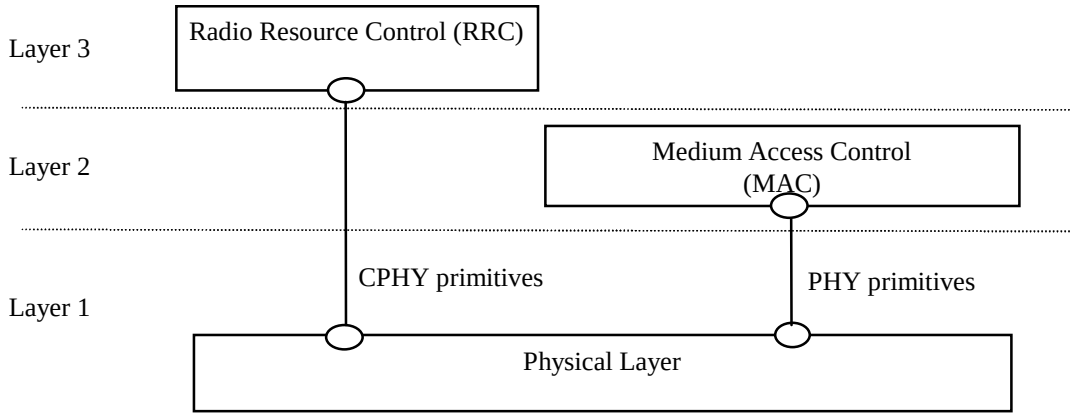

Figure 1: Interfaces with the Physical Layer

4.1 Interface to MAC

The physical layer interfaces the MAC entity of layer 2. Communication between the Physical Layer and MAC is in an abstract way performed by means of PHY-primitives defined which do not constrain implementations.

NOTE: The terms physical layer and layer 1, will be used synonymously in this description.

The PHY-primitives exchanged between the physical layer and the data link layer provide the following functions:

- transfer of transport blocks over the radio interface;
- indicate the status of the layer 1 to layer 2.

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4.2 Interface to RRC

The physical layer interfaces the RRC entity of layer 3 in the UE and in the network.

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Communication is performed in an abstract way by means of CPHY-primitives. They do not constrain implementations.

The CPHY-primitives exchanged between the physical layer and the Network layer provide the following function:

- control of the configuration of the physical layer.

The currently identified exchange of information across that interface has only a local significance to the UE or Network.

5 Services and functions of the physical layer

5.1 General

The physical layer offers data transport services to higher layers. The access to these services is through the use of transport channels via the MAC sub-layer. The characteristics of a transport channel are defined by its transport format (or format set), specifying the physical layer processing to be applied to the transport channel in question, such as convolutional channel coding and interleaving, and any service-specific rate matching as needed.

The physical layer operates exactly according to the L1 radio frame timing. A transport block is defined as the data accepted by the physical layer to be jointly CRC protected. The transmission block timing is then tied exactly to the TTI timing, e.g. every transmission block is generated precisely every TTI.

A UE can set up multiple transport channels simultaneously, each having own transport characteristics (e.g. offering different error correction capability). Each transport channel can be used for information stream transfer of one radio bearer or for layer 2 and higher layer signalling messages.

The multiplexing of transport channels onto the same or different physical channels is carried out by L1. Except for HS-DSCH and E-DCH the Transport Format Combination Indication field (TFCI) shall uniquely identify the transport format used by each transport channel of the Coded Composite Transport Channel within the current radio frame.

In case of HS-DSCH the identification of the transport format and channelisation codes is realised with the Transport Format and Resource Indication field (TFRI) on an associated shared control channel.

In case of FDD E-DCH the identification of the transport format is realised with the E-DCH Transport Format Combination Indication field (E-TFCI) on a associated dedicated control channel.

In the case of TDD E-DCH the identification of the transport format is realised with the E-DCH Transport Format Combination Indication field (E-TFCI) multiplexed onto E-PUCH.

5.2 Overview of L1 functions

The physical layer performs the following main functions:

- FEC encoding/decoding of transport channels;
- measurements and indication to higher layers (e.g. FER, SIR, interference power, transmission power, etc…);
- macrodiversity distribution/combining and soft handover execution;
- error detection on transport channels;
- multiplexing of transport channels and demultiplexing of coded composite transport channels;
- rate matching;
- mapping of coded composite transport channels on physical channels;
- modulation and spreading/demodulation and despreading of physical channels;
- frequency and time (chip, bit, slot, frame) synchronisation;
- closed-loop power control;
- power weighting and combining of physical channels;
- RF processing;
- support of Uplink Synchronisation as defined in [5] (TDD only);
- timing advance on uplink channels (TDD only).

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5.3 L1 interactions with L2 retransmission functionality

Provided that the RLC PDUs are mapped one-to-one onto the Transport Blocks, Error indication may be provided by L1 to L2. For that purpose, the L1 CRC can be used for individual error indication of each RLC PDU.

The L1 CRC may serve multiple purposes:

- error indication for uplink macro diversity selection combining (L1);
- error indication for each erroneous Transport Block in transparent and unacknowledged mode RLC;
- quality indication;
- error indication for each erroneous Transport Block in acknowledged mode RLC.

Regardless of the result of the CRC check, all Transport Blocks are delivered to L2 along with the associated error indications for transport channel other than HS-DSCH and E-DCH. In case of HS-DSCH and E-DCH an error indication is provided to L2 in case of CRC failure.

In case of HS-DSCH and E-DCH retransmissions of Transport Blocks may be requested before transport blocks are delivered to L2.

6 Model of physical layer of the UE

6.1 Uplink models

Figure 2 shows models of the UE's physical layer in the uplink for both FDD and TDD mode. It shows the models for DCH, RACH, E-DCH, and USCH (TDD only). Some restriction exist for the use of different types of transport channel at the same time, these restrictions are described in the clause "UE Simultaneous Physical Channel combinations". More details can be found in [3] and [4].

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