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Contents

Foreword

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

1 Scope

The present document describes the characteristics of the Layer 1 multiplexing and channel coding in the FDD mode of UTRA.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] 3GPP TS 25.201: "Physical layer - General Description".

[2] 3GPP TS 25.211: "Physical channels and mapping of transport channels onto physical channels (FDD)".

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

[4] 3GPP TS 25.214: "Physical layer procedures (FDD)".

[5] 3GPP TS 25.215: "Physical layer – Measurements (FDD)".

[6] 3GPP TS 25.221: "Physical channels and mapping of transport channels onto physical channels (TDD)".

[7] 3GPP TS 25.222: "Multiplexing and channel coding (TDD)".

[8] 3GPP TS 25.223: "Spreading and modulation (TDD)".

[9] 3GPP TS 25.224: "Physical layer procedures (TDD)".

[10] 3GPP TS 25.225: "Physical layer – Measurements (TDD)".

[11] 3GPP TS 25.302: "Services Provided by the Physical Layer".

[12] 3GPP TS 25.402: "Synchronization in UTRAN, Stage 2".

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

[14] ITU-T Recommendation X.691 (12/97) "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)"

[15] 3GPP TS 25.306: "UE Radio Access capabilities".

[16] 3GPP TS 25.321: "Medium Access Control (MAC) protocol specification".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Assisting secondary serving HS-DSCH Cell(s): In addition to the serving HS-DSCH cell, a cell in the secondary downlink frequency, where the UE is configured to simultaneously monitor a HS-SCCH set and receive HS-DSCH if it is scheduled in that cell. There can be up to two assisting secondary serving HS-DSCH cells.

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

Cell group: A group of (one, two, or three) Multiflow mode cells that have the same CPICH timing. The cells that belong to a cell group are indicated by higher layers.

DL FET: DL FET refers to early termination of DL DPCH transmission upon receiving an acknowledgement message. In this context, a DL FET ACK/NACK message represents an acknowledge message sent on UL DPCCH for DL FET.

DL_DCH_FET_Config: Higher layers signal this configuration parameter to indicate enhanced DCH physical layer configuration. The possible values are 0 and 1. The value 0 indicates Mode 0 configuration where DL transport channels concatenation and DL FET ACK/NACK signalling on UL are not configured. The value 1 indicates Mode 1 where DL transport channel concatenation and DL FET ACK/NACK signalling on UL are configured.

MIMO mode: This term refers to the downlink MIMO configuration with two transmit antennas

MIMO mode with four transmit antennas: This term refers to the downlink MIMO configuration with four transmit antennas

Multiflow mode: The UE is configured in Multiflow mode when it is configured with assisting serving HS-DSCH cell.

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

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

TG: Transmission Gap is consecutive empty slots that have been obtained with a transmission time reduction method. The transmission gap can be contained in one or two consecutive radio frames.

TGL: Transmission Gap Length is the number of consecutive empty slots that have been obtained with a transmission time reduction method. $0 \leq TGL \leq 14$. The CFNs of the radio frames containing the first empty slot of the transmission gaps, the CFNs of the radio frames containing the last empty slot, the respective positions N_{first} and N_{last} within these frames of the first and last empty slots of the transmission gaps, and the transmission gap lengths can be calculated with the compressed mode parameters described in [5].

TrCH number: The transport channel number identifies a TrCH in the context of L1. The L3 transport channel identity (TrCH ID) maps onto the L1 transport channel number. The mapping between the transport channel number and the TrCH ID is as follows: TrCH 1 corresponds to the TrCH with the lowest TrCH ID, TrCH 2 corresponds to the TrCH with the next lowest TrCH ID and so on.

UL DPCH 10ms Mode: When configured by higher layers for the TTI to be transmitted [16], UL DPCH follows physical channel procedures specific to this mode. UL DPCH 10ms Mode can only happen when DL_DCH_FET_Config is configured.

UL 20ms Compression Interval (CI): A time interval of 20ms duration aligned to a 20ms TTI defined for UL DPCH physical layer procedures when DL_DCH_FET_Config is configured by higher layers.

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

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

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

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

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

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

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

3.2 Symbols

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

$\lceil x \rceil$	round towards ∞, i.e. integer such that $x \le \lceil x \rceil < x+1$
$\lfloor x \rfloor$	round towards $-\infty$, i.e. integer such that $x-1 < \lfloor x \rfloor \le x$
$/x/$	absolute value of x
sgn(x)	signum function, i.e. $\mathrm{sgn}(x) = \begin{cases} 1; & x \ge 0 \\ -1; & x < 0 \end{cases}$
N_{first}	The first slot in the *TG*, located in the first compressed radio frame if the TG spans two frames.
N_{last}	The last slot in the *TG*, located in the second compressed radio frame if the TG spans two frames.
N_{tr}	Number of transmitted slots in a radio frame.

