EXHIBIT 1021

3GPP TS 25.321 V6.6.0 (2005-09)

Technical Specification

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Medium Access Control (MAC) protocol specification
(Release 6)

The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP.

The present document has not been subject to any approval process by the 3GPP Organisational Partners and shall not be implemented.
This Specification is provided for future development work within 3GPP only. The Organisational Partners accept no liability for any use of this Specification.
Specifications and reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organisational Partners' Publications Offices.

Keywords
UMTS, radio

3GPP

Postal address

3GPP support office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet
http://www.3gpp.org

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TTA, TTC).
All rights reserved.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 3

Contents

Foreword 6
1 Scope 7
2 References 7
3 Definitions and abbreviations 8
3.1 Definitions 8
3.1.1 HS-DSCH Specific Definitions 8
3.1.2 E-DCH Specific Definitions 8
3.2 Abbreviations 9
4 General 10
4.1 Objective 10
4.2 MAC architecture 10
4.2.1 MAC Entities 10
4.2.2 MAC-b 11
4.2.3 Traffic Related Architecture - UE Side 11
4.2.3.1 MAC-c/sh/m entity – UE Side 12
4.2.3.2 MAC-d entity – UE Side 14
4.2.3.3 MAC-hs entity – UE Side 15
4.2.3.4 MAC-e/es entity – UE Side 16
4.2.4 Traffic Related Architecture - UTRAN Side 17
4.2.4.1 MAC-c/sh/m entity – UTRAN Side 18
4.2.4.2 MAC-d entity – UTRAN Side 19
4.2.4.3 MAC-hs entity – UTRAN Side 21
4.2.4.4 MAC-es entity – UTRAN Side 22
4.2.4.5 MAC-e entity – UTRAN Side 23
4.3 Channel structure 24
4.3.1 Transport channels 24
4.3.2 Logical Channels 24
4.3.2.1 Logical channel structure 25
4.3.2.2 Control Channels 25
4.3.2.3 Traffic Channels 25
5 Services provided to upper layers 25
5.1 Description of Services provided to upper layers 26
6 Functions 26
6.1 Description of the MAC functions 26
6.2 Relation between MAC Functions and Transport Channels 27
6.2.1 Relation between MAC Functions and Transport Channels in UTRAN 27
6.2.2 Relation of MAC Functions and Transport Channels in UE 28
7 Services expected from physical layer 28
8 Elements for layer-to-layer communication 28
8.1 Primitives between layers 1 and 2 29
8.1.1 Primitives 29
8.1.2 Parameters 29
8.2 Primitives between MAC and RLC 29
8.2.1 Primitives 29
8.2.2 Parameters 30
8.3 Primitives between MAC and RRC 31
8.3.1 Primitives 31
8.3.2 Parameters 31
9 Elements for peer-to-peer communication 33
9.1 Protocol data units 33
9.1.1 General 33

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 4

9.1.2 MAC PDU (not HS-DSCH or E-DCH) ... 33
9.1.3 MAC-d PDU (HS-DSCH) ... 33
9.1.4 MAC PDU (HS-DSCH) ... 33
9.1.5 MAC PDU (E-DCH) ... 34
9.2 Formats and parameters ... 35
9.2.1 MAC PDU: Parameters of the MAC PDU header (not HS-DSCH or E-DCH) and MAC-d PDU header (HS-DSCH and E-DCH) ... 35
9.2.1.1 MAC header for DTCH and DCCH (not mapped on HS-DSCH or E-DCH) ... 38
9.2.1.1a MAC-d Header for DTCH and DCCH (mapped on HS-DSCH) ... 38
9.2.1.1b MAC-d Header for DTCH and DCCH (mapped on E-DCH) ... 39
9.2.1.2 MAC header for BCCH ... 39
9.2.1.3 MAC header for PCCH ... 39
9.2.1.4 MAC header for CCCH ... 39
9.2.1.5 MAC Header for CTCH ... 39
9.2.1.6 MAC Header for SHCCH ... 40
9.2.2 MAC PDU: Parameters of the MAC header (HS-DSCH) ... 41
9.2.2.1 MAC header for DTCH and DCCH ... 41
9.2.3 Signalling of Transport Block size for HS-DSCH ... 42
9.2.3.1 Transport block size for FDD ... 42
9.2.3.2 Transport block size for 3.84 Mcps TDD ... 43
9.2.3.3 Transport block size for 1.28 Mcps TDD ... 46
9.2.4 MAC PDU: Parameters of the MAC header (E-DCH) ... 48
9.2.4.1 MAC-es header parameters ... 48
9.2.4.2 MAC-e header parameters ... 48
9.2.5 Signaling of control information for E-DCH ... 48
9.2.5.1 HARQ information ... 48
9.2.5.2 DL Scheduling information ... 48
9.2.5.2.1 Relative Grants ... 48
9.2.5.2.2 Absolute Grant ... 50
9.2.5.3 UL Scheduling information ... 50
9.2.5.3.1 Happy Bit ... 50
9.2.5.3.2 Scheduling Information ... 50
9.2.5.4 Transport block size ... 52

