COMMUNICATIONS AND MULTIMEDIA ACT 1998

COMMISSION DETERMINATION ON THE MANDATORY STANDARDS FOR INTERNATIONAL MOBILE TELECOMMUNICATION 2000 TERRESTRIAL COMPONENT

DETERMINATION NO. 5 of 2002

Pursuant to the Ministerial direction on International Mobile Telecommunications 2000 Terrestrial Component, Direction No. 5 of 2001, and in exercise of the powers conferred by Sections 55 and 104 (2) of the Communications and Multimedia Act 1998 *[Act 588]*, the Commission hereby determines as follows:

Citation And Commencement

1. This Determination may be cited as the **Commission Determination on the Mandatory Standards for the International Mobile Telecommunications 2000 Terrestrial Component, Determination No. 5 of 2002.**

2. This Determination shall come into operation on 31 July 2002.

Interpretation

3. In this Determination, unless the context otherwise requires -

   "3GPP" means the Third Generation Partnership Project which comprises regional standards development organizations such as the Japanese Association of Radio Businesses, China Wireless Telecommunications Standards Group, European Telecommunications Standards Institute, the United States Standards Committee T1, Telecommunications Technology Association of Korea and Telecommunication Technology Committee of Japan which agreed to cooperate to produce a complete set of globally applicable Technical Specifications for the Third Generation Mobile System based on the evolved Global System for Mobile Communication core networks and the Universal Terrestrial Radio Access in both Frequency Division Duplex and Time Division Duplex modes.

4. Any terms used in this Determination shall, unless the context otherwise requires, have the same meaning as in the Act or the Regulations made under it.

5. Unless the context otherwise requires, words in the singular include the plural and vice versa.

Licensees subject to these mandatory standards

6. All holders of network facilities provider licences, network service provider licences, applications service provider licences and content applications service provider licences shall be subject to these mandatory standards.

Standard for International Mobile Telecommunications 2000 Terrestrial Component

7. The mandatory standard for IMT 2000 terrestrial component is as set out below -

(1) IMT-2000 Code Division Multiple Access Direct Spread

(A) Introduction

The IMT-2000 radio interface specifications for CDMA Direct Spread technology are developed by a partnership of SDOs[1]. This interface is called the Universal Terrestrial Radio Access (UTRA) Frequency Division Duplex (FDD) or Wideband CDMA (WCDMA).

These radio interface specifications have been developed with the strong objective of harmonization with the TDD component (see Section (2)) to achieve maximum commonality. This was achieved by harmonization of important parameters of the physical layer and a common set of protocols in the higher layers are specified for both FDD and TDD.

In the development of this radio interface the core network specifications are based on an evolved GSM-MAP, but the specifications include the necessary capabilities for operation with an evolved ANSI-41 based core network.

The radio access scheme is direct-sequence CDMA with information spread over approximately 5 MHz bandwidth with a chip rate of 3.84 Mcps. The radio interface is defined to carry a wide range of services to efficiently support both circuit-switched services (e.g. PSTN- and ISDN-based networks) as well as packet-switched services (e.g. IP-based networks). A flexible radio protocol has been designed where several different services such as speech, data, multimedia can simultaneously be used by a user and multiplexed on a single carrier. The defined radio bearer services provide for both real-time and non-real time services support by employing transparent and/or non-transparent data transport. The quality of service can be adjusted in terms such as delay, bit error ratio, frame error ratio.

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[1] Currently, these specifications are developed within the Third Generation Partnership Project (3GPP) where the participating SDOs are ARIB, CWTS, ETSI, T1, TTA and TTC.

(B) Radio Access Network Architecture

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

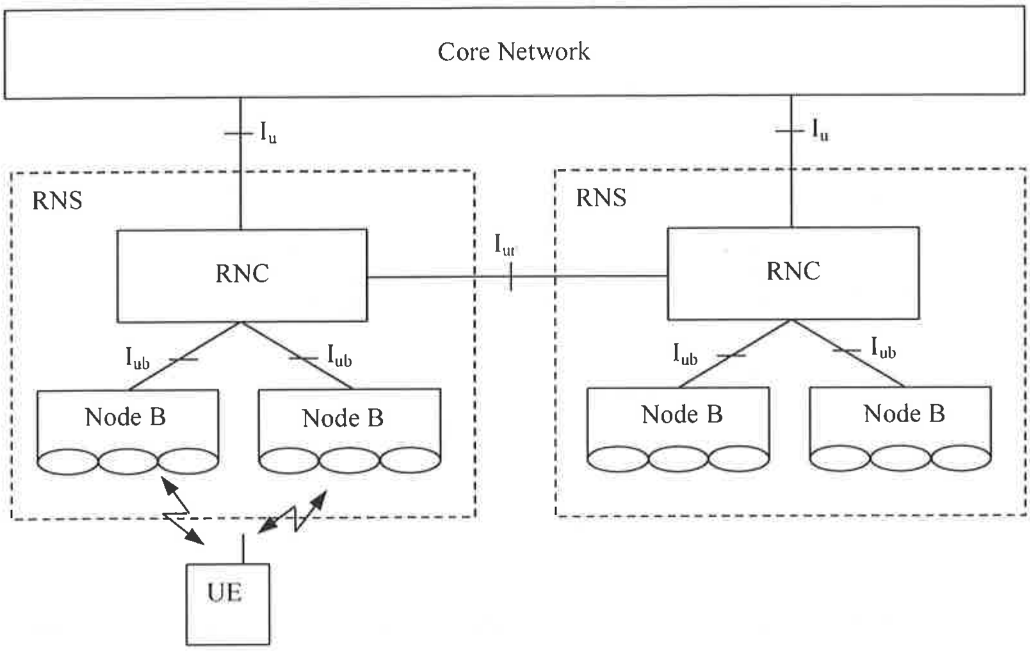

Figure 1: Radio access network architecture (cells are indicated by ellipses)

The architecture of this radio interface 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. The RNC is responsible for the handover decisions that require signalling to the User Equipment (UE). In case macro diversity between different Node Bs 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 this radio interface, the RNCs of the Radio Network Subsystems can be interconnected together through the I_{ur}. The I_u and I_{ur} are logical interfaces. The 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 Recommendation ITU-R M.1035. Layer 2 (L2) is split into two sublayers, Radio Link Control (RLC) and Medium Access Control (MAC). Layer 3 (L3) and RLC are divided into Control (C-) and User (U-) planes. In the C-plane, L3 is partitioned into sublayers where the lowest sublayer, denoted as Radio Resource Control (RRC), interfaces with L2. 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 elements in this radio interface for the U-plane.

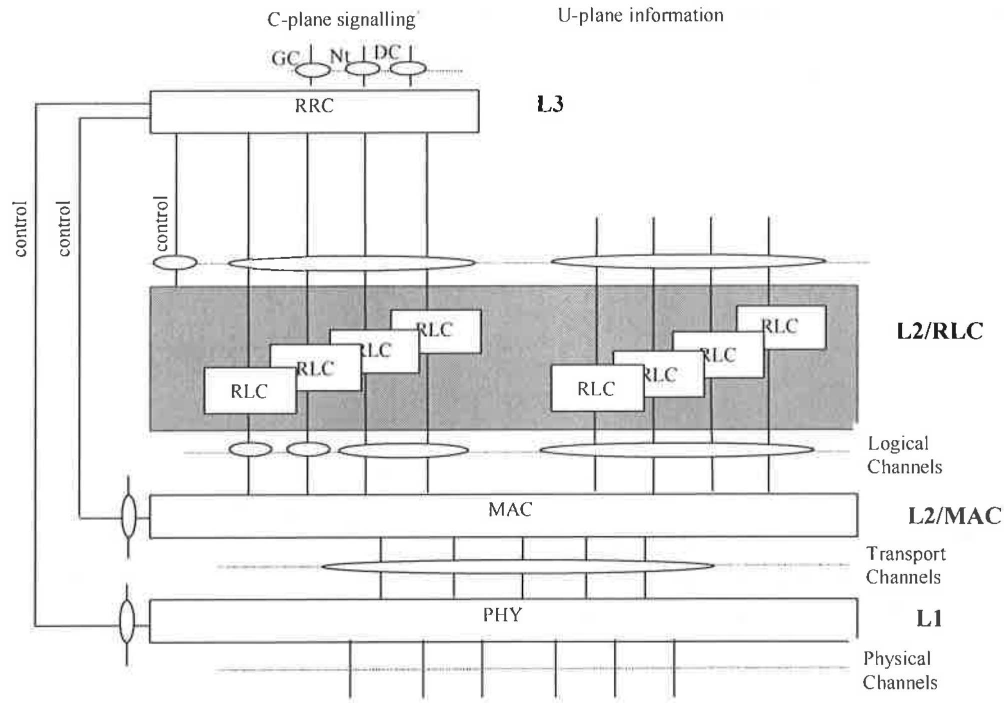

Figure 2: Radio interface protocol architecture of the RRC sublayer, L2 and L1

Each block in Figure 2 represents an instance of the respective protocol. Service Access Points (SAP) for peer-to-peer communications 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 characterizes 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 characterized by how the information is transferred over the radio interface (see Section (1).(C).(b). 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 to a certain carrier frequency, code, and, on the uplink, relative phase (0 or $\pi/2$). In the C-plane, the interface between RRC and higher L3 sublayer (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.

Figure3 shows the general structure and some additional terminology definitions of the channel formats at the various sublayer interfaces indicated in Figure . The figure indicates how higher layer Service Data Units (SDUs) 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.

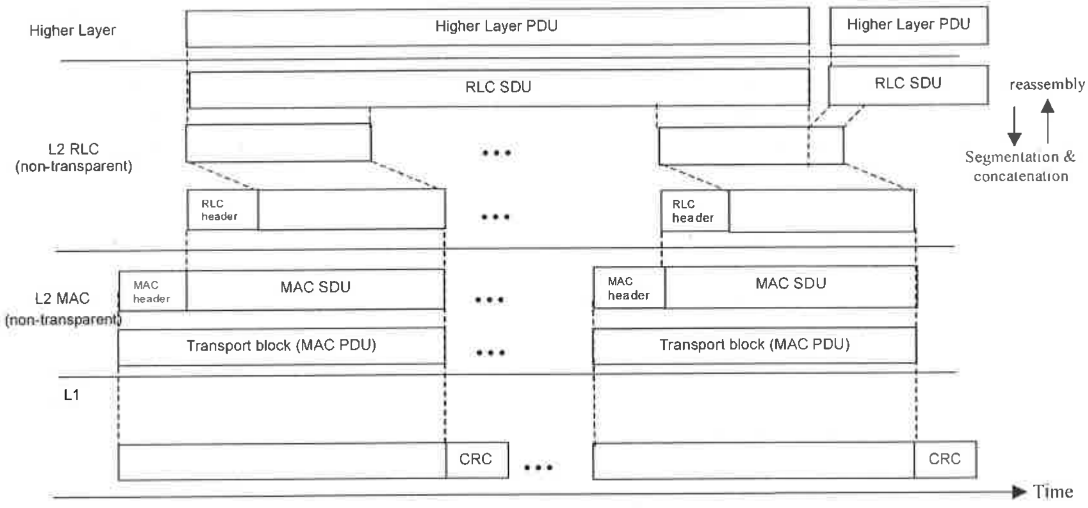

Figure 3: Data flow for a service using a non-transparent RLC and non-transparent MAC (see Sections (1).(D).(a) and (b) for further definitions of the MAC and RLC services and functionality)

(C) Physical Layer

(a) 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) synchronization;

– 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).

