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RADIO INTERFACE SPECIFICATIONS FOR IMT-2000 DEVELOPED BY 3GPP TSG RAN

This document provides a response to the liaison statement sent from ITU-T SG11 Chair to SDOs and Partnership Projects on the topic of radio interface Specifications. It contains information about the draft radio interface Specifications developed by 3GPP TSG RAN. These Specifications are submitted to ITU-T SG 11 in order to facilitate their activity on IMT-2000.

It is recognised that not all Specifications listed in this document may be relevant to ITU-T SG 11. However, 3GPP TSG RAN is developing a complete set of Specifications for the Radio Access Network.

The purpose of the contribution is to indicate the structure and content that 3GPP is using to develop its Specifications for the radio interface, which has been accepted by SDOs in all 3 regions.

In the Appendix A the 3GPP RAN TSG Specification structure is shown.

These Specifications show the present detailed level and status of the work performed in 3GPP RAN TSG. These Specifications are not yet approved, the documents and their content can only be used as preliminary information at this point in time.

All Specifications listed in Appendix A can be downloaded from the Web:

http://www.3gpp.org/TSG/June_status_list.htm

In Appendix B, the ‘Overview’ requested by ITU-R TG 8/1 is attached for information.

APPENDIX 1

RADIO INTERFACE SPECIFICATIONS STRUCTURE

25.200 Series

25.201 Physical layer – general description
Version: 2.1.0

This specification describes the documents being produced by the 3GPP TSG RAN WG1and first complete versions expected to be available by end of 1999. This specification gives also general description of the physical layer of the UTRA air interface,

The 25.200 series specifies Um point for the 3G mobile system. This series defines the minimum level of specifications required for basic connections in terms of mutual connectivity and compatibility.

25.211 Physical channels and mapping of transport channels onto physical channels (FDD)
Version: 2.1.0

This specification describes the characteristics of the Layer 1 transport channels and physicals channels in the FDD mode of UTRA. The main objectives of the document are to be a part of the full description of the UTRA Layer 1, and to serve as a basis for the drafting of the actual technical specification (TS).

25.212 Multiplexing and channel coding (FDD)
Version: 2.0.0

This specification describes the documents being produced by the 3GPP TSG RAN WG1and first complete versions expected to be available by end of 1999. This specification describes the characteristics of the Layer 1 multiplexing and channel coding in the FDD mode of UTRA.

The 25.200 series specifies Um point for the 3G mobile system. This series defines the minimum level of specifications required for basic connections in terms of mutual connectivity and compatibility.

25.213 Spreading and modulation (FDD)
Version: 2.1.0

The present document describes spreading and modulation for UTRA Physical Layer FDD mode.

25.214 Physical layer procedures (FDD)
Version: 1.1.0

This document specifies and establishes the characteristics of the physicals layer procedures in the FDD mode of UTRA.

25.221 Physical channels and mapping of transport channels onto physical channels (TDD)
Version: 1.1.0

25.222 Multiplexing and channel coding (TDD)
Version: 2.0.0

This 3GPP Report describes multiplexing, channel coding and interleaving for UTRA Physical Layer TDD mode.

Text without revision marks has been approved in the previous TSG-RAN WG1 meetings, while text with revision marks is subject to approval.

25.223 Spreading and modulation (TDD)
Version: 2.1.0

This document establishes the characteristics of the spreading and modulation in the TDD mode. The main objectives of the document are to be a part of the full description of the Layer 1, and to serve as a basis for the drafting of the actual technical specification (TS).

25.224 Physical layer procedures description (TDD)

Version: 1.0.0

The present document describes the Physical Layer Procedures in the TDD mode of UTRA.

25.231 Physical layer – Measurements

Version: 0.3.0

This 3GPP Telecommunication Specification TS contains the description of the measurements done at the UE and network in order to support operation in idle mode and connected mode.

As far as the measurements in idle mode are concerned, this TS described the following :

- measurements for the cell selection for a UE supporting FDD and/or TDD
- measurements for cell reselection for a UE camping on an FDD or TDD cell

As far as the measurements in connected mode are concerned, this TS describes measurements when the UE is connected to an FDD cell or cells (in Soft handover) or a TDD cell for the cell connected state (see reference [8]), or camping on an FDD cell for the UTRA connected state. This TS provides the minimum requirements for the UE and networks. Some explanatory text is also contained in the TS but it is more of a descriptive nature than normative.

As far as the measurements for the handover preparation, this specification defines the requirements to the UE and UTRAN, as well as parametrisation rules for the compressed mode in order to accommodate idle periods. This latter aspects may need to be moved to some other specifications. The description of the compressed mode (different type of compressed frames define by the compressed mode A/B, the number if idle slots and the position of such transmission gap) is outside the scope of this specification and is covered in 25.211 and 25.212.

25.300 Series

25.301 Radio Interface Protocol Architecture

Version: 3.1.0

The present document shall provide an overview and overall description of the UE-UTRAN radio interface protocol architecture as agreed within the 3GPP TSG RAN working group 2. Details of the radio protocols will be specified in companion documents.

25.302 Services provided by the Physical Layer

Version: 2.3.0

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

25.303 UE functions and Interlayer Procedures in Connected Mode

Version: 3.0.0

This document defines the UE States and the principal tasks undertaken by the UE when in Connected Mode. It includes informative interlayer procedures for the UE to perform the required tasks.

This document attempts to provide a comprehensive overview of the different states and transitions within the connected mode of a UMTS terminal. The applicable set of states for a given service may be a subset of the total set of possible states.

In addition to describing the states and related transitions, this document describes all procedures that assign, reconfigure and release radio resources. Included are e.g. procedures for transitions between different states and substates, handovers and measurement reports. The emphasis is on showing the combined usage of both peer-to-peer messages and interlayer primitives to illustrate the functional split between the layers, as well as the combination of elementary procedures for selected examples. The peer-to-peer elementary procedure descriptions are described in the related protocol descriptions /1, 2, 3/ and they are thus not within the scope of this document.

25.304 UE procedures in Idle Mode

Version: 1.2.0

The present document shall describe the overall idle mode process for the UE and the functional division between the non-access stratum and access stratum in the UE. The UE is in idle mode when the connection of the UE is closed on all layers, e.g. there is neither an MM connection nor an RRC connection.

This document presents also examples of inter-layer procedures related to the idle mode processes and describes idle mode functionality of a dual mode UMTS/GSM UE.

25.321 Medium Access Control (MAC) Protocol Specification

Version: 3.0.0

The scope of this description is the specification of the MAC protocol.

The following lists the contents for the specification of the MAC protocol:

1. list of procedures
2. logical flow diagrams for normal procedures
3. logical description of message
4. principles for error handling
5. some exceptional procedures which are felt criteria
6. It should, as far as possible, have the same format and outline as the final specification
7. exact message format
8. all scenarios

25.322 Radio Link Control (RLC) Protocol Specification

Version: 1.1.0

The scope of this description is to describe the RLC protocol. A description document is intermediate between a stage 2 document and a protocol specification. Once completed, it should be sufficient for manufacturers to start some “ high level design ” activities. It should allow as well to assess the complexity of the associated protocol. After the completion of a description document, the drafting of the protocol specification should not have to face difficulties which would impact the other protocols i.e. the radio interface protocol architecture should be stable. This means that some procedures which are felt critical in terms of complexity will need to be studied in more details in the description document so that no problem is faced in the writing of the final protocol.

The following lists typical contents for a description document :

1. list of procedures
2. logical flow diagrams for normal procedures
3. logical description of message (where it should be possible to guess roughly the size of the various information elements)
4. principles for error handling
5. some exceptional procedures which are felt critica
6. It should, as far as possible, have the same format and outline as the final specification

The following is not covered

1. exact message format
2. all scenarios

25.331 Radio Resource Control (RRC) Protocol Specification

Version: 1.1.0

The scope of this specification is to describe the Radio Resource Control protocol for the 3GPP radio system.