Unless otherwise is explicitly stated when the symbol is used, the meaning of the following symbols is:

Λ	List of transport channels numbers $i_1, i_2, \ldots, i_B$, corresponding to downlink transport channels to be concatenated when DL_DCH_FET_Config = 1.
i	TrCH number
j	TFC number
k	Bit number
l	TF number
m	Transport block number
n_i	Radio frame number of TrCH i.
p	PhCH number
r	Code block number
I	Number of TrCHs in a CCTrCH.
C_i	Number of code blocks in one TTI of TrCH i.
F_i	Number of radio frames in one TTI of TrCH i, except for uplink when UL_DPCH_10ms_Mode is configured. In uplink, when UL_DPCH_10ms_Mode is configured, F_i is the number of radio frames in the transmission time interval of TrCH i divided by 2.
M_i	Number of transport blocks in one TTI of TrCH i.
$N_{data,j}$	Number of data bits that are available for the CCTrCH in a radio frame with TFC j.
$N_{data,j}^{cm}$	Number of data bits that are available for the CCTrCH in a compressed radio frame with TFC j.
P	Number of PhCHs used for one CCTrCH.
PL	Puncturing Limit for the uplink. Signalled from higher layers
RM_i	Rate Matching attribute for TrCH i. Signalled from higher layers, or determined as specified in clause 4.2.0.

Temporary variables, i.e. variables used in several (sub)clauses with different meaning.

x, X
y, Y
z, Z

3.3 Abbreviations

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

ARQ	Automatic Repeat Request
BCH	Broadcast Channel
BER	Bit Error Rate
BLER	Block Error Rate
BS	Base Station
CCPCH	Common Control Physical Channel
CCTrCH	Coded Composite Transport Channel
CFN	Connection Frame Number
CLTD	Closed Loop Transmit Diversity
CRC	Cyclic Redundancy Check
DCH	Dedicated Channel
DL	Downlink (Forward link)
DPCCH	Dedicated Physical Control Channel
DPCCH2	Dedicated Physical Control Channel 2
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
DS-CDMA	Direct-Sequence Code Division Multiple Access
DTX	Discontinuous Transmission
FACH	Forward Access Channel
E-AGCH	E-DCH Absolute Grant Channel
E-DCH	Enhanced Dedicated Channel
E-DPCCH	E-DCH Dedicated Physical Control Channel
E-DPDCH	E-DCH Dedicated Physical Data Channel
E-HICH	E-DCH Hybrid ARQ Indicator Channel
E-RGCH	E-DCH Relative Grant Channel
E-RNTI	E-DCH Radio Network Temporary Identifier
E-ROCH	E-DCH Rank and Offset Channel
FDD	Frequency Division Duplex
F-DPCH	Fractional Dedicated Physical Channel
F-TPICH	Fractional Transmitted Precoding Indicator Channel
FER	Frame Error Rate
GF	Galois Field
HARQ	Hybrid Automatic Repeat reQuest
HS-DPCCH	Dedicated Physical Control Channel (uplink) for HS-DSCH
HS-DPCCH$_2$	Secondary Dedicated Physical Control Channel (uplink) for HS-DSCH, when Secondary_Cell_Enabled is greater than 3
HS-DSCH	High Speed Downlink Shared Channel
HS-PDSCH	High Speed Physical Downlink Shared Channel
HS-SCCH	Shared Control Channel for HS-DSCH
MAC	Medium Access Control
MBSFN	MBMS over a Single Frequency Network
Mcps	Mega Chip Per Second
MIMO	Multiple Input Multiple Output
MS	Mobile Station
OVSF	Orthogonal Variable Spreading Factor (codes)
PCCC	Parallel Concatenated Convolutional Code
PCH	Paging Channel
PhCH	Physical Channel
PRACH	Physical Random Access Channel
RACH	Random Access Channel
RSC	Recursive Systematic Convolutional Coder
RV	Redundancy Version
RX	Receive
SCH	Synchronization Channel
SF	Spreading Factor
SFN	System Frame Number
SIR	Signal-to-Interference Ratio
SNR	Signal to Noise Ratio

S-DPCCH	Secondary Dedicated Physical Control Channel
S-E-DPCCH	Secondary Dedicated Physical Control Channel for E-DCH
S-E-DPDCH	Secondary Dedicated Physical Data Channel for E-DCH
S-E-RNTI	Secondary E-RNTI
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
TPI	Transmitted Precoding Indicator
TrCH	Transport Channel
TTI	Transmission Time Interval
TX	Transmit
UL	Uplink (Reverse link)

4 Multiplexing, channel coding and interleaving

4.1 General

Data stream from/to MAC and higher layers (Transport block / Transport block set) is encoded/decoded to offer transport services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting, rate matching, interleaving and transport channels mapping onto/splitting from physical channels.

4.2 General coding/multiplexing of TrCHs

This section only applies to the transport channels: DCH, RACH, BCH, FACH and PCH. Other transport channels which do not use the general method are described separately below.

Data arrives to the coding/multiplexing unit in form of transport block sets once every transmission time interval. The transmission time interval is transport-channel specific from the set {10 ms, 20 ms, 40 ms, 80 ms}, where 80 ms TTI for DCH shall not be used unless SF=512.

The following coding/multiplexing steps can be identified:

- add CRC to each transport block (see subclause 4.2.1);
- transport block concatenation and code block segmentation (see subclause 4.2.2);
- channel coding (see subclause 4.2.3);
- radio frame equalisation (see subclause 4.2.4);
- rate matching (see subclause 4.2.7);
- insertion of discontinuous transmission (DTX) indication bits (see subclause 4.2.9);
- interleaving (two steps, see subclauses 4.2.5 and 4.2.11);
- radio frame segmentation (see subclause 4.2.6);
- multiplexing of transport channels (see subclause 4.2.8);
- physical channel segmentation (see subclause 4.2.10);
- mapping to physical channels (see subclause 4.2.12).

The coding/multiplexing steps for uplink and downlink are shown in figure 1 and figure 2 respectively.