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, 16 or 24 bits depending on the service requirements.

The transport block concatenation and code block segmentation functionality performs serial concatenation of those transport blocks that will be sent in one transport time interval and any code block segmentation if necessary.

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 convolutional coding rates are ½ or 1/3 while the rate is 1/3 for turbo codes. The possible interleaving depths are 10, 20, 40 or 80 milliseconds.

The radio frame segmentation performs padding of bits. 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 Transport Channel multiplexing stage combines transport channels in a serial fashion. This is done every 10 milliseconds. 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.

The downlink can use discontinuous transmission (DTX) on a slot to slot basis for variable rate transmission. The insertions could either be at fixed or at flexible positions.

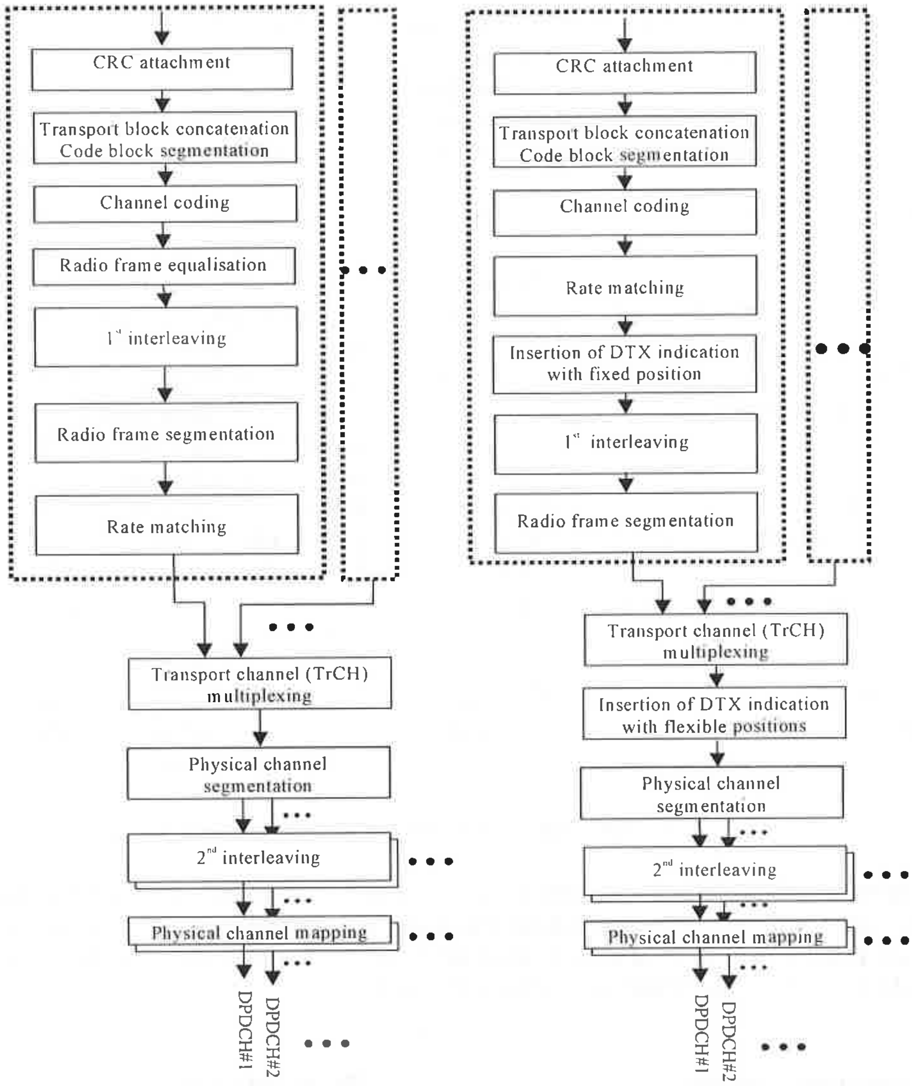

Figure 4: Transport channel multiplexing structure (left: UL; right: DL)

(b) Transport Channels

The interface to the MAC layer is the transport channels (see Figure 2). The transport channels define how and with which type of characteristics the data is transferred by the physical layer. They are categorized 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 summarizes the different types of available transport channels and their intended use. The random access channel on the uplink is contention-based while the dedicated channel is reservation-based.

Table 1: Defined transport channels 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.
CPCH (Common packet channel)	Common; uplink	FDD only. Short and medium sized user packets. Always associated with a downlink channel for power control.
DSCH (Downlink shared channel)	Common; downlink	Carries dedicated user data and control information using a shared channel.

(c) Transport channels to physical channel mapping

The transport channels are mapped onto the physical channels. Figure 55 shows the different physical channels and summarizes the mapping of transport channels onto physical channels. Each physical channel has its tailored slot content. The slot content for the DCH is shown in Section (1).(c).(d).

Transport Channels	Physical Channels
BCH	Primary Common Control Physical Channel (Primary CCPCH) (Downlink; 30 kbps fixed rate)
FACH PCH	Secondary Common Control Physical Channel (Secondary CCPCH) (Downlink; Variable rate.)
RACH	Physical Random Access Channel (PRACH) (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)
	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

(d) Physical Frame Structure

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

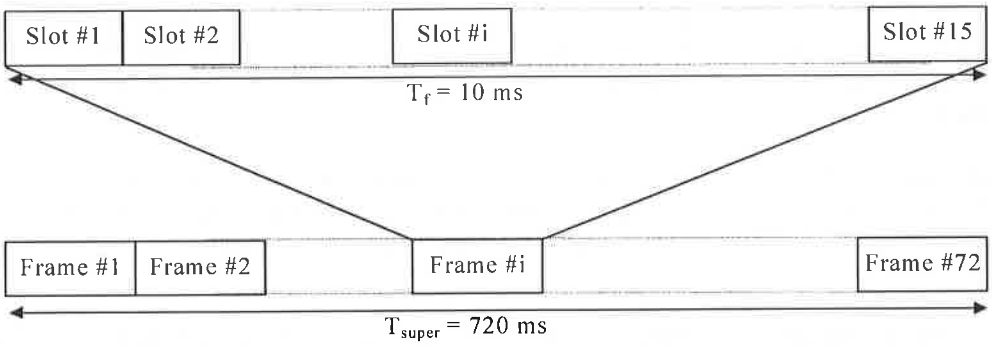

Figure 6: Basic frame structure

Figure7 shows the content for a slot used by the DCH. 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.

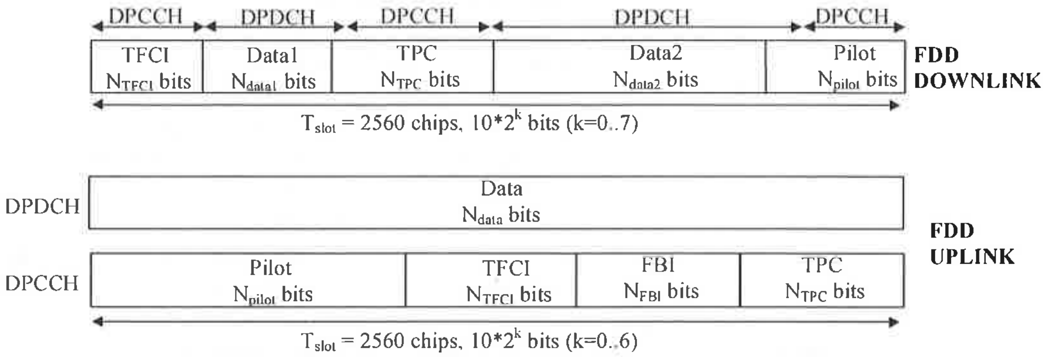

Figure 7: The slot content for the DPDCH/DPCCH

For the uplink, the DPDCH bit rate can vary between 15 up to 960 kbps using spreading factors 256 down to 4. To obtain higher bit rates for a user several physical channels can be used. The bit rate of the DPCCH is fixed to 15 kbps. For the downlink the DPDCH bit rate is variable between 15 up to 1 920 kbps with a spreading factor ranging from 512 down to 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.

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.

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.

(e) Spreading, Modulation And Pulse Shaping

Uplink

Spreading consists of two operations. The first is the channelization 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 channelization operation, data symbol on so-called I- and Q branches are independently multiplied with a code. The channelization 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 illustrates the spreading and modulation for the case of multiple uplink

DPDCHs. Note that this figure only shows the principle, and does not necessarily describe an actual implementation.

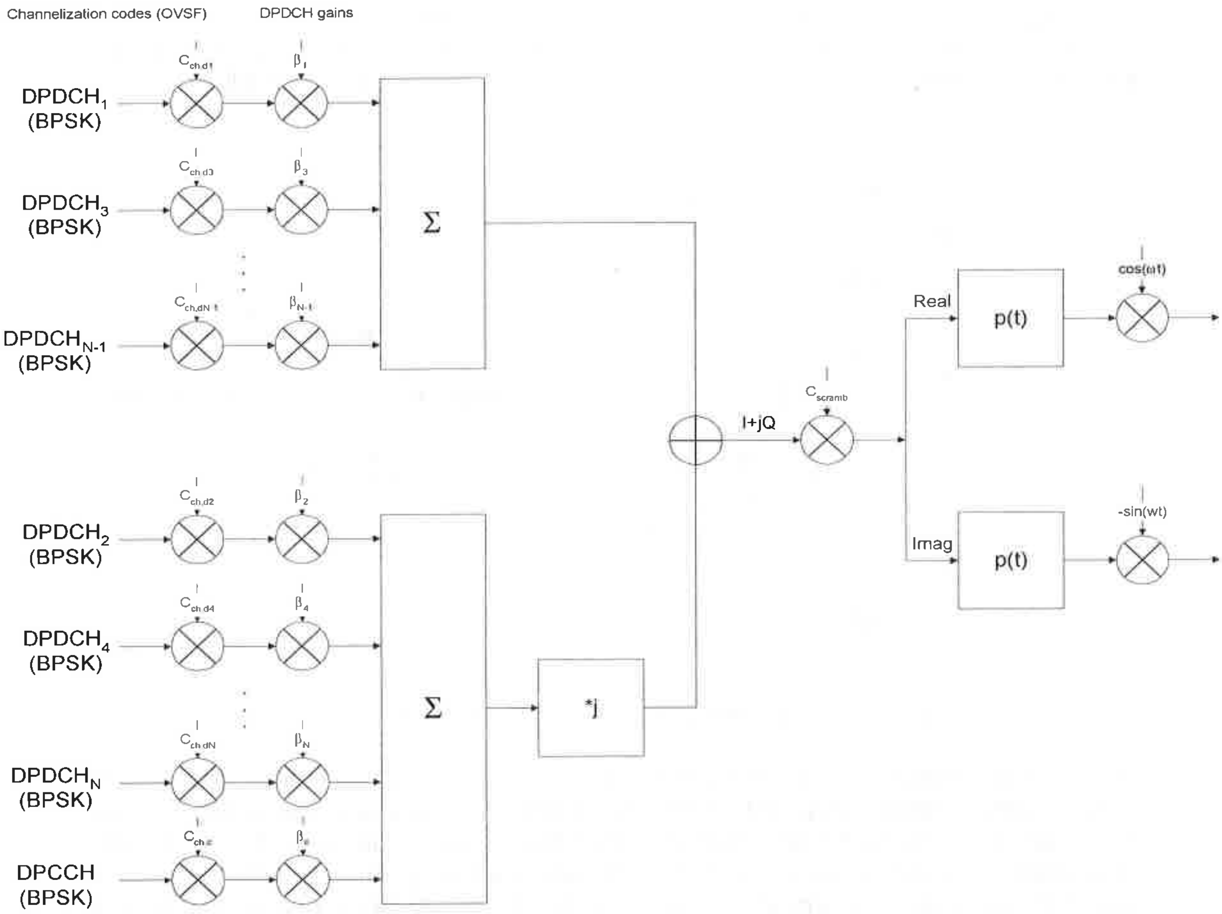

Figure 8: Spreading/modulation for uplink DPDCH/DPCCH

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 channelization 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 (38 400 chips equal to one frame length, Gold code based) scrambling code 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