25.400 Series

25.401 UTRAN Overall Description

Version: 1.1.1

This document describes the overall architecture of the UTRAN, including internal interfaces and assumptions on the radio and Iu interfaces.

25.410 UTRAN Iu Interface: General Aspects and Principles

Version: 0.2.1

The present document is an introduction to the UMTS 25.41x series of Technical Specifications that define the Iu interface for the interconnection of Radio Network Controller (RNC) component of the UMTS Terrestrial Radio Access Network (UTRAN) to the Core Network of the UMTS system.

25.411 UTRAN Iu interface Layer 1

Version: 3.0.0

The present document specifies the standards allowed to implement Layer 1 on the I_u interface.
The specification of transmission delay requirements and O&M requirements are not in the scope of this document.

25.412 UTRAN Iu interface signalling transport

Version: 3.0.0

The present document specifies the standards for user data transport protocols and related signalling protocols to establish user plane transport bearers.

25.413 RANAP Specification

Version: 1.0.2

25.414 UTRAN Iu interface data transport & transport signalling

Version: 3.0.0

The present document specifies the standards for user data transport protocols and related signalling protocols to establish user plane transport bearers.

25.415 Iu interface CN-UTRAN user plane protocols

Version: 0.1.3

This Technical Specification defines the protocols being used to transport and control over the Iu interface, the Iu User Data Streams.

25.420 UTRAN Iur Interface: General Aspects and Principles

Version: 0.1.3

The present document is an introduction to the TSG RAN TS 25.42x series of UMTS Technical Specifications that define the Iur Interface. It is a logical interface for the interconnection of two Radio Network Controller (RNC) components of the UMTS Terrestrial Radio Access Network (UTRAN) for the UMTS system.

25.421 UTRAN Iur interface Layer 1

Version: 3.0.0

The present document specifies the standards allowed to implement Layer 1 on the I_{ur} interface.
The specification of transmission delay requirements and O&M requirements are not in the scope of this document.

25.422 UTRAN Iur interface signalling transport
Version: 3.0.0

The present document specifies the standards for user data transport protocols and related signalling protocols to establish user plane transport bearers.

25.423 RNSAP Specification
Version: 1.1.1

The present document specifies the radio network layer signalling procedures between RNCs in UTRAN.

25.424 Iur interface data transport & transport signalling for Common Transport Channel data streams
Version: 3.0.0

This document shall provide a description of the UTRAN RNS-RNS (Iur) interface Data Transport and Transport Signalling for Common Transport Channel data streams as agreed within the TSG-RAN working group 3.

25.425 UTRAN Iur interface user plane protocols for Common Transport Channel data streams
Version: 0.2.0

This document shall provide a description of the UTRAN RNS-RNS (Iur) interface user plane protocols for Common Transport Channel data streams as agreed within the TSG-RAN working group 3.

25.426 Iur & Iub interface data transport & transport signalling for DCH data streams
Version: 3.0.0

The scope of this Technical Specification is to specify the transport bearers for the DCH data streams on UTRAN Iur and Iub interfaces. The corresponding Transport Network Control plane is also specified. The physical layer for the transport bearers is outside the scope of this TS.

25.427 Iur & Iub interface user plane protocol for DCH data streams
Version: 0.2.1

This document shall provide a description of the UTRAN Iur and Iub interfaces user plane protocols for Dedicated Transport Channel data streams as agreed within the TSG-RAN working group 3.

25.430 UTRAN Iub Interface: General Aspects and Principles
Version: 0.1.2

The present document is an introduction to the TSG RAN TS 25.43x series of UMTS Technical Specifications that define the Iub Interface. The Iub interface is a logical interface for the interconnection of NodeB and Radio Network Controller (RNC) components of the UMTS Terrestrial Radio Access Network (UTRAN) for the UMTS system.

25.431 Iub interface Layer 1
Version: 3.0.0

The present document specifies the standards allowed to implement Layer 1 on the I_{ub} interface.
The specification of transmission delay requirements and O&M requirements is not in the scope of this document.

25.432 UTRAN Iub interface signalling transport
Version: 3.0.0

The present document specifies the signalling transport related to NBAP signalling to be used across the Iub Interface. The Iub interface is a logical interface for the interconnection of NodeB and Radio Network Controller (RNC) components of the UMTS Terrestrial Radio Access Network (UTRAN) for the UMTS system. The radio network control signalling between these nodes is based on the NodeB application part (NBAP).

25.433 NBAP Specification
Version: 1.0.2

The present document specifies the standards for NBAP specification to be used over Iub Interface.

25.434 UTRAN Iub interface data transport & transport signalling for Common Transport Channel data streams

Version: 3.0.0

This document shall provide a description of the UTRAN RNC-Node B (Iub) interface Data Transport and Transport Signalling for CCH data streams as agreed within the TSG-RAN working group 3.

25.435 Iub interface user plane protocols for Common Transport Channel data streams

Version: 0.2.1

This document shall provide a description of the UTRAN RNC-Node B(Iub) interface user plane protocols for Common Transport Channel data streams as agreed within the TSG-RAN working group 3.

25.100 Series

25.101 UE Radio transmission and reception (FDD)

Version: 2.0.0

This document establishes the minimum RF characteristics of the FDD mode of UTRA.

25.102 UE Radio transmission and reception (TDD)

Version: 1.1.0

This document establishes the minimum RF characteristics of the TDD mode of UTRA for the User Equipment (UE).

25.103 RF parameters in support of Radio Resource Management

Version: 1.0.0

This Technical Specification shall describe RF parameters and Requirements for the Radio Resource Management.

25.104 BTS Radio transmission and reception (FDD)

Version: 2.0.0

This document establishes the Base Station minimum RF characteristics of the FDD mode of UTRA.

25.105 BTS Radio transmission and reception (TDD)

Version: 1.1.0

This document establishes the minimum RF characteristics of the TDD mode of UTRA.

25.141 Basestation conformance testing (FDD)

Version: 1.0.0

This specification describes the documents being produced by the 3GPP TSG RAN WG4and first complete versions expected to be available by end of 1999. This specification gives also general description of the physical layer of the UTRA air interface,

The 25.100 series specifies.

For each test, two conformance requirements are specified:

- essential conformance requirements;
- complete conformance requirements.

Essential conformance requirements are those which are required:

a) to ensure compatibility between the radio channels in the same cell;

b) to ensure compatibility between cells, both co-ordinated and unco-ordinated;

c) to ensure compatibility with existing systems in the same or adjacent frequency bands;

d) to verify the important aspects of the transmission quality of the system.

Essential conformance requirements are sufficient to verify the performance of the equipment for radio type approval purposes, in countries where this is applicable.

Complete conformance requirements may be tested to verify all aspects of the performance of a BSS. These requirements are intended to be used by manufacturers and operators to allow conformance and acceptance testing to be performed in a consistent manner; the tests to be performed should be agreed between the parties.

In some tests there are separate requirements for micro-BTS and BTS. If there is no separate requirement for a micro-BTS, the requirements for the BTS apply to a micro-BTS.

In the present document, the reference point for RF connections (except for the measurement of mean transmitted RF carrier power) is the antenna connector, as defined by the manufacturer. This EN does not apply to repeaters or RF devices which may be connected to an antenna connector of a BSS, except as specified in subclause 4.10.

25.142 Basestation conformance testing (TDD)

Version: 0.0.1

The present document specifies the Radio Frequency (RF) test methods and conformance requirements for UTRA Base Transceiver Stations (BTS) operating in the TDD mode. These have been derived from, and are consistent with, the core UTRA specifications specified in the requirements reference subclause of each test.

For each test, two conformance requirements are specified:

- essential conformance requirements;
- complete conformance requirements.