Figure9 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 channelization code c_{ch} (real spreading) and subsequently scrambled by the scrambling code C_{scramb} (complex scrambling).

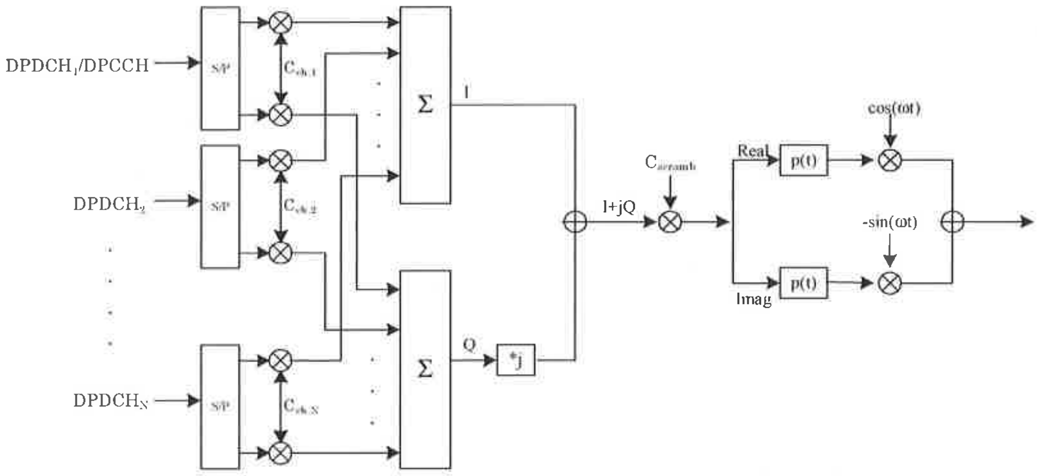

Figure 9: Spreading/modulation for downlink DPCH

The channelization 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 of 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.

(D) Layer 2

(a) 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. The interface to the RLC sublayer is through logical channel service access points. It also reallocates radio resources on request by the RRC sublayer as well as provides measurements to the upper layers. The logical channels are divided into control channels and traffic channels. 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.

Figure10 shows the possibilities of mapping the logical channel DTCH (dedicated traffic channel) onto transport channels. There are possibilities to map onto shared transport channels as well as dedicated transport channels. The choice of mapping could be determined on e.g. amount of traffic a user creates.

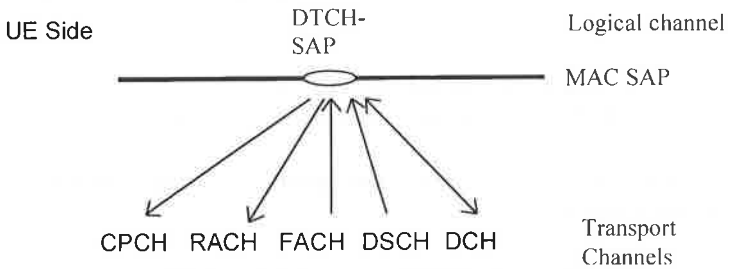

Figure 10: The possible transport channel mappings of the dedicated traffic channel (DTCH) (The arrows show the direction of the channel (UE side). The directions are reversed from the network side)

(b) RLC Sublayer

The RLC 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:
  a) 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;
  b) unique delivery: The RLC sublayer shall deliver each SDU only once to the receiving upper layer using duplication detection function;
  c) 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:

a) 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;
b) unique delivery: The RLC sublayer shall deliver each SDU only once to the receiving upper layer using duplication detection function;
c) 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;
d) 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.

An example of the data flow for non-transparent (acknowledged/unacknowledged) data transfer is shown in Figure3.

(E) Layer 3 (Radio Resource Control Sublayer)

The Radio Resource Control (RRC) sublayer handles the control plane signalling of Layer 3 between the UEs and the radio interface. 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 the radio access network.** 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) 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 the radio access network 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.

- **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 this radio 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 the radio access network.

- **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 radio access network capacity.

(F) Summary Of Major Technical Parameters

Parameter	"Value"
Multiple access technique and duplexing scheme	Multiple Access: Direct Sequence-CDMA Duplexing: FDD
Chip rate	3.84 Mcps
Frame length and structure	Frame length: 10 ms 15 slots per frame, each 666.666 μs
Occupied bandwidth	Less than 5 MHz
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) = 50 dB
Adjacent channel selectivity (receiver side)	UE: ACS (5 MHz) = 33 dB BS: ACS (5 MHz) = 45 dB
Random access mechanism	Acquisition indication based random-access mechanism with power ramping on preamble followed by message
Pilot structure	Uplink: Dedicated pilots Downlink: Common and/or dedicated pilots
Inter base station asynchronous/synchronous operation	Asynchronous; Synchronous (Optional)

(2) IMT-2000 CDMA Time Division Duplex

(A) Introduction

The IMT-2000 radio interface specifications for CDMA TDD technology are developed by a partnership of standards development organizations (SDOs)[2]. This radio interface is called the Universal Terrestrial Radio Access (UTRA) Time Division Duplex (TDD) and TD-SCDMA.

The UTRA TDD specifications have been developed with the strong objective of harmonization with the FDD component (see Section (1)) to achieve maximum commonality. This was achieved by harmonization of important parameters of the physical layer and a common set of protocols in the higher layers are specified for both FDD and TDD. The TD-SCDMA specifications were originally developed in China and introduced by CWTS. TD-SCDMA has significant commonality with UTRA TDD. Within the current specifications, capabilities are included to enable introduction of TD-SCDMA properties into a joint concept.

In the development of this radio interface the core network specifications are based on an evolved GSM-MAP, but the specifications include the necessary capabilities for operation with an evolved ANSI-41 based core network.

The radio access scheme is direct-sequence code division multiple access. There are two chiprate versions: UTRA TDD with information spread over approximately 5 MHz bandwidth and a chip rate of 3.84 Mcps and TD-SCDMA with information spread over approximately 1.6MHz bandwidth and a chiprate of 1.28 Mcps. The radio interface is defined to carry a wide range of services to efficiently support both circuit-switched services (e.g. PSTN- and ISDN-based networks) as well as packet-switched services (e.g. IP-based networks). A flexible radio protocol has been designed where several different services such as speech, data, multimedia can simultaneously be used by a user and multiplexed on a single carrier. The defined radio bearer services provide for both real-time and non-real time services support by employing transparent and/or non-transparent data transport. The quality of service can be adjusted in terms such as delay, bit error ratio, frame error ratio.

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(B) Radio Access Network Architecture

The overall architecture of the system is shown in Figure.

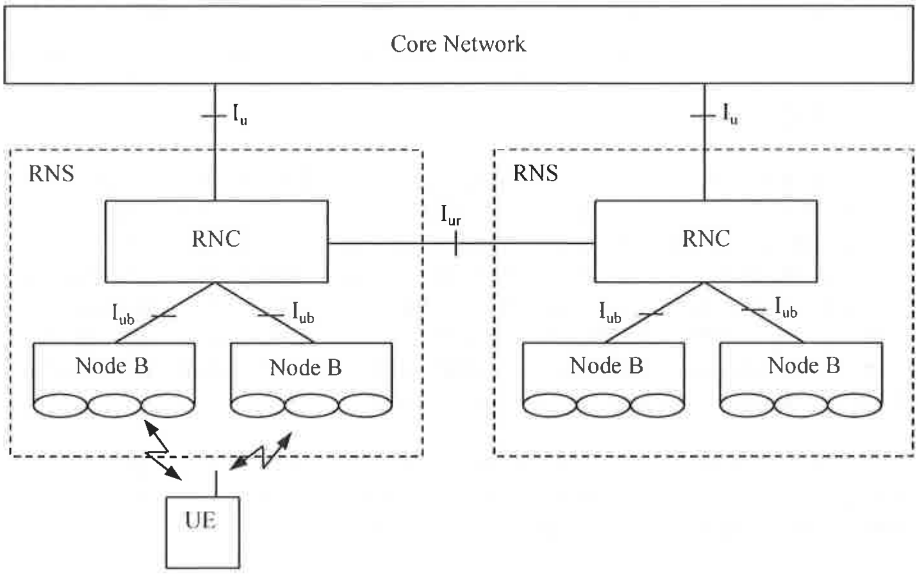


Figure 11: Radio Access Network Architecture (Cells are indicated by ellipses)

The architecture of this radio interface 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.

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

Inside the radio interface, 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.

Figure12 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 (L2) is split into two sublayers, Radio Link Control (RLC) and Medium Access Control (MAC). Layer 3 (L3) and RLC are divided into Control (C-) and User (U-) planes.

In the C-plane, L3 is partitioned into sublayers where the lowest sublayer, denoted as Radio Resource Control (RRC), interfaces with L2. 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 elements in UTRAN for the U-plane.