In the context of the present specification, essential conformance requirements are those which are required for an efficient use of the spectrum, so as to avoid undue interference and corresponding service degradation. In detail, essential requirements are required

a) to ensure compatibility between the radio channels in the same cell;

b) to ensure compatibility between cells, both co-ordinated and uncoordinated;

c) to ensure compatibility with existing systems in the same or adjacent frequency bands.

System performance tests are not considered to include essential conformance requirements.

Essential conformance requirements are sufficient to verify the performance of the equipment for radio type approval purposes, in countries where this is applicable.

Complete conformance requirements may be tested to verify all aspects of the performance of a BTS. These requirements are intended to be used by manufacturers and operators to allow conformance and acceptance testing to be performed in a consistent manner; the tests to be performed should be agreed between the parties.

The present release of this specification defines the tests for essential conformance requirements only; tests for complete conformance requirements are due for later releases.

In this TS, the reference point for RF connections (except for the measurement of mean transmitted RF carrier power) is the antenna connector, as defined by the manufacturer. This TS does not apply to repeaters or RF devices which may be connected to an antenna connector of a BTS.

25.113 Basestation EMC[1]

Version: 0.0.0

[1] This Specification does not include the antenna port immunity and emissions.

APPENDIX 2

5.x Radio Interface No. X

5.x.1 Introduction

[TG 8/1 responsibility]

5.x.2 Overview of the FDD DS-CDMA and TDD CDMA radio interface

5.x.2.1 Introduction

For FDD and TDD the radio access scheme is Direct-Sequence Code Division Multiple Access (DS-CDMA) with information spread over approximately 5 MHz bandwidth with a chip rate of 3.84 Mcps. The technology employs both, frequency division duplex (FDD) and time division duplex (TDD). It is defined to carry a wide range of user data services (multimedia, packet etc.) simultaneously multiplexed on a single carrier. The specifications are developed and specified within the 3GPP organisation. The overall architecture is briefly introduced in Section 5.x.2.2. Then the description continues with an overview on the radio protocol layers that are relevant for the radio access specific parts, i.e. the physical layer, layer 2 and radio resource layer 3 of the radio interface.

5.x.2.2 Architecture

The overall architecture of the system is shown in Figure 1.

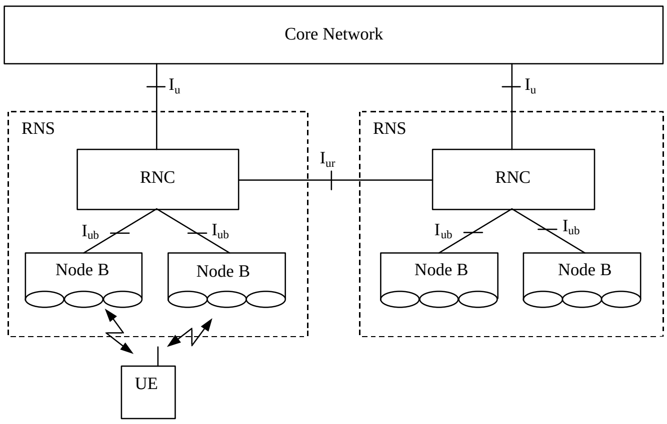

Figure 1. UTRAN Architecture

The Universal Terrestrial Radio Access Network (UTRAN) architecture consists of a set of Radio Network Subsystems (RNS) connected to the Core Network through the I_u interface.

A RNS consists of a Radio Network Controller (RNC) and one or more entities called Node B. Node B are connected to the RNC through the I_{ub} interface. Node B can handle one or more cells (indicated by egg-shaped circles).

The RNC is responsible for the handover decisions that require signalling to the User Equipment (UE).

In case macro diversity between different Node B is used the RNC comprises a combining/splitting function to support it.

The Node B can comprise an optional combining/splitting function to support macro diversity inside a Node B.

Inside the UTRAN, the RNCs of the Radio Network Subsystems can be interconnected together through the I_{ur}. The I_u and I_{ur} are logical interfaces. I_{ur} can be conveyed over physical direct connection between RNCs or via any suitable transport network.

Figure 2 shows the radio interface protocol architecture for the radio access network. On a general level, the protocol architecture is similar to the current ITU-R protocol architecture as described in ITU-R recommendation M.1035. Layer 2 is split into two sublayers, Radio Link Control (RLC) and Medium Access Control (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 core network. There are no L3 in UTRAN for the U-plane.

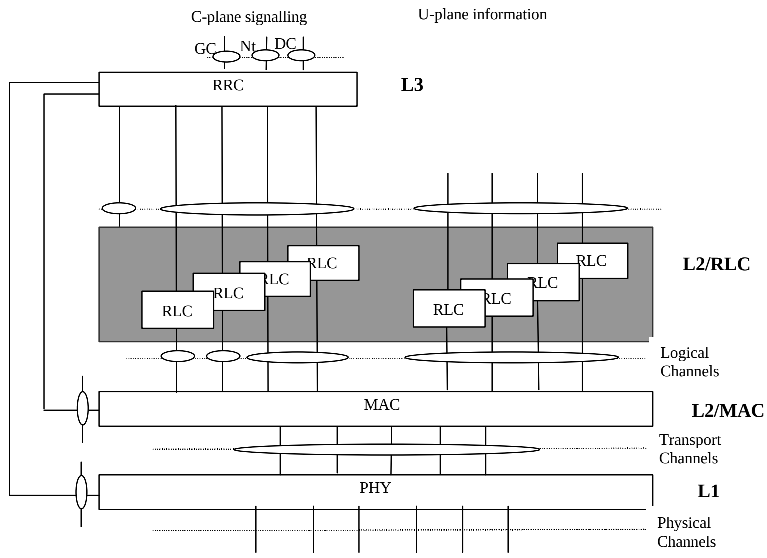

Figure 2. Radio interface protocol architecture of the RRC sublayer, L2 and Physical layer (L1).

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 SAPs between RLC and the MAC sublayer provide the logical channels. The type of information transferred characterises a logical channel. The logical channels are divided into control channels and traffic channels. The different types are not further described in this overview. The SAP between MAC and the physical layer provides the transport channels. A transport channel is characterised by how the information is transferred over the radio interface, see Section 5.x.2.3.2 for an overview of the types defined. The physical layer generates the physical channels that will be transmitted over the air. A physical channel corresponds in FDD to a certain carrier frequency, code, and, on the uplink, relative phase (0 or $\pi/2$). In TDD the physical channel is defined by carrier frequency, code, time slot and multi-frame information. 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. These SAPs are not further discussed in this overview.

Also shown in the figure are connections between RRC and MAC as well as RRC and L1 providing local inter-layer control services (including measurement results). An equivalent control interface exists between RRC and the RLC 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 (RLC, MAC, and L1).

Figure 3 shows the general structure and some additional terminology definitions of the channel formats at the various sublayer interfaces indicated in Figure 2. The figure indicates how higher layer Service data Units (SDU) and Protocol Data Units (PDUs) are segmented and multiplexed to transport blocks to be further treated by the physical layer. The transmission chain of the physical layer is described in the next section.

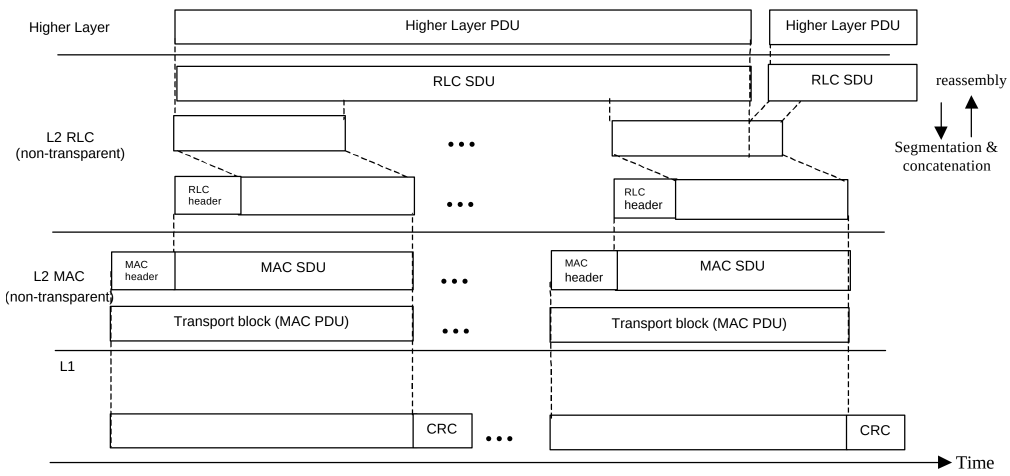

Figure 3. Data flow for a service using a non-transparent RLC and non-transparent MAC, see sections 5.x.2.4.1-2 for further definitions of the MAC and RLC services and functionality.

In TDD the Opportunity Driven Multiple Access (ODMA) is applicable. ODMA operates on relaylinks between different Relays. These Relays may be represented by either UEs with ODMA capability or ODMA seeds (ODMA equipment permanently located in the network). Relays/Seeds may act as gateways to connect the ODMA equipment to the UTRAN. This can be done using either FDD or TDD.

5.x.2.3 Physical layer

5.x.2.3.1 Physical layer functionality and building blocks

The physical layer includes the following functionality:

- Macrodiversity distribution/combining and soft handover execution
- Error detection on transport channels and indication to higher layers
- Forward Error Control (FEC) encoding/decoding of transport channels
- Multiplexing of transport channels and demultiplexing of coded composite transport channels
- Rate matching (data multiplexed on Dedicated Channels (DCH))
- Mapping of coded composite transport channels on physical channels
- Power weighting and combining of physical channels
- Modulation and spreading/demodulation and despreading of physical channels
- Frequency and time (chip, bit, slot, frame) synchronisation
- Radio characteristics measurements including Frame Error Rate (FER), Signal-to-Interference (SIR), Interference Power Level etc., and indication to higher layers
- Closed-loop power control
- Radio Frequency (RF) processing

Figure 4 gives the physical layer transmission chain for the user plane data, i.e. from the level of transport channels down to the level of physical channel. The figure shows how several transport channels can be multiplexed onto one or more dedicated physical data channels (DPDCH). For the TDD mode the left part of Figure 4 is used for both uplink and downlink.

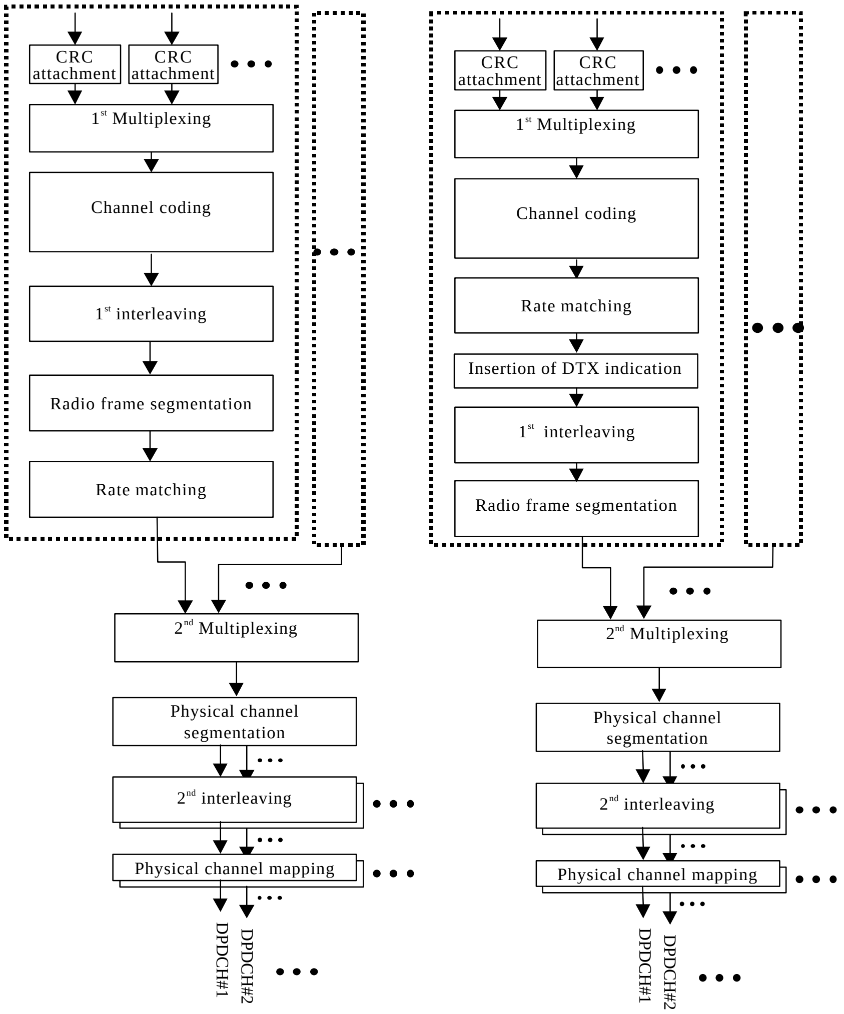

Figure 4. Transport channel multiplexing structure: Left: FDD UL and TDD UL/DL; Right: FDD DL.

The cyclic redundancy check (CRC) provides for error detection of the transport blocks for the particular transport channel. The CRC can take the length zero (no CRC), 8 or 16 depending on the service requirements.

The 1st multiplexing may perform the multiplexing of fixed rate transport channels with the same level of quality of service.

The types of channel coding defined are convolutional coding, turbo coding and no coding. Real-time services use only FEC encoding while non real-time services uses a combination of FEC and ARQ. The ARQ functionality resides in the RLC layer of Layer 2.

The rate matching adapts any remaining differences of the bit rate so the number of outgoing bits fit to the available bit rates of the physical channels. Repetition coding and/or puncturing is used for this purpose.

The 2nd multiplexing stage combines transport channels in a serial fashion. The output of this operation is also called coded composite transport channels.

If several physical channels will be used to transmit the data, the split is made in the physical channel segmentation unit.

In the FDD downlink discontinuous transmission (DTX) on a slot to slot basis can be used for variable rate transmission. This is controlled by the ‘Insertion of DTX indication’ box.

5.x.2.3.2 Transport channels

5.x.2.3.2.1 Transport channels relevant for both FDD and TDD

The interface to the MAC layer is the transport channels, see Figure 1. The transport channels define how and with which type of characteristics the data is transferred by the physical layer. They are categorised into dedicated channels or common channels where many UEs are sharing the latter type. Introducing an information field containing the address then does the address resolution, if needed. The physical channel itself defines a dedicated channel. Thus no specific address is needed for the UE. Table 1 summarises the different types of available transport channels that are relevant for both FDD and TDD and their intended use.

Table 1. The defined transport channels relevant for both FDD and TDD and their intended use.

Transport channel	**Type and direction**	**Used for**
DCH (Dedicated channel)	Dedicated; uplink and downlink	User or control information to a UE (entire cell or part of cell (lobe-forming))
BCH (Broadcast channel)	Common; downlink	Broadcast system and cell specific information
FACH (Forward access channel)	Common; downlink	Control information when system knows UE location or short user packets to a UE
PCH (Paging channel)	Common; downlink	Control information to UEs when good sleep mode properties are needed, e.g. idle mode operation
RACH (Random access channel)	Common; uplink	Control information or short user packets from an UE
DSCH (Downlink shared channel)	Common; downlink	Carries dedicated user data and control information using a shared channel.
DSCH control channel	Common; downlink	Carries control information when the DSCH is not associated with a DCH

The random access channel on the uplink is contention-based while the dedicated channel is reservation-based.

5.x.2.3.2.2 Transport channels relevant for FDD only

Table 2 summarises the different types of available transport channels that are relevant for FDD only and their intended use.