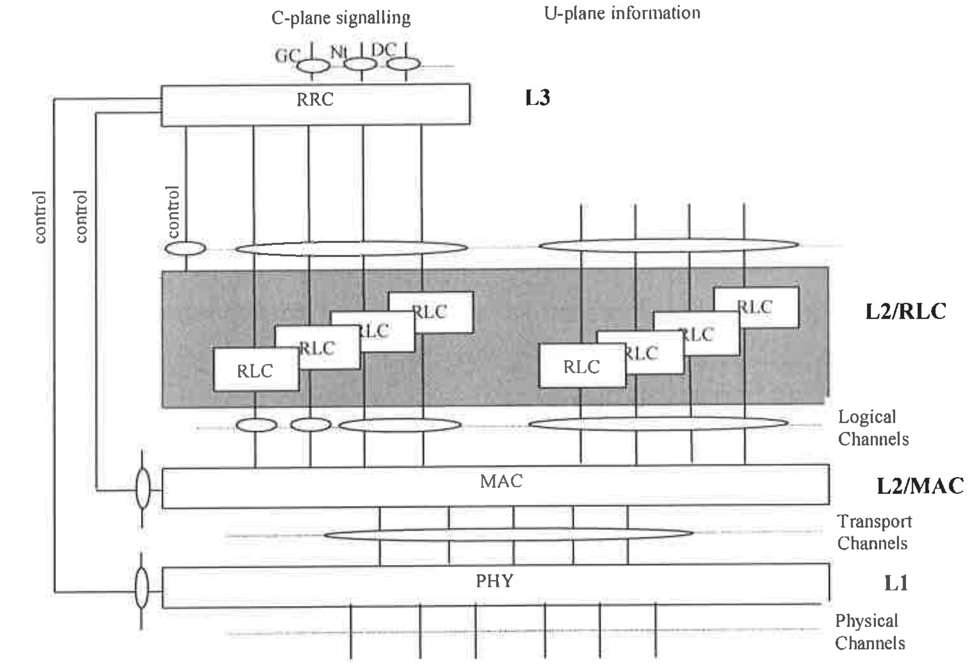


Figure 12: Radio interface protocol architecture of the RRC sublayer (L2 and L1)

Each block in Figure12 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 characterizes 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 characterized by how the information is transferred over the radio interface, see Section (2).(C) for an overview of the types defined. The physical layer generates the physical channels that will be transmitted over the air. 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 Figure12 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).

Figure13 shows the general structure and some additional terminology definitions of the channel formats at the various sublayer interfaces indicated in Figure12. 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.

Opportunity Driven Multiple Access (ODMA) operates on relay links 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 radio interface. This can be done using either this radio interface or the radio interface in Section (1).

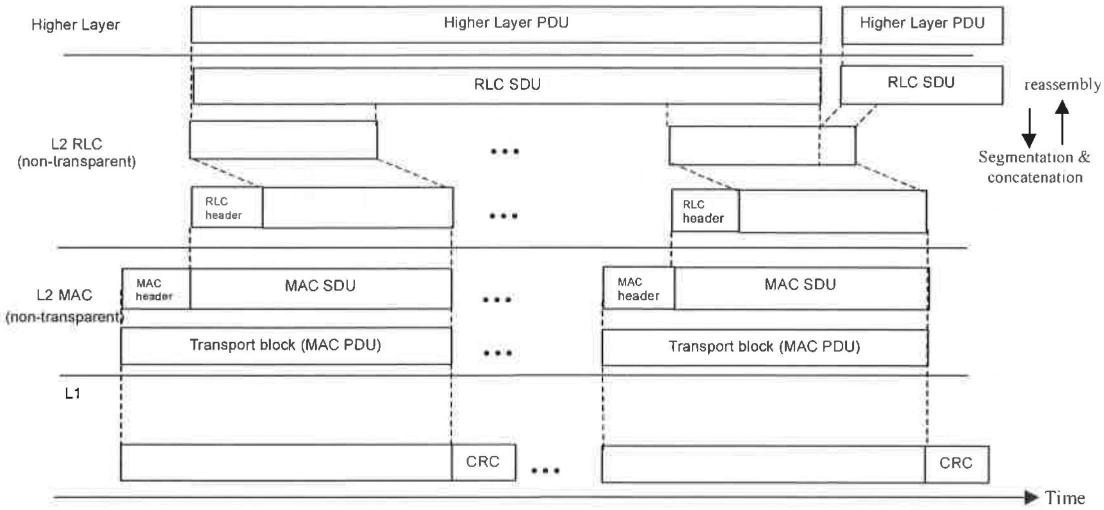


Figure13: Data flow for a service using a non-transparent RLC and non-transparent MAC (see Sections (1).(D).(a) and (b) for further definitions of the MAC and RLC services and functionality)

(C) Physical Layer

(a) UTRA TDD

(i) Physical Layer Functionality And Building Blocks

The physical layer includes the following functionality:

- Error detection on transport channel 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 and Shared Channels).
- 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) synchronization.

- 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.
- Support of Timing Advance on uplink channels.

Figure14 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).

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, 16 or 24 bits depending on the service requirements.

The transport block concatenation and code block segmentation functionality performs serial concatenation of those transport blocks that will be sent in one transport time interval and any code block segmentation if necessary.

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 convolutional coding rates are 1/2 or 1/3 while the rate is 1/3 for turbo codes.

The possible interleaving depths are 10, 20, 40 or 80 milliseconds.

The radio frame segmentation performs padding of bits. 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 TrCH multiplexing stage combines transport channels in a serial fashion. This is done every 10 milliseconds. 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.

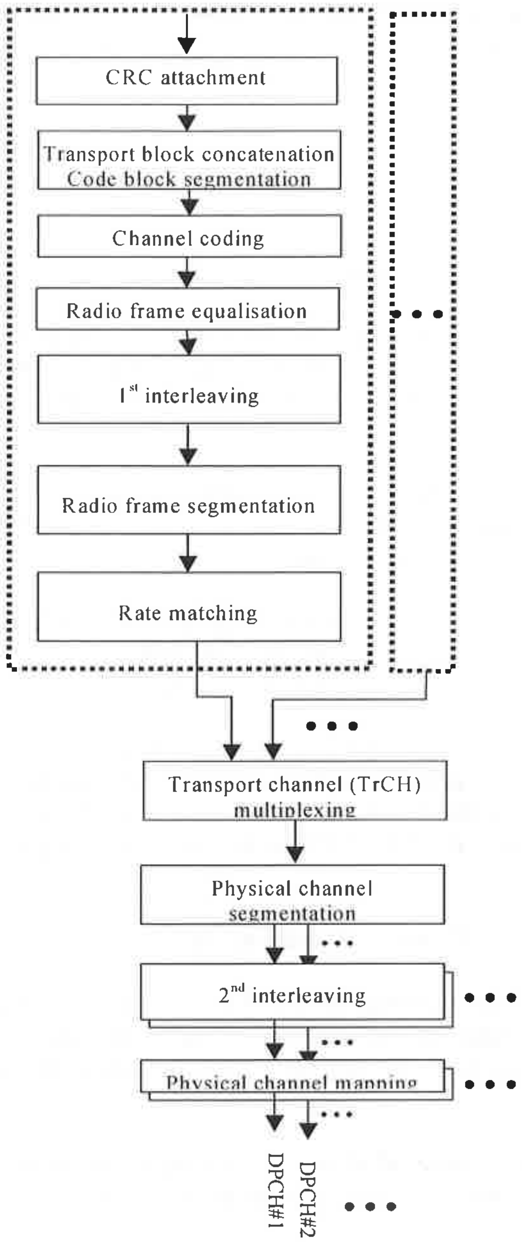


Figure 14: Transport channel multiplexing structure

(ii) Transport Channels

The interface to the MAC layer is the transport channels, see Figure12. The transport channels define how and with which type of characteristics the data is transferred by the physical layer. They are categorized 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 summarizes the different types of available transport channels.

Table 2: The defined transport channels

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
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
DSCH (Downlink shared channel)	Common; downlink	Carries dedicated user data and control information using a shared channel.

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

(iii) Transport Channels To Physical Channel Mapping

The transport channels are mapped onto the physical channels and Figure15 shows the different physical channels and summarizes the mapping of transport channels onto physical channels. Each physical channel has its tailored slot content. The dedicated channel (DCH) is shown in Section (2).(C).(a).(iv).

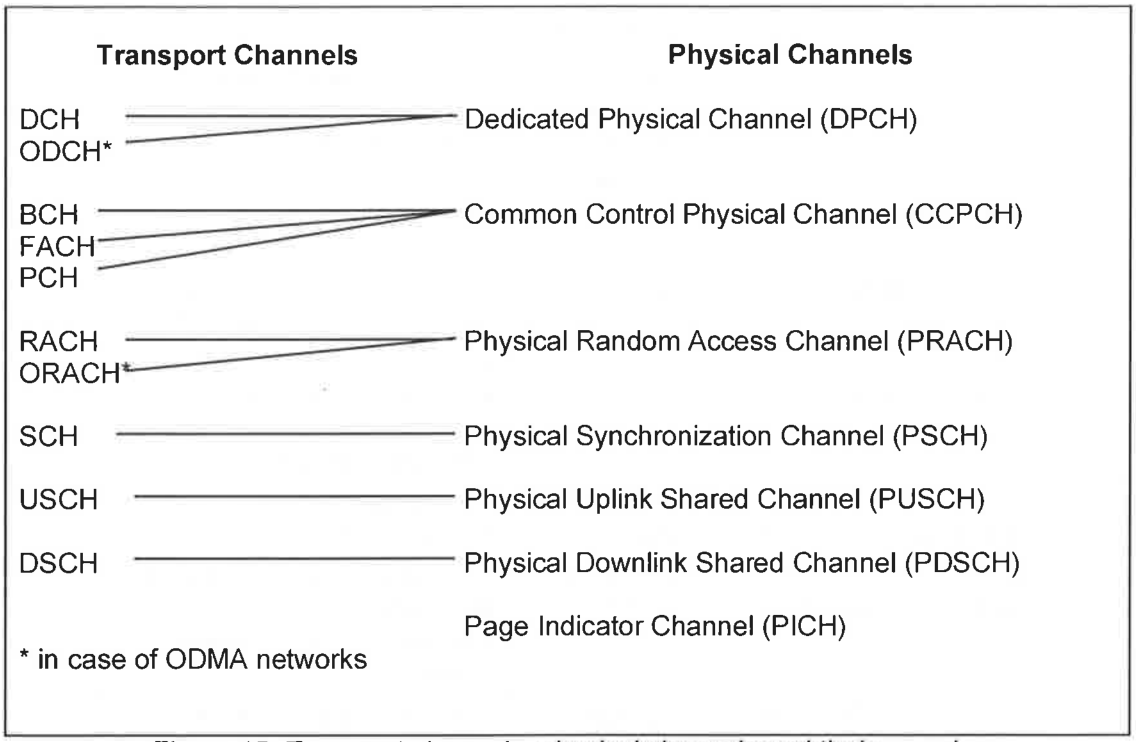


Figure 15: Transport channels, physical channels and their mapping

(iv) Physical Frame Structure

The basic physical frame rate is 10 milliseconds with 15 slots. Figure 1616 shows the frame structure.