Table 2. The defined transport channels relevant for FDD only and their intended use.

Transport channel	**Type and direction**	**Used for**
FAUSCH (Fast uplink signalling channel)	Dedicated; uplink	FDD only. Carries control information from an UE
CPCH (Common packet channel)	Common; uplink	FDD only. Short and medium sized user packets. Always associated with a downlink channel for power control

The common packet channel on the uplink is contention-based while the dedicated channel is reservation-based.

5.x.2.3.2.3 Transport channels relevant for TDD only

Table 3 summarises the different types of available transport channels that are relevant for TDD only and their intended use.

Table 3. The defined transport channels relevant for TDD only and their intended use.

Transport channel	**Type and direction**	**Used for**
USCH (Uplink shared channel)	Common; Uplink	TDD only. Carries dedicated user data and control information using a shared channel
ODCH (ODMA Dedicated channel)	Dedicated	TDD only. Applicable for ODMA relaying
ORACH (ODMA Random Access Channel)	Common	TDD only. Applicable for ODMA relaying

5.x.2.3.3 Transport channels to Physical channel mapping

The transport channels are mapped onto the physical channels. Figure 5 (FDD) and Figure 6 (TDD) show the different physical channels and summarises the mapping of transport channels onto physical channels. Each physical channel has its tailored slot content. The dedicated channel (DCH) is shown in section 5.x.2.3.4.

5.x.2.3.3.1 Transport channels, physical channels and their mapping for FDD

Transport Channels	Physical Channels
BCH	Primary Common Control Physical Channel (Primary CCPCH) (Downlink; 30 kbps fixed rate)
FACH	Secondary Common Control Physical Channel (Secondary CCPCH) (Downlink; Variable rate.)
PCH	
RACH	Physical Random Access Channel (PRACH)
FAUSCH	(Uplink)
CPCH	Physical Common Packet Channel (PCPCH) (Uplink)
DCH	Dedicated Physical Data Channel (DPDCH) (Downlink/Uplink)
	Dedicated Physical Control Channel (DPCCH) (Downlink/Uplink; Associated with a DPDCH)
DSCH	Physical Downlink Shared Channel (PDSCH) (Downlink)
DSCH control channel	Physical Shared Channel Control Channel (PSCCCH) (Downlink)
	Synchronisation Channel (SCH) (Downlink; uses part of the slot of primary CCPCH; used for cell search)
	Common Pilot Channel (CPICH) (Downlink, used as phase reference for other downlink physical channels)
	Acquisition Indication Channel (AICH) (Downlink; used to carry acquisition indicator for the random access procedure)
	Page Indication Channel (PICH) (Downlink; used to carry page indicators to indicate the presence of a page message on the PCH)

Figure 5: Transport –channels, physical –channels and their mapping – FDD

5.x.2.3.3.2 Transport channels, physical channels and their mapping for TDD

Transport Channels	Physical Channels
DCH	Dedicated Physical Channel (DPCH)
ODCH*	
BCH	Common Control Physical Channel (CCPCH)
FACH	
PCH	
RACH	Physical Random Access Channel (PRACH)
ORACH*	
SCH	Physical Synchronisation Channel (PSCH)
USCH	Physical Uplink Shared Channel (PUSCH)
DSCH	Physical Downlink Shared Channel (PDSCH)
	Page Indicator Channel (PICH)

* in case of ODMA networks

Figure 6 Transport channels, physical channels and their mapping - TDD

5.x.2.3.4 Physical frame structure - FDD

The basic physical frame rate is 10 milliseconds with 15 slots. Figure 7 shows the frame structure.

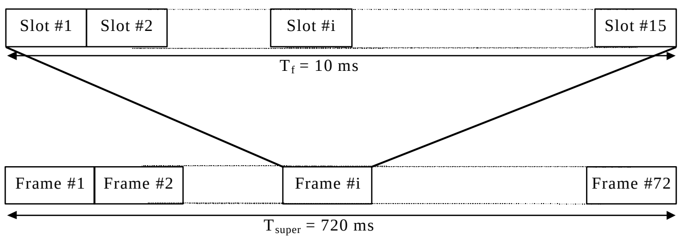

Figure 7. Basic frame structure.

Figure 8 shows the content for a slot used by the DCH. For the FDD the uplink physical channels DPDCH and DPCCH are I/Q multiplexed while the downlink channels are time multiplexed. The DPDCH, the channel where the user data is transmitted on, is always associated with a DPCCH containing Layer 1 control information. The Transport Format Combination Indicator (TFCI) field is used for indicating the demultiplexing scheme of the data stream. The TFCI field does not exist for combinations that are static (i.e. fixed bit rate allocations) or blind transport format detection is employed. The Feedback Information (FBI) field is used for transmit and site diversity functions. The Transmit Power Control (TPC) bits are used for power control.

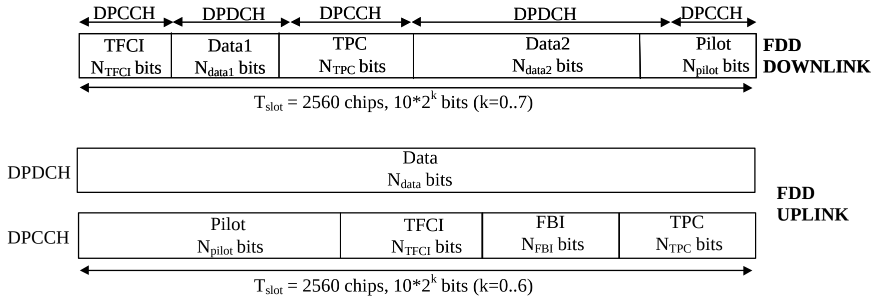

Figure 8. The slot content for the DPDCH/DPCCH. The exact bit allocations are not shown.

A Common Pilot Channel (CPICH) is defined. It is an unmodulated downlink channel, that is the phase reference for other downlink physical channels.

There is always one primary CPICH in each cell. There may also be additional secondary CPICHs in a cell.

For the uplink, the maximum physical channel bit rate is 960 kbps using a spreading factor of 4. To obtain higher bit rates for a user several physical channels can be used. The channel bit rate of the DPCCH is fixed to 16 kbps. For the downlink the maximum channel bit rate is 1920 kbps with a spreading factor of 4. Note that the symbol bit rate is equal to the channel bit rate for the uplink while it is half of the channel bit rate for the downlink. The maximum spreading factors are 512 for the downlink and 256 for the uplink.

To be able to support inter-frequency handover as well as measurements on other carrier frequencies or carriers of other systems, like GSM, a compressed mode of operation is defined. The function is implemented by having some slots empty, but without deleting any user data. Instead the user data is transmitted in the remaining slots. The number of slots that is not used can be variable with a minimum of three slots (giving minimum idle lengths of at least 1.73 milliseconds). The slots can be empty either in the middle of a frame or at the end and in the beginning of the consecutive frame. If and how often is controlled by the RRC functionality in Layer 3.

5.x.2.3.5 Physical frame structure – TDD

The basic physical frame rate is 10 milliseconds with 15 slots. Figure 9 shows the frame structure.

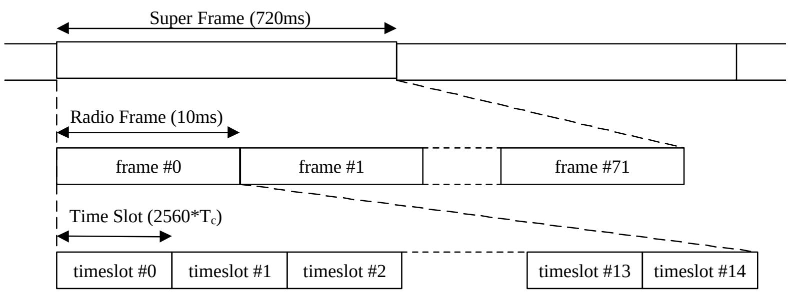

Figure 9: Basic frame structure – TDD

Each 10 ms frame consists of 15 time slots, each allocated to either the uplink or the downlink. With such a flexibility , the TDD mode can be adapted to different environments and deployment scenarios. In any configuration at least one time slot has to be allocated for the downlink and at least one time slot has to be allocated for the uplink.

When operating ODMA at least one common timeslot has to be allocated for the ORACH. If large quantities of information have to be transferred between ODMA nodes then it is normal to use at least one timeslot for the ODCH (Figure 10).

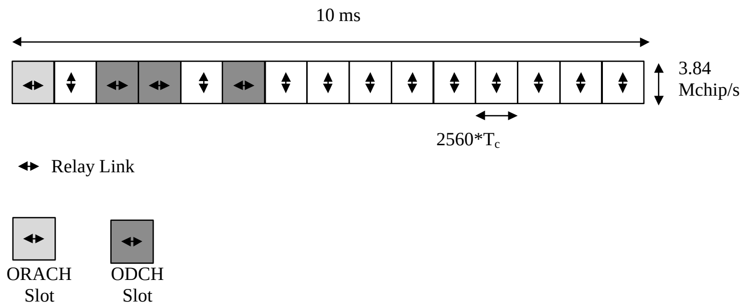

Figure 10: TDD frame structure example for ODMA operation

Figure 11 and Figure 12 show the two burst formats stating the content for a slot used by a DCH. The usage of either burst format 1 or 2 is depending on the application for UL or DL and the number of allocated users per timeslot.

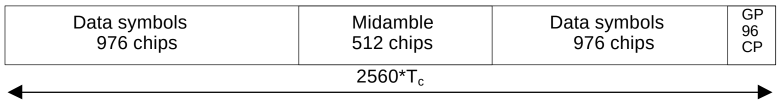

Figure 11: Burst structure of the burst type 1. GP denotes the guard period and CP the chip periods.

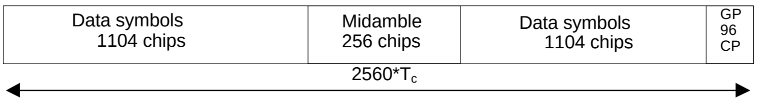

Figure 12: Burst structure of the burst type 2. GP denotes the guard period and CP the chip periods.

In both cases data bits are QPSK modulated and the resulting symbols are spread with a channelisation code of length 1 to 16. Due to this variable spreading factor, each data part of one burst provides the number of symbols as shown in Table 4 below.

Table 4 Number of data symbols in TDD bursts.

Spreading factor (Q)	Number of symbols (N) per data field in Burst 1	Number of symbols (N) per data field in Burst 2
1	976	1104
2	488	552
4	244	276
8	122	138
16	61	69

Thus, the number of bits per TDD burst is four times the number shown in Table.Usage of multicode and multiple timeslots can be applied.

5.x.2.3.6 Spreading, modulation and pulse shaping

Uplink - FDD

Spreading consists of two operations. The first is the channelisation operation, which transforms every data symbol into a number of chips, thus increasing the bandwidth of the signal. The number of chips per data symbol is called the Spreading Factor (SF). The second operation is the scrambling operation, where a scrambling code is applied to the spread signal.

In the channelisation operation, data symbol on so-called I- and Q-branches are independently multiplied with a code. The channelisation codes are Orthogonal Variable Spreading Factor (OVSF) codes that preserve the orthogonality between a user's different physical channels. With the scrambling operation, the resultant signals on the I- and Q-branches are further multiplied by complex-valued scrambling code, where I and Q denote real and imaginary parts, respectively. Note that before complex multiplication binary values 0 and 1 are mapped to +1 and -1, respectively.

Figure 13 illustrates the spreading and modulation for the case of multiple uplink DPDCHs when total data rate is less than or equal to 960 kbps in the 5MHz band (the 1920 kbps case is not shown here). Note that this figure only shows the principle, and does not necessarily describe an actual implementation. Modulation is dual-channel QPSK (i.e.; separate BPSK on I- and Q-channel), where the uplink DPDCH and DPCCH are mapped to the I and Q branch respectively. The I and Q branches are then spread to the chip rate with two different channelisation codes and subsequently complex scrambled by a UE specific complex scrambling code C_{scramb}. There are 2^{24} uplink-scrambling codes. Either short (256 chips from the family of S(2) codes) or long (38400 chips equal to one frame length, Gold code based) scrambling codes is used on the uplink. The short scrambling code is typically used in cells where the base station is equipped with an advanced receiver, such as a multi-user detector or interference canceller whereas the long codes gives better interference averaging properties.
The pulse-shaping filters are root-raised cosine (RRC) with roll-off α=0.22 in the frequency domain.
The modulation of both DPCCH and DPDCH is BPSK. The modulated DPCCH is mapped to the Q-branch, while the first DPDCH is mapped to the I-branch. Subsequently added DPDCHs are mapped alternatively to the I or Q-branches.

Downlink - FDD

Figure 14 illustrates the spreading and modulation for the downlink DPCH. Data modulation is QPSK where each pair of two bits are serial-to-parallel (S/P) converted and mapped to the I and Q branch respectively. The I and Q branch are then spread to the chip rate with the same channelisation code c_{ch} (real spreading) and subsequently scrambled by the scrambling code C_{scramb} (complex scrambling).
The channelisation codes are the same codes as used in the uplink that preserve the orthogonality between downlink channels of different rates and spreading factors. There are a total 512*512 = 262,144 scrambling codes, numbered 0…262,143. The scrambling codes are divided into 512 sets each of a primary scrambling code and 511 secondary scrambling codes. Each cell is allocated one and only one primary scrambling code. The primary CCPCH is always transmitted using the primary scrambling code. The other downlink physical channels can be transmitted with either the primary scrambling code or a secondary scrambling code from the set associated with the primary scrambling code of the cell.
The pulse-shaping filters are root raised cosine (RRC) with roll-off α=0.22 in the frequency domain.