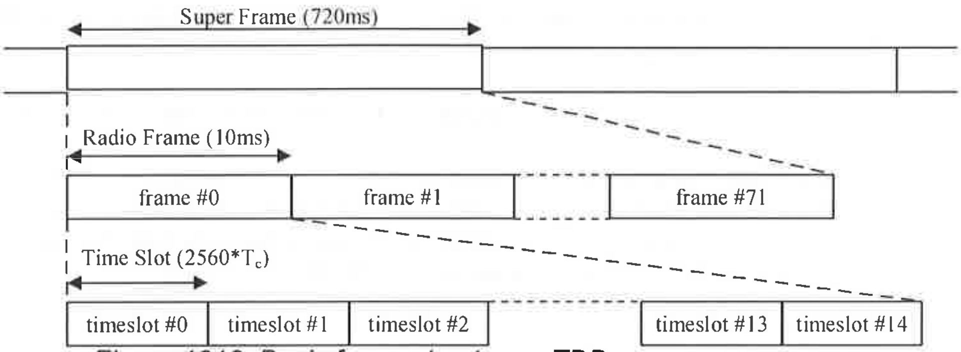


Figure 1616: Basic frame structure – TDD

Each 10 ms frame consists of 15 time slots, each allocated to either the uplink or the downlink. With such a flexibility, this radio interface 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 (Figure17).

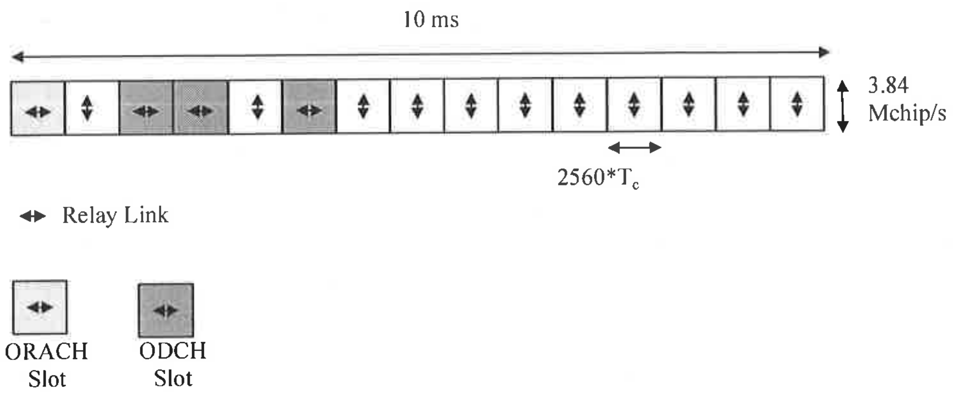


Figure 17: TDD frame structure example for ODMA operation

Figure18 and Figure19 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 18: Burst structure of the burst type 1 (GP denotes the guard period and CP the chip periods)

Figure 19: 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 channelization 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 Table3 below.

Table 3: 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 Table3. Usage of multicode and multiple timeslots can be applied.

(v) Spreading, Modulation And Pulse Shaping

Spreading is applied after modulation and before pulse shaping. It consists of two operations. The first is the channelization operation, which transform 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 the radio interface specified in Section (1), but it should be noted that the midamble part in TDD bursts (see Figure18 and Figure19) is not spread.

The applied channelization codes are OVSF-codes (Orthogonal Variable Spreading Factor-codes) that preserves 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 filter are root-raised cosine with roll-off α=0.22 in the frequency domain.

(b) TD-SCDMA

(i) Physical Layer Functionality And Building Blocks

The physical layer includes the following functionality:

- FEC encoding/decoding of transport channels.
- Macrodiversity distribution/combining and handover execution.
- Multiplexing/demultiplexing of transport channels and of coded composite transport channels.
- Mapping of coded composite transport channels on physical channels.
- Modulation and spreading/demodulation and despreading of physical channels.
- Frequency and time (chip, bit, time slot, subframe) synchronization.
- Power control.
- Random access process.
- Dynamic channel allocation (DCA).
- ODMA specific procedures (optional).
- Power weighting and combining of physical channels.
- RF processing.

- Error detection.
- Rate matching (data multiplexed on DCH).
- Radio characteristics measurements including FER, SIR, DOA, timing advance, etc.
- Handover measurements.
- Uplink synchronization.
- Beamforming for both uplink and downlink (Smart antenna).
- UE location/positioning (Smart antenna).

Figure20 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 channels (DPCH). 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, 16 or 24 bits depending on the service requirements.

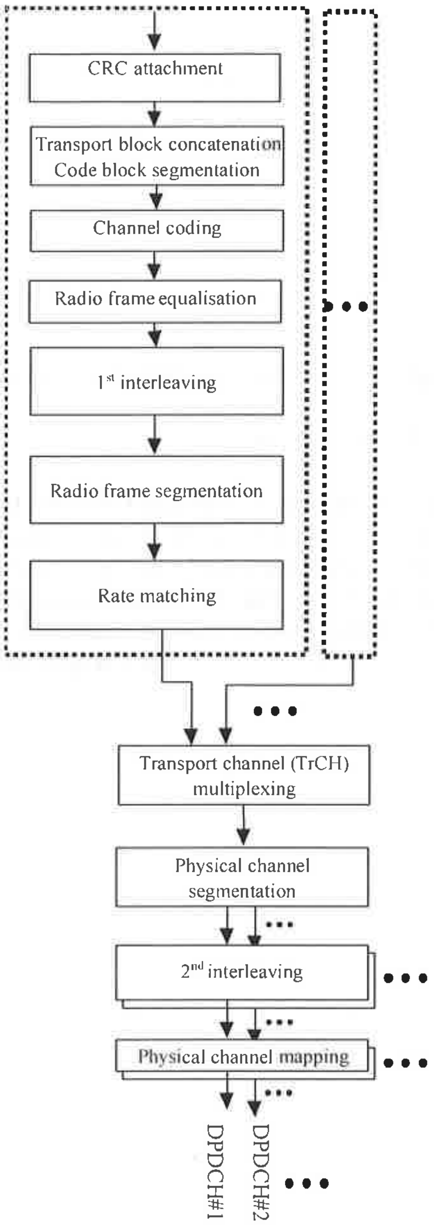


Figure 20: Transport channel multiplexing structure

The transport block concatenation and code block segmentation functionality performs serial concatenation of those transport blocks that will be sent in one transport time interval and any code block segmentation if necessary.

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 convolutional coding rates are 1/2 or 1/3 while the rate is 1/3 for turbo codes. The possible interleaving depths are 10, 20, 40 or 80 milliseconds.

The radio frame equalization performs padding of bits. 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 TrCH multiplexing stage combines transport channels in a serial fashion. This is done every 10 milliseconds. 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.

(ii) Transport Channels

The interface to the MAC layer is the transport channels, see Figure11. The transport channels define how and with which type of characteristics the data is transferred by the physical layer. They are categorized 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 4 summarizes the different types of available transport channels.

Table 4: The defined transport channels

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
SCH (Pilot and Synchronization channel)	Common; uplink and downlink	Transmit uplink/downlink pilot sequence and synchronization codes
ODCH* (ODMA Dedicated channel)	Dedicated	Applicable for ODMA relaying
ORACH* (ODMA Random Access Channel)	Common	Applicable for ODMA relaying
DSCH (Downlink shared channel)	Common; downlink	Carries dedicated user data and control information using a shared channel.
USCH (Uplink shared channel)	Common; Uplink	Carries dedicated user data and control information using a shared channel
*: item which is an option		

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

(iii) Transport Channels To Physical Channel Mapping

The transport channels are mapped onto the physical channels and Figure21 shows the different physical channels and summarizes the mapping of transport channels onto physical channels. Each physical channel has its tailored slot content. The dedicated channel (DCH) is shown in Section (2).(C).(b).(iv).

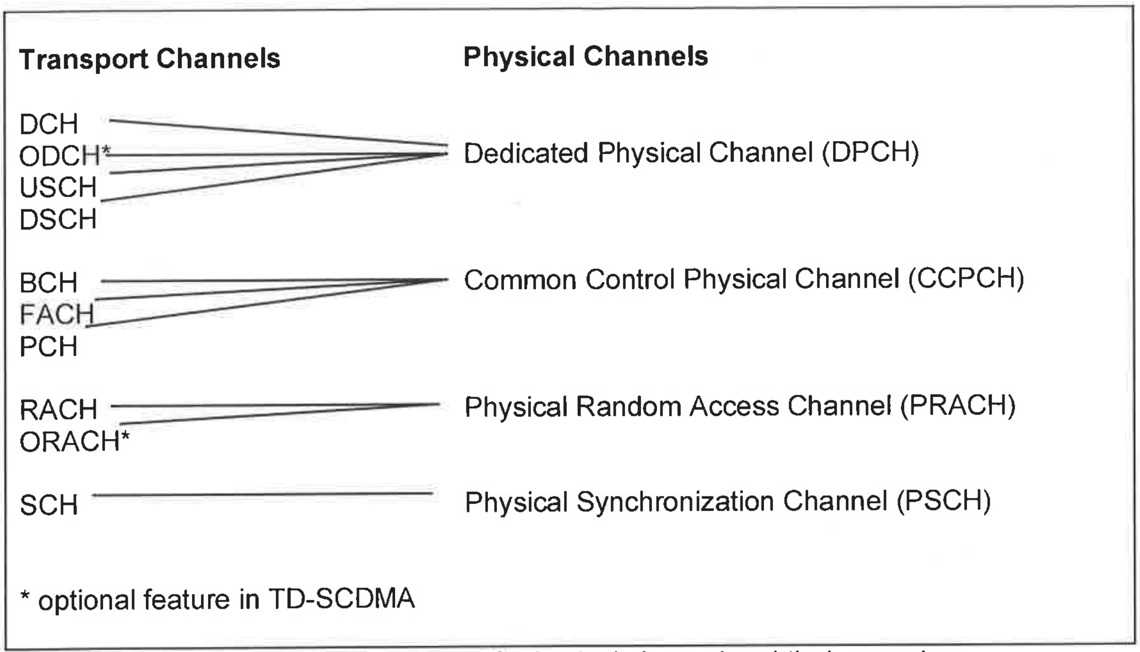


Figure 21: Transport channel, physical channel and their mapping

(iv) Frame Structure

Physical channels take four-layer structure of super-frames, radio frames, sub-frames and time slots/codes as shown in Figure22. One super frame has the length of 720ms, which is composed by 72 radio frames. The radio frame has a duration of 10 ms and is subdivided into 2 sub-frames of 5ms each, and each subframe is then subdivided into 7 main time slots (TS) of 675 µs duration each and 3 special time slots: DwPTS (downlink pilot), G (guard period) and UpPTS (uplink pilot).