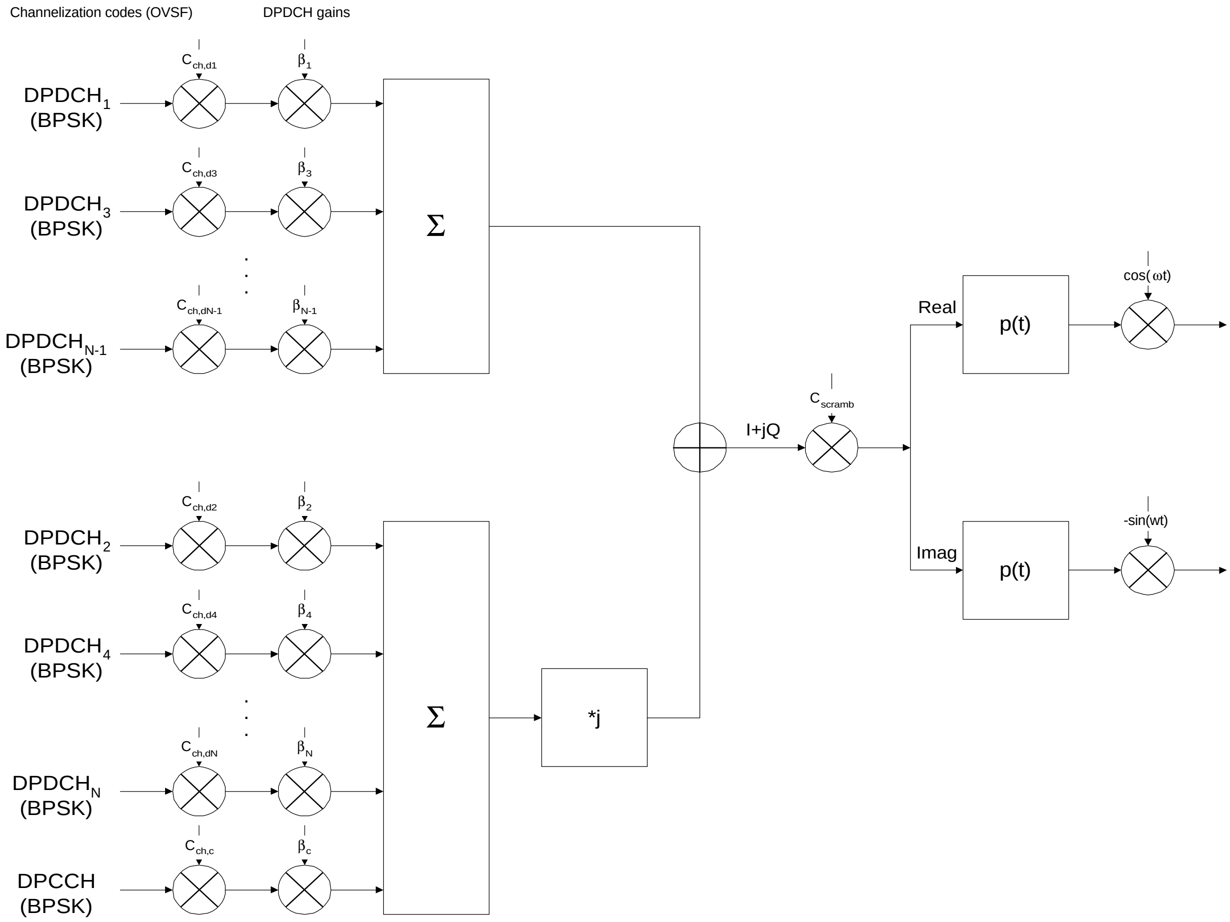

Figure 13. Spreading/modulation for uplink DPDCH/DPCCH for user services less than or equal to 960kbps in the 5MHz band

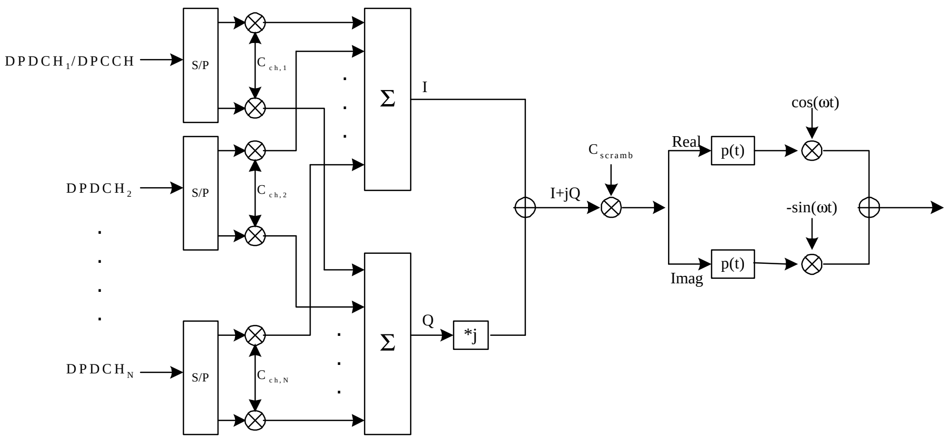

Figure 14. Spreading/modulation for downlink DPCH.

Up- and Downlink – TDD

Spreading is applied after modulation and before pulse shaping. It consists of two operations. The first is the channelisation operation, which transforms every data symbol into a number of chips, thus increasing the bandwidth of the signal. The number of chips per data symbol is called the Spreading Factor (SF) and is in the range of 1 to 16. The second operation is the scrambling operation, where a scrambling code is applied to the spread signal. This procedure is similar to FDD Mode, but it should be noted that the midamble part in TDD bursts (see Figure 11 and Figure 12) is not spread.

The applied channelisation codes are OVSF-codes (Orthogonal Variable Spreading Factor-codes) that preserve the distinguishability of different users. The applied scrambling code is cell-specific and 128 different scrambling codes are available.

In the Uplink, the applied midamble is user specific and derived from a cell-specific Basic Midamble Sequence. In the Downlink, the applied midamble is either user specific or common for the whole cell. In each case 128 different Basic Midamble sequences are available.

After spreading same pulse-shaping is applied as in FDD Mode, i.e. the filters are root-raised cosine with roll-off α=0.22 in the frequency domain.

5.x.2.4 Layer 2

5.x.2.4.1 Medium Access Control (MAC) layer

The MAC sublayer is responsible for the handling of the data streams coming from the RLC and RRC sublayers. It provides an unacknowledged transfer mode service to the upper layers. It also reallocates radio resources on request by the RRC sublayer as well as provides measurements to the upper layers. Thus, the functionality handles issues like:

- Mapping of the different logical channels to the appropriate transport channels and selection of appropriate transport format for the transport channels based on the instantaneous source bit rate. It also performs the multiplexing /demultiplexing of the PDUs to/from transport blocks which are thereafter further treated by the physical layer.
- performs dynamic switching between common and dedicated transport channels based on information from the RRC sublayer
- handles priority issues for services to one UE according to information from higher layers and physical layer (e.g. available transmit power level) as well as priority handling between UEs by means of dynamic scheduling in order to increase spectrum efficiency
- monitor traffic volume that can be used by the RRC sublayer
- In TDD only, the routing of higher layers signalling, the support of fast DCA by monitoring the links of assigned resources and the maintenance of the respective MAC signalling connection are additionally supported by the MAC.

5.x.2.4.2 Radio Link Control (RLC) sublayer

The RL C sublayer provides three different types of data transfer modes:

- **Transparent data transfer**. This service transmits higher layer PDUs without adding any protocol information, possibly including segmentation/reassemble functionality.

- **Unacknowledged data transfer**. This service transmits higher layer PDUs without guaranteeing delivery to the peer entity. The unacknowledged data transfer mode has the following characteristics:
    - Detection of erroneous data: The RLC sublayer shall deliver only those SDUs to the receiving higher layer that are free of transmission errors by using the sequence-number check function.
    - Unique delivery: The RLC sublayer shall deliver each SDU only once to the receiving upper layer using duplication detection function.
    - Immediate delivery: The receiving RLC sublayer entity shall deliver a SDU to the higher layer receiving entity as soon as it arrives at the receiver.

- **Acknowledged data transfer**. This service transmits higher layer PDUs and guarantees delivery to the peer entity. In case RLC is unable to deliver the data correctly, the user of RLC at the transmitting side is notified. For this service, both in-sequence and out-of-sequence delivery are supported. In many cases a higher layer protocol can restore the order of its PDUs. As long as the out-of-sequence properties of the lower layer are known and controlled (i.e. the higher layer protocol will not immediately request retransmission of a missing PDU) allowing out-of-sequence delivery can save memory space in the receiving RLC. The acknowledged data transfer mode has the following characteristics:
    - Error-free delivery: Error-free delivery is ensured by means of retransmission. The receiving RLC entity delivers only error-free SDUs to the higher layer.
    - Unique delivery: The RLC sublayer shall deliver each SDU only once to the receiving upper layer using duplication detection function.
    - In-sequence delivery: RLC sublayer shall provide support for in-order delivery of SDUs, i.e.,

RLC sublayer should deliver SDUs to the receiving higher layer entity in the same order as the transmitting higher layer entity submits them to the RLC sublayer.

- Out-of-sequence delivery: Alternatively to in-sequence delivery, it shall also be possible to allow that the receiving RLC entity delivers SDUs to higher layer in different order than submitted to RLC sublayer at the transmitting side.

It also provides for RLC connection establishment/release. As well as QoS setting and notification to higher layers in case of unrecoverable errors.

5.x.2.5 Layer 3 (Radio resource control sublayer)

The Radio Resource Control (RRC) sublayer handles the control plane signalling of Layer 3 between the UEs and UTRAN. In addition to the relation with the upper layers (such as core network) the following main functions are performed:

- **Broadcast of information provided by the non-access stratum (Core Network).** The RRC layer performs system information broadcasting from the network to all UEs. The system information is normally repeated on a regular basis. This function supports broadcast of higher layer (above RRC) information. This information may be cell specific or not. As an example RRC may broadcast Core Network location service area information related to some specific cells.
- **Broadcast of information related to the access stratum.** The RRC layer performs system information broadcasting from the network to all UEs This function supports broadcast of typically cell-specific information.
- **Establishment, maintenance and release of an RRC connection between the UE and UTRAN.** The establishment of an RRC connection is initiated by a request from higher layers at the UE side to establish the first Signalling Connection for the UE. The establishment of an RRC connection includes an optional cell re-selection, an admission control, and a layer 2 signalling link establishment.
- **Establishment, reconfiguration and release of Radio Access Bearers.** The RRC layer will, on request from higher layers, perform the establishment, reconfiguration and release of radio access bearers in the user plane. A number of radio access bearers can be established to an UE at the same time. At establishment and reconfiguration, the RRC layer performs admission control and selects parameters describing the radio access bearer processing in layer 2 and layer 1, based on information from higher layers.
- **Assignment, reconfiguration and release of radio resources for the RRC connection.** The RRC layer handles the assignment of radio resources (e.g. codes and, for TDD only, timeslots) needed for the RRC connection including needs from both the control and user plane. The RRC layer may reconfigure radio resources during an established RRC connection. This function includes co-ordination of the radio resource allocation between multiple radio bearers related to the same RRC connection. RRC controls the radio resources in the uplink and downlink such that UE and UTRAN can communicate using unbalanced radio resources (asymmetric uplink and downlink). RRC signals to the UE to indicate resource allocations for purposes of handover to GSM or other radio systems.
- **RRC connection mobility functions.** The RRC layer performs evaluation, decision and execution related to RRC connection mobility during an established RRC connection, such as handover, preparation of handover to GSM or other systems, cell re-selection and cell/paging area update procedures, based on e.g. measurements done by the UE.
- **Paging/notification.** The RRC layer can broadcast paging information from the network to selected UEs. The RRC layer can also initiate paging during an established RRC connection.
- **Routing of higher layer PDUs.** This function performs at the UE side routing of higher layer PDUs to the correct higher layer entity, at the UTRAN side to the correct RANAP entity.
- **Control of requested QoS**. This function ensures that the QoS requested for the radio access bearers can be met. This includes the allocation of a sufficient number of radio resources.
- **UE measurement reporting and control of the reporting.** The measurements performed by the UE are controlled by the RRC layer, in terms of what to measure, when to measure and how to report, including both UMTS air interface and other systems. The RRC layer also performs the reporting of the measurements from the UE to the network.
- **Outer loop power control.** The RRC layer controls setting of the target of the closed loop power control.
- **Control of ciphering.** The RRC layer provides procedures for setting of ciphering (on/off) between the UE and UTRAN.
- **Initial cell selection and re-selection in idle mode.** Selection of the most suitable cell based on idle

mode measurements and cell selection criteria.
- **Arbitration of the radio resource allocation between the cells**. This function shall ensure optimal performance of the overall UTRAN capacity.

The following functions are for TDD only:

- **Broadcast of ODMA relay node neighbour information.** The RRC layer performs probe information broadcasting to allow ODMA routeing information to be collected.
- **Collating ODMA neighbour list and gradient information.** The ODMA relay node neighbour lists and their respective gradient information maintained by the RRC.
- **Maintenance of number of ODMA relay node neighbours.** The RRC will adjust the broadcast powers used for probing messages to maintain the desired number of neighbours.
- **Establishment, maintenance and release of a route between ODMA relay nodes.** The establishment of an ODMA route and RRC connection based upon the routeing algorithm.
- **Interworking between the Gateway ODMA relay node and the UTRAN.** The RRC layer will control the interworking communication link between the Gateway ODMA relay node and the UTRAN.
- **Contention resolution**. The RRC handles reallocations and releases of radio resources in case of collisions indicated by lower layers.
- **Slow DCA**. Allocation of preferred radio resources based on long-term decision criteria.

5.x.3 Detail Specification of Radio Interface #4

The detailed Specifications are defined in the documents identified by the external references which follow.

[List of references to titles (and location) of 3GPP Specs + Scope/Introduction]

5.x.3.1 Complete FDD DS-CDMA Radio Interface Specification

3GPP set of FDD Specs

5.x.3.2 Complete TDD CDMA Radio Interface Specification

3GPP set of TDD Specs

Annex

The Summary of Major Technical Parameters Table (FDD)

Parameter	**"Value"**	**Reference to SDOs/3GPPs Specifications**
Multiple access technique and duplexing scheme	Multiple Access: DS-CDMA Duplexing: FDD	TSG RAN WG1: TS 25.201
Chip rate	3.84 Mcps	TSG RAN WG4: TS 25.101
Frame length and structure	Frame length: 10 ms 15 slots per frame, each 666.666µs	TSG RAN WG1: TS 25.211
Occupied bandwidth	Less than 5 MHz	TSG RAN WG4: TS 25.101 TSG RAN WG4: TS 25.104
Adjacent Channel Leakage power ratio (transmitter side)	UE (UE Power Class: + 21 dBm): ACLR (5 MHz) = 33 dB ACLR (10 MHz) = 43 dB BS: ACLR (5 MHz) = 45 dB ACLR (10 MHz) = 55 dB	TSG RAN WG4: TS 25.101 TSG RAN WG4: TS 25.104
Adjacent channel selectivity (receiver side)	UE: ACS (5 MHz) = 33 dB BS: ACS (5 MHz) = 45 dB	TSG RAN WG4: TS 25.101 TSG RAN WG4: TS 25.104
Random access mechanism	Acquisition indication based random-access mechanism with power ramping on preamble followed by message.	TSG RAN WG1: TS 25.211 TSG RAN WG1: TS 25.214
Pilot structure	Uplink: Dedicated pilots Downlink: Common and/or dedicated pilots	TSG RAN WG1: TS 25.211
Inter base station asynchronous/synchronous operation	Asynchronous; Synchronous (Optional)	TSG RAN WG1: TS 25.214 TSG RAN WG4: TS 25.104

The Summary of Major Technical Parameters Table (TDD)

Parameter	"Value"	Reference to SDOs/3GPPs Specifications
Multiple access technique and duplexing scheme	Multiple Access: TDMA/CDMA Duplexing: TDD	TSG RAN WG1: TS 25.201
Chip rate	3.84 Mcps	TSG RAN WG4: TS 25.102
Frame length and structure	Frame length: 10 ms 15 slots per frame, each 666.666 μs	TSG RAN WG1: TS 25.221
Occupied bandwidth	Less than 5 MHz	TSG RAN WG4: TS 25.102 TSG RAN WG4: TS 25.105
Adjacent Channel Leakage power ratio (transmitter side)	UE: (UE Power Class: + 21 dBm) ACLR (5 MHz) = 33 dB ACLR (10 MHz) = 43 dB BS: ACLR (5 MHz) = 45 dB ACLR (10 MHz) = 55 dB	TSG RAN WG4: TS 25.102 TSG RAN WG4: TS 25.105
Adjacent channel selectivity (receiver side)	UE: ACS = 33 dB BS: ACS = 45 dB	TSG RAN WG4: TS 25.102 TSG RAN WG4: TS 25.105
Random access mechanism	RACH burst on dedicated Uplink slot(s)	TSG RAN WG1: TS 25.221 TSG RAN WG1: TS 25.224
Channel estimation	Midambles are used for channel estimation	TSG RAN WG1: TS 25.221
Inter base station asynchronous/synchronous operation	Synchronous operation	TSG RAN WG1: TS 25.224 TSG RAN WG4: TS 25.105