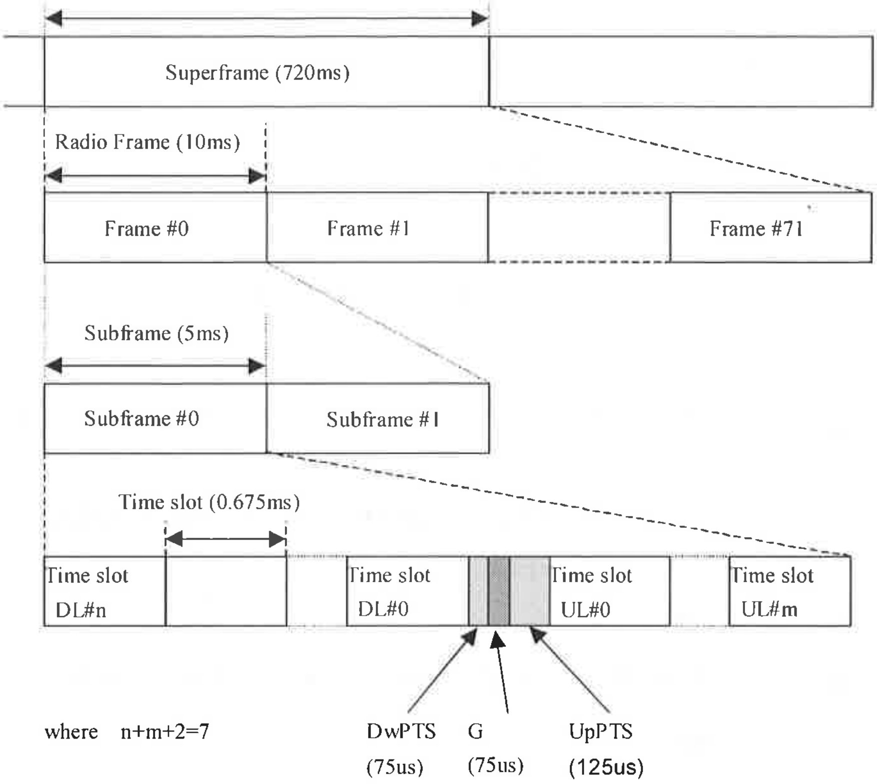
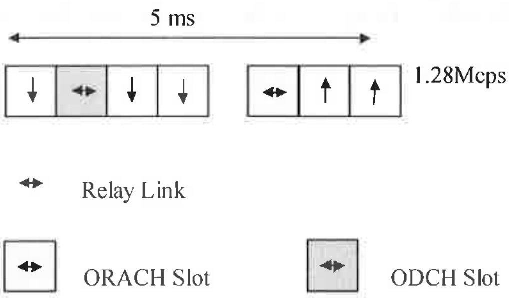


Figure 22: Frame and burst structure

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 (Figure23).

Figure 23: Frame structure for ODMA operation



The burst structure is shown in Figure24. The burst type consist of two data symbol fields, a midamble of 144 chips and a guard period of 16 chips. The data fields of the burst type are 704 chips long. Data bits in the burst are QPSK modulated and are spread by the spreading factor of 1 to 16. The guard period for the burst type is 16 chips period long.

Figure 24: Burst structure

The corresponding number of symbols depends on the spreading factor as indicated in Table5.

Table 5: Number of data symbols in one burst with different SF

Spreading factor (Q)	Number of symbols (N) per data field in Burst
1	352
2	176
4	88
8	44
16	22

(v) Spreading, Modulation And Pulse Shaping

Spreading is applied after modulation and before pulse shaping. It consists of two operations. The first is the channelization 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. It should be noted that the midamble part in TDD bursts is not spread.

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

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.

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

(vi) Transmission And Reception

The frequency band assumed for operation are unpaired frequency bands at 2 GHz. Also system can work in other frequency bands available. Several Tx power classes for UEs are being defined currently.

(D) Layer 2

(a) 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. The interface to the RLC sublayer is through logical channel service access points. It also reallocates radio resources on request by the RRC sublayer as well as provides measurements to the upper layers. The logical channels are divided into control channels and traffic channels. 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;

Figure25 shows the possibilities of mapping the logical channel DTCH (dedicated traffic channel) onto transport channels. There are possibilities to map onto shared transport channels as well as dedicated transport channels. The choice of mapping could be determined on e.g. amount of traffic a user creates.

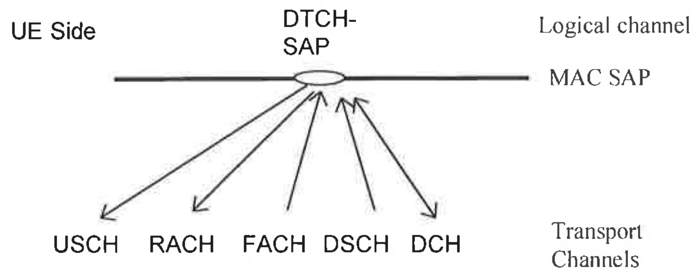


Figure 25: The possible transport channel mappings of the dedicated traffic channel (DTCH) (The arrows shows the direction of the channel (UE side); the directions are reversed from the network side)

(b) Radio Link Control (RLC) sublayer

The RLC 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.

An example of the data flow for non-transparent (acknowledged/unacknowledged) data transfer is shown in Figure13.

(E) Layer 3 (Radio Resource Control Sublayer)

The Radio Resource Control (RRC) sublayer handles the control plane signalling of Layer 3 between the UEs and the radio access network. 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 this radio interface.** 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 the radio access network 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.

- **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 this radio 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 the radio access network.

- **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 radio access network capacity.

- **Broadcast of ODMA relay node neighbour information.** The RRC layer performs probe information broadcasting to allow ODMA routing 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 routing algorithm.

- **Interworking between the Gateway ODMA relay node and the radio access network.** The RRC layer will control the interworking communication link between the Gateway ODMA relay node and the radio access network.

- **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.

- **Timing advance control**.* The RRC controls the operation of timing advance.

- **Active UE positioning** ** This RRC layer will determine the position of each active UE according to the received information from physical layer.

  * TD-SCDMA does not support this function.
  **UTRA TDD does not support this function.

(F) Summary Of Major Technical Parameters

Parameter	**"Value"**
Multiple access technique and duplexing scheme	Multiple Access: TDMA/CDMA Duplexing: TDD
Chip rate	3.84 Mcps 1.28 Mcps
Frame length and structure	Frame length: 10 ms 15 slots per frame, each 666.666 μs Sub-frame length: 5 ms 7 main slots per sub-frame, each 675 μs
Occupied bandwidth	Less than 5 MHz Less than 1.6MHz
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 UE: (UE Power Class: + 21 dBm) ACLR (1.6 MHz) = 33 dB ACLR (3.2 MHz) = 43 dB BS: ACLR (1.6 MHz) = 40 dB ACLR (3.2 MHz) = 50 dB
Adjacent channel selectivity (receiver side)	UE: ACS = 33 dB BS: ACS = 45 dB
Random access mechanism	RACH burst on dedicated Uplink slot(s)
Channel estimation	Midambles are used for channel estimation
Inter base station asynchronous/synchronous operation	Synchronous operation

(3) Detail Specifications

(A) 3GPP Documents Series Titles And Its Descriptions

The 3GPP document series titles and its descriptions are as listed below.

21-series Requirements specifications
These specifications are often transient and contain requirements towards other specifications. They may become obsolete when technical solutions have been fully specified; they could then, e.g., be replaced by reports describing the performance of the system, they could be deleted without replacement or be kept for historical reasons but turned into background material. When found necessary and appropriate, the transient or permanent nature of a requirement specification may be expressed in its scope.

22-series Service aspects
Specifications in this series specify services, service features, building blocks or platforms for services (a service feature or service building block may provide certain generic functionality's for the composition of a service, including the control by the user; a platform may comprise a single or more network elements, e.g. UIM, mobile terminal, auxiliary system to the core network etc.); stage 1 specifications that are felt appropriate belong into this series; reports defining services which can be realized by generic building blocks etc. also belong into this series.

23-series Technical realization
This series mainly contains stage 2 specifications (or specifications of a similar nature describing interworking over several interfaces, the behaviour in non-exceptional cases, etc.).

24-series Signalling protocols (MS - CN network)
This series contains the detailed and bit exact stage 3 specifications of protocols between mobile station and the radio access in the network.

25-series Radio aspects

25.100-series UTRA radio performance aspects
This series defines the radio performance of UTRAN.
25.200-series UTRA radio aspects
This series defines the (Physical) layer 1 of UTRA.
25.300-series UTRA radio interface signalling aspects
This series defines the layer 2/3 of the UMTS radio.
25.400-series UTRAN Network aspects
This series defines the lub, lur and lu interfaces within UTRAN

26-series Codecs (speech, video, etc.)
This series defines speech codecs and other codecs (video etc., to be identified) for the 3GPP 3rd Generation Mobile System.

27-series Data
This series defines the functions necessary to support data applications.

28-series Signalling protocols (RSS - network part)
This series contains the detailed and bit exact stage 3 specifications of protocols between RSS and Core Network.

29-series Signalling protocols (NSS)
This series contains the detailed and bit exact stage 3 specifications of protocols within the Core Network.

30-series Program management
This series contains the 3GPP 3rd Generation Mobile System, Project plans/project work programme and stand alone documents for major work items.

31-series UIM
This series specifies the User Identity Module (UIM) and the interfaces between UIM and other entities.

32-series Operation and management
This series defines the application of TMN for the 3GPP 3rd Generation Mobile System and other functions for operation, administration and maintenance of a 3rd Generation Mobile System network.

33-series Security aspects
This series contains specifications of security functions for the 3GPP 3rd Generation Mobile System.

34-series Test specifications
This series contains the test specifications for the 3GPP 3rd Generation Mobile System.

35-series Security algorithms
This series contains specifications of confidentiality and integrity algorithms for 3GPP 3rd Generation Mobile System.

(B) 3GPP Specification Documents for IMT-2000 CDMA DS and IMT-2000 CDMA TDD

The detailed specifications for the IMT-2000 CDMA Direct Spread and IMT-2000 CDMA TDD contained in the list of 3GPP Documents are listed in Table6.

*Table 6: **3GPP Specification documents for IMT-2000 CDMA DS and IMT-2000 CDMA TDD***

Number	Title	Version
01.01	GSM Release 1999 Specifications	8.1.0
03.55	Dual Transfer Mode (DTM); Stage 2	8.0.0
04.65	Mobile Station (MS) - Serving GPRS Support Node (SGSN); Subnetwork Dependent Convergence Protocol (SNDCP)	8.1.0
04.68	Group Call Control (GCC) Protocol	8.1.0
04.69	Broadcast Call Control (BCC) protocol	8.1.0
04.71	Location services (LCS) stage 3	8.1.0
05.01	Physical Layer on the Radio Path (General Description)	8.5.0
05.02	Multiplexing and Multiple Access on the Radio Path	8.7.0
05.03	Channel Coding	8.6.0
05.04	Modulation	8.1.0
05.05	Radio Transmission and Reception	8.7.1
05.08	Radio Subsystem Link Control	8.7.1
05.09	Link Adaptation	8.2.0
05.10	Radio subsystem synchronization	8.6.1
08.31	Location Services LCS: Serving Mobile Location Centre - Serving Mobile Location Centre (SMLC - SMLC); SMLCPP specification	8.0.0
08.51	Base Station Controller - Base Tranceiver Station (BSC-BTS) Interface General Aspects	8.0.0
08.52	Base Station Controller - Base Tranceiver Station (BSC-BTS) Interface - Interface Principles	8.0.0
08.54	BSC-BTS : Layer 1 Structure of Physical Circuits	8.0.0
08.56	BSC-BTS Layer 2 Specification	8.0.0
08.58	Base Station Controler - Base Transceiver Station (BCS-BTS) Interface Layer 3 Specification	8.6.0
08.60	Inband Control of Remote Transcoders and Rate Adaptors for EFR/FR	8.1.0
08.61	Inband Control of Remote Transcoder and Rate Adaptors; (Half Rate)	8.0.0
08.62	Inband Tandem Free Operation (TFO) of Speech Codecs; Service Description; Stage 3	8.0.1
08.71	Location services (LCS) SMLC-BSS interface L 3	8.2.0

21.101	3rd Generation mobile system Release 1999 Specifications	3.2.0
21.111	USIM and IC card requirements	3.3.0
21.133	Security Threats and Requirements	3.1.0
22.001	Principles of circuit telecommunication services supported by a Public Land Mobile Network (PLMN)	3.2.0
22.002	Circuit Bearer Services -Supported by a PLMN	3.5.0
22.003	Circuit Teleservices supported by a Public Land Mobile Network (PLMN)	3.2.0
22.004	General on Supplementary Services	3.2.1
22.011	Service accessibility	3.3.0
22.016	International Mobile Equipment Identities (IMEI)	3.2.0
22.022	Personalisation of GSM ME Mobile functionality specification; Stage 1	3.1.0
22.024	Description of Charge Advice Information (CAI)	3.0.1
22.030	Man-Machine Interface (MMI) of the Mobile Station (MS)	3.4.0
22.034	High Speed Circuit Switched Data (HSCSD); Stage 1	3.2.1
22.038	SIM application toolkit (SAT); Stage 1	3.2.0
22.041	Operator Determined Call Barring	3.2.0
22.042	Network Identity and Time Zone (NITZ), stage 1	3.0.1
22.043	Support of Localised Service Area (SoLSA); Stage 1	3.1.0
22.057	Mobile Station Application Execution Environment (MExE); Stage 1	3.0.1
22.060	General Packet Radio Service (GPRS); Stage 1	3.5.0
22.066	Support of Mobile Number Portability (MNP); Stage 1	3.2.0
22.067	enhanced Multi-Level Precedence and Pre-emption service (eMLPP); Stage 1	3.0.1
22.071	Location Services (LCS); Stage 1	3.3.0
22.072	Call Deflection; Stage 1	3.0.1
22.078	CAMEL; Stage 1	3.6.0
22.079	Support of Optimal –Routing Stage 1	3.0.1
22.081	Line Identification Supplementary Services; Stage 1	3.2.0
22.082	Call Forwarding (CF) –Supplementary Services; Stage 1	3.0.1
22.083	Call Waiting (CW) and Call Hold (HOLD) Supplementary Services;	3.0.1

	Stage 1	
22.084	MultiParty (MPTY) Supplementary Service; Stage 1	3.0.1
22.085	Closed User Group (CUG) Supplementary Services; Stage 1	3.1.0
22.086	Advice of Charge (AoC) Supplementary Services; Stage 1	3.1.0
22.087	User-to-user signalling (UUS); Stage 1	3.1.0
22.088	Call Barring (CB) Supplementary Services; Stage 1	3.0.2
22.090	Unstructured Supplementary Service Data (USSD); Stage 1	3.1.0
22.091	Explicit Call Transfer (ECT) Supplementary Services; Stage 1	3.1.0
22.093	Call Completion to Busy Subscriber (CCBS); Stage 1	3.0.1
22.094	Follow Me Service description; Stage 1	3.1.0
22.096	Calling Name Presentation (CNAP); Stage 1 (T1P1)	3.0.1
22.097	Multiple Subscriber Profile (MSP); Stage 1	3.2.0
22.100	UMTS Phase 1	3.6.0
22.101	UMTS Service principles	3.12.0
22.105	Services & Service capabilities	3.10.0
22.115	Service aspects Charging and billing	3.3.0
22.121	Provision of Services in UMTS - The Virtual Home Environment; Stage 1	3.3.0
22.129	Handover Requirements between UMTS and GSM or other Radio Systems	3.5.0
22.135	Multicall Stage 1	3.4.0
22.140	Multimedia Messaging Service; Stage 1	3.1.0
23.002	Network Architecture	3.4.0
23.003	Numbering, Addressing and Identification	3.7.0
23.007	Restoration procedures	3.4.0
23.008	Organisation of subscriber data	3.5.0
23.009	Handover procedures	3.5.0
23.011	Technical Realization of Supplementary Services – General Aspects	3.1.0
23.012	Location management procedures	3.3.0
23.014	Support of Dual Tone Multi-Frequency (DTMF) signalling	3.1.0
23.015	Technical realisation of Operator Determined Barring (ODB)	3.1.0

23.016	Subscriber data management; Stage 2	3.6.0
23.018	Basic Call Handling - Technical realisation	3.6.0
23.032	Universal Geographical Area Description (GAD)	3.1.0
23.034	High Speed Circuit Switched Data (HSCSD); Stage 2	3.3.0
23.038	Alphabets & Language	3.3.0
23.040	Technical realisation of Short Message Service	3.5.0
23.041	Technical Realization of Cell Broadcast Service	3.3.0
23.042	Compression algorithm for SMS	3.1.0
23.054	Shared Interworking Functions; Stage 2	3.0.0
23.057	Mobile Station Application Execution Environment (MExE)	3.3.0
23.060	General Packet Radio Service (GPRS) Service description; Stage 2	3.6.0
23.066	Support of GSM Mobile Number Portability (MNP) stage 2	3.3.0
23.067	enhanced Multi-Level Precedence and Pre-emption Service (EMLPP); Stage 2	3.2.0
23.070	Routeing of calls to/from Public Data Networks (PDN)	3.0.0
23.072	Call Deflection Supplementary Service; Stage 2	3.3.0
23.073	Support of Localised Service Area (SoLSA); Stage 2	3.0.1
23.078	Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 3 - Stage 2	3.7.0
23.079	Support of Optimal Routeing – Phase 1; Stage 2	3.6.0
23.081	Line Identification Supplementary Services; Stage 2	3.1.0
23.082	Call Forwarding (CF) Supplementary Services; Stage 2	3.5.0
23.083	Call Waiting (CW) and Call Hold (HOLD) Supplementary Service;Stage 2	3.2.0
23.084	MultiParty (MPTY) Supplementary Service; Stage 2	3.2.0
23.085	Closed User Group (CUG) Supplementary Service; Stage 2	3.1.0
23.086	Advice of Charge (AoC) Supplementary Service; Stage 2	3.1.0
23.087	User-to-User Signalling (UUS); Stage 2	3.1.0
23.088	Call Barring (CB) Supplementary Service; Stage 2	3.2.0
23.090	Unstructured Supplementary Service Data (USSD); Stage 2	3.2.0
23.091	Explicit Call Transfer (ECT) Supplementary Service; Stage 2	3.2.0

23.093	Call Completion to Busy Subscriber (CCBS); Stage 2	3.2.0
23.094	Follow Me Stage 2	3.2.0
23.096	Name Identification Supplementary Service - Stage 2	3.0.1
23.097	Multiple Subscriber Profile (MSP); Stage 2	3.1.1
23.101	General UMTS Architecture	3.1.0
23.107	Quality of Service, Concept and Architecture	3.5.0
23.108	Mobile Radio Interface Layer 3 specification, Core Network Protocols stage 2 (structured procedures)	3.2.0
23.110	UMTS Access Stratum Services and Functions	3.4.0
23.116	Super Charger; Stage 2	3.0.0
23.119	Gateway Location Register (GLR); Stage2	3.0.0
23.121	Architecture Requirements for Release 1999	3.5.1
23.122	Non-Access-Stratum functions related to Mobile Station (MS) in idle mode	3.5.0
23.127	Virtual Home Environment; Stage 2	3.3.0
23.135	Multicall; Stage 2	3.2.0
23.140	Multimedia Messaging Service (MMS)	3.0.1
23.171	Functional stage 2 description of location services in UMTS	3.2.0
24.002	GSM-UMTS Public Land Mobile Network (PLMN) Access Reference Configuration	3.1.0
24.007	Mobile Radio Interface Signalling Layer 3 - General Aspects	3.6.0
24.008	Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3	3.6.0
24.010	Mobile Radio Interface Layer 3 - Supplementary Services Specification - General Aspects	3.1.0
24.011	Point-to-Point (PP) Short Message Service (SMS) Support on Mobile Radio Interface	3.5.0
24.012	Short Message Service Cell Broadcast (SMSCB) Support on the Mobile Radio Interface	3.0.0
24.022	Radio Link Protocol (RLP) for Data and Telematic Services on the (MS-BSS) Interface and the Base Station System - Mobile-services Switching Centre (BSS-MSC) Interface	3.4.0
24.030	Location Services LCS Stage 3 SS (MO-LR)	3.1.0

24.067	Enhanced Multi-Level Precedence and Pre-emption service (eMLPP); Stage 3	3.1.0
24.072	Call Deflection Supplementary Service; Stage 3	3.0.0
24.080	Mobile radio Layer 3 Supplementary Service specification - Formats and coding	3.4.0
24.081	Line Identification Supplementary Service; Stage 3	3.1.0
24.082	Call Forwarding Supplementary Service; Stage 3	3.0.0
24.083	Call Waiting (CW) and Call Hold (HOLD) Supplementary Service;Stage 3	3.0.0
24.084	MultiParty (MPTY) Supplementary Service; Stage 3	3.0.0
24.085	Closed User Group (CUG) Supplementary Service; Stage 3	3.0.0
24.086	Advice of Charge (AoC) Supplementary Service; Stage 3	3.0.0
24.087	User-to-User Signalling (UUS); Stage 3	3.0.0
24.088	Call Barring (CB) Supplementary Service; Stage 3	3.0.0
24.090	Unstructured Supplementary Service Data (USSD); Stage 3	3.0.0
24.091	Explicit Call Transfer (ECT) Supplementary Service; Stage 3	3.0.0
24.093	Call Completion to Busy Subscriber (CCBS); Stage 3	3.0.0
24.096	Name Identification Supplementary Service; Stage 3	3.0.0
24.135	Multicall Stage 3	3.1.0
25.101	UE Radio transmission and reception (FDD)	3.5.0
25.102	UE Radio transmission and reception (TDD)	3.5.0
25.104	UTRA (BS) FDD; Radio transmission and reception	3.5.0
25.105	UTRA (BS) TDD: Radio transmission and reception	3.5.0
25.113	Base station EMC	3.4.0
25.123	Requirements for support of radio resource management (TDD)	3.4.0
25.133	Requirements for support of radio resource management (FDD)	3.4.0
25.141	Base station conformance testing (FDD)	3.4.1
25.142	Base station conformance testing (TDD)	3.4.0
25.201	Physical layer -General Description	3.1.0
25.211	Physical channels and mapping of transport channels onto physical channels (FDD)	3.5.0
25.212	Multiplexing and channel coding (FDD)	3.5.0

25.213	Spreading and modulation (FDD)	3.4.0
25.214	Physical layer procedures (FDD)	3.5.0
25.215	Physical layer; Measurements (FDD)	3.5.0
25.221	Physical channels and mapping of transport channels onto physical channels (TDD)	3.5.0
25.222	Multiplexing and channel coding (TDD)	3.5.0
25.223	Spreading and modulation (TDD)	3.4.0
25.224	Physical layer procedures (TDD)	3.5.0
25.225	Physical layer; Measurements (TDD)	3.5.0
25.301	Radio Interface Protocol Architecture	3.6.0
25.302	Services provided by the physical layer	3.7.0
25.303	UE functions and inter-layer procedures in connected mode	3.6.0
25.304	UE Procedures in Idle Mode and Procedures for Cell Reselection in Connected Mode	3.5.0
25.305	Stage 2 Functional Specification of Location Services in UTRAN (LCS)	3.4.0
25.306	UE Radio Access capabilities definition	3.0.0
25.321	Medium Access Control (MAC) Protocol Specification	3.6.0
25.322	Radio Link Control (RLC) Protocol Specification	3.5.0
25.323	Packet Data Convergence Protocol (PDCP) protocol	3.3.0
25.324	Broadcast/Multicast Control (BMC)	3.3.0
25.331	Radio Resource Control (RRC) Protocol Specification	3.5.0
25.401	UTRAN Overall Description	3.5.0
25.402	Synchronisation in UTRAN Stage 2	3.4.0
25.410	UTRAN Iu Interface: General Aspects and Principles	3.3.0
25.411	UTRAN Iu interface Layer 1	3.3.0
25.412	UTRAN Iu interface signalling transport	3.6.0
25.413	UTRAN Iu interface RANAP signalling	3.4.0
25.414	UTRAN Iu interface data transport & transport signalling	3.6.0
25.415	UTRAN Iu interface user plane protocols	3.5.0
25.419	UTRAN Iu interface: Cell broadcast protocols between SMS-CBC and RNC	3.3.0

25.420	UTRAN Iur Interface: General Aspects and Principles	3.2.0
25.421	UTRAN Iur interface Layer 1	3.0.0
25.422	UTRAN Iur interface signalling transport	3.5.0
25.423	UTRAN Iur interface RNSAP signalling	3.4.0
25.424	UTRAN Iur interface data transport & transport signalling for CCH data streams	3.5.0
25.425	UTRAN Iur interface user plane protocols for CCH data streams	3.3.0
25.426	UTRAN Iur and Iub interface data transport & transport signalling for DCH data streams	3.5.0
25.427	UTRAN Iur and Iub interface user plane protocols for DCH data streams	3.5.0
25.430	UTRAN Iub Interface: General Aspects and Principles	3.4.0
25.431	UTRAN Iub interface Layer 1	3.0.0
25.432	UTRAN Iub interface signalling transport	3.1.0
25.433	UTRAN Iub interface NBAP signalling	3.4.1
25.434	UTRAN Iub interface data transport & transport signalling for CCH data streams	3.4.0
25.435	UTRAN Iub interface user plane protocols for CCH data streams	3.5.0
25.442	UTRAN Implementation Specific O&M Transport	3.1.0
26.071	AMR speech Codec; General description	3.0.1
26.073	AMR speech Codec; C-source code	3.1.0
26.074	AMR speech Codec; Test sequences	3.0.2
26.090	AMR speech Codec; Transcoding Functions	3.1.0
26.091	AMR speech Codec; Error concealment of lost frames	3.1.0
26.092	AMR speech Codec; comfort noise for AMR Speech Traffic Channels	3.0.1
26.093	AMR speech Codec; Source Controlled Rate operation	3.3.0
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26.101	AMR speech Codec; Frame Structure	3.1.0
26.102	AMR speech Codec; Interface to Iu and Uu	3.2.0
26.103	Codec lists	3.0.0
26.104	AMR speech Codec; Floating point C-Code	3.1.0

26.110	Codec for Circuit switched Multimedia Telephony Service; General Description	3.0.1
26.111	Codec for Circuit switched Multimedia Telephony Service; Modifications to H.324	3.4.0
26.131	Narrow Band (3,1kHz) Speech & Video Telephony Terminal Acoustic Characteristics	3.1.0
26.132	Narrow Band (3,1kHz) Speech & Video Telephony Terminal Acoustic Test Specification.	3.1.0
27.001	General on Terminal Adaptation Functions (TAF) for Mobile Stations (MS)	3.7.0
27.002	Terminal Adaptation Functions (TAF) for services using Asynchronous bearer capabilities	3.5.0
27.003	Terminal Adaptation Functions (TAF) for services using Synchronous bearer capabilities	3.5.0
27.005	Use of Data Terminal Equipment - Data Circuit terminating Equipment (DTE - DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)	3.1.0
27.007	AT command set for 3G User Equipment (UE)	3.7.0
27.010	Terminal Equipment to User Equipment (TE-UE) multiplexer protocolUser Equipment (UE)	3.3.0
27.060	GPRS Mobile Stations supporting GPRS	3.4.0
27.103	Wide Area Network Synchronisation	3.1.0
29.002	Mobile Application Part (MAP) specification	3.7.2
29.006	Interworking between the Public Land Mobile Network (PLMN) and a Packet Switched Public Data Network/Integrated Services Digital Network (PSPDN/ISDN) for the support of packet switched data transmission services	3.0.0
29.007	General requirements on Interworking between the PLMN and the ISDN or PSTN	3.7.0
29.010	Information Element Mapping between Mobile Station - Base Station System (MS - BSS) and Base Station System - Mobile-services Switching Centre (BSS - MCS) Signalling Procedures and the Mobile Application Part (MAP)	3.4.0

29.011	Signalling Interworking for Supplementary Services	3.0.0
29.013	Signalling interworking between ISDN supplementary services Application Service Element (ASE) and Mobile Application Part (MAP) protocols	3.0.0
29.016	Serving GPRS Support Mode SGSN - Visitors Location Register (VLR); Gs Interface Network Service Specification	3.1.0
29.018	Serving GPRS Support Mode SGSN - Visitors Location Register (VLR); Gs Interface Layer 3 Specification	3.5.0
29.060	GPRS Tunnelling protocol (GTP) across the Gn and Gp interface	3.7.0
29.061	General Packet Radio Service (GPRS); Interworking between the Public Land Mobile Network (PLMN) supporting GPRS and Packet	3.4.0
29.078	CAMEL; Stage 3	3.6.0
29.108	Application of the Radio Access Network Application Part (RANAP) on the E-interface	3.1.0
29.119	GPRS Tunnelling Protocol (GTP) specification for Gateway Location Register (GLR)	3.0.0
29.120	Mobile Application Part (MAP) specification for Gateway Location Register (GLR); Stage 3	3.1.0
29.198	Open Services Architecture API part 1	3.2.0
31.101	UICC-terminal interface; Physical and logical characteristics	3.3.0
31.102	Characteristics of the USIM Application	3.4.0
31.110	Numbering system for telecommunication IC card applications	3.2.0
31.111	USIM Application Toolkit (USAT)	3.3.0
31.120	Terminal tests for the UICC Interface; part 1	3.0.0
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31.122	UICC Test Specification	3.0.0
32.005	Telecommunications Management; Charging and billing; 3G call and event data for the Circuit Switched (CS) domain	3.3.1
32.015	Telecommunications Management; Charging and billing; 3G call and event data for the Packet Switched (PS) domain	3.4.0
32.101	3G Telecom Management principles and high level requirements	3.3.0
32.102	3G Telecom Management Architecture	3.2.0

32.104	3G Performance Management	3.4.0
32.106-1	Telecommunication Management; Configuration Management; Part 1: 3G configuration management; Concept and requirements	3.1.0
32.106-2	Telecommunication Management; Configuration Management; Part 2: Notification Integration Reference Point; Information Service version 1	3.2.0
32.106-3	Telecommunication Management; Configuration Management; Part 3: Notification Integration Reference Point; CORBA solution set version 1:1	3.2.0
32.106-4	Telecommunication Management; Configuration Management; Part 4: Notification Integration Reference Point; CIMP Solution Set Version 1:1	3.1.0
32.106-5	Telecommunication Management; Configuration Management; Part 5: Basic Configuration Management IRP information model (including NRM) version 1	3.0.0
32.106-6	Telecommunication Management; Configuration Management; Part 6: Basic Configuration Management IRP CORBA solution set version 1:1	3.0.0
32.106-7	Telecommunication Management; Configuration Management; Part 7: Basic Configuration Management IRP CMIP solution set version 1:1	3.0.0
32.106-8	Telecommunication Management; Configuration Management; Part 8: Name convention for Managed Objects	3.1.0
32.111-1	Telecommunication Management; Fault Management; Part 1: 3G fault management requirements	3.2.0
32.111-2	Telecommunication Management; Fault Management; Part 2: Alarm Integration Reference Point: Information Service	3.3.0
32.111-3	Telecommunication Management; Fault Management; Part 3: Alarm Integration Reference Point: CORBA solution set version 1:1	3.3.0
32.111-4	Telecommunication Management; Fault Management; Part 4: Alarm Integration Reference Point: CMIP solution set	3.1.1
33.102	Security Architecture	3.7.0

33.103	Security Integration Guidelines	3.4.0
33.105	Cryptographic Algorithm requirements	3.6.0
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33.107	Lawful interception architecture and functions	3.1.0
33.120	Security Objectives and Principles	3.0.0
34.108	Common Test Environments for User Equipment (UE) Conformance Testing	3.2.0
34.109	Logical Test Interface (TDD and FDD)	3.2.0
34.121	Terminal Conformance Specification, Radio Transmission and Reception (FDD)	3.3.0
34.122	Terminal Conformance Specification, Radio Transmission and Reception (TDD)	3.2.0
34.123-1	UE Conformance Specification, Part 1 – Conformance specification	3.2.0
34.123-2	UE Conformance Specification, Part 2 – ICS	3.2.0
34.124	Electromagnetic compatibility (EMC) requirements for Mobile terminals and ancillary equipment	3.2.0
35.201	Specification of the 3GPP confidentiality and integrity algorithms; Document 1: f8 and f9 specifications	3.1.0
35.202	Specification of the 3GPP confidentiality and integrity algorithms; Document 2: Kasumi algorithm specification	3.1.0
35.203	Specification of the 3GPP confidentiality and integrity algorithms; Document 3: Implementors' test data	3.1.0
35.204	Specification of the 3GPP confidentiality and integrity algorithms; Document 4: Design conformance test data	3.1.0
35.206	Security Algorithms Group of Experts (SAGE); Specification of the MILENAGE algorithm set; An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4 and f5*; Document 1: Algorithm specifications	3.0.0
35.207	Security Algorithms Group of Experts (SAGE); Specification of the MILENAGE algorithm set; An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4 and f5*; Document 1: Implementors' test data	3.0.0

35.208	Security Algorithms Group of Experts (SAGE); Specification of the MILENAGE algorithm set; An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4 and f5*; Document 1: Design conformance test data	3.0.0

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