10 Handling of unknown, unforeseen and erroneous protocol data ... 53

11 Specific functions ... 53
11.1 Traffic volume measurement for dynamic radio bearer control ... 53
11.2 Control of RACH transmissions ... 54
11.2.1 Access Service Class selection ... 54
11.2.2 Control of RACH transmissions for FDD mode ... 55
11.2.3 Control of RACH transmissions for TDD ... 58
11.2.3.1 Control of RACH transmissions for 3.84 Mcps TDD ... 58
11.2.3.2 Control of RACH Transmissions for 1.28 Mcps TDD ... 59
11.3 Void ... 61
11.4 Transport format combination selection in UE (non E-DCH) ... 61
11.5 Ciphering ... 63
11.6 Control of HS-DSCH transmission and reception ... 63
11.6.1 Network operation ... 63
11.6.1.1 Scheduler ... 64
11.6.1.2 HARQ entity ... 64
11.6.1.3 HARQ process ... 64
11.6.2 UE operation ... 65
11.6.2.1 HARQ Entity ... 65
11.6.2.2 HARQ process ... 65
11.6.2.3 Reordering entity ... 66
11.6.2.3.1 Definitions ... 66
11.6.2.3.2 Reordering functionality ... 67
11.6.2.4 Disassembly entity ... 68
11.6.2.5 MAC-hs Reset ... 68
11.6.2.6 Reconfiguration of MAC-hs parameters ... 69
11.7 HS-DSCH Provided Bit Rate measurement ... 69

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 5

11.8 Control of E-DCH transmission and reception 70
11.8.1 UE operation 70
11.8.1.1 HARQ Operation 70
11.8.1.1.1 HARQ entity 70
11.8.1.1.2 HARQ process 70
11.8.1.2 Multiplexing and TSN setting entity 71
11.8.1.2.1 TSN setting process operation 71
11.8.1.3 Serving Grant Update 72
11.8.1.3.1 Baseline Procedure 72
11.8.1.3.2 Handling at start of E-DCH transmission 73
11.8.1.3.3 Handling at serving cell change 73
11.8.1.4 E-TFC Selection 74
11.8.1.5 Happy Bit Setting 75
11.8.1.6 Scheduling Information reporting 76
11.8.1.6.1 Report Triggering when SG = “Zero_Grant” or all processes are deactivated 76
11.8.1.6.2 Report Triggering when SG <> “Zero_Grant” and at least one process is activated 76
11.8.2 Node B operation 77
11.8.2.1 HARQ Operation 77
11.8.2.1.1 HARQ entity 77
11.8.2.1.2 HARQ process 77
11.8.2.2 De-multiplexing 77
11.8.2.3 Scheduler 77
11.8.2.4 E-DCH Provided Bit Rate measurement 78
11.8.3 RNC operation 78
11.8.3.1 Re-ordering entity 78

Annex A (normative): HS-DSCH Transport Block Size Table for FDD 79

Annex B (normative): E-DCH Transport Block Size Tables for FDD 80
B.1 2ms TTI E-DCH Transport Block Size Table 0 80
B.2 2ms TTI E-DCH Transport Block Size Table 1 81
B.3 10ms TTI E-DCH Transport Block Size Table 0 82
B.4 10ms TTI E-DCH Transport Block Size Table 1 83

Annex C (informative): Change history 84

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 6

Foreword

This Technical Specification (TS) has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 7

1 Scope

The present document specifies the MAC protocol.

The specification describes:

- MAC architecture;
- MAC entities;
- channel structure;
- services provided to upper layers;
- MAC functions;
- services expected from the physical layer;
- elements for layer-to-layer communication including primitives between MAC and RLC;
- elements for peer-to-peer communication;
- protocol data units, formats and parameters;
- elementary procedures.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

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

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

[4] 3GPP TS 25.303: "Interlayer Procedures in Connected Mode".

[5] 3GPP TS 25.304: "UE Procedures in Idle Mode and Procedures for Cell Reselection in Connected Mode".

[6] 3GPP TS 25.322: "RLC Protocol Specification".

[7] 3GPP TS 25.331: "Radio Resource Control (RRC); protocol specification".

[8] 3GPP TR 25.921: "Guidelines and Principles for Protocol Description and Error Handling".

[9] 3GPP TR 25.990: "Vocabulary for the UTRAN".

[10] 3GPP TS 33.102: "Security architecture".

[11] 3GPP TS 25.425: "UTRAN Iur Interface User Plane Protocols for Common Transport Channel Data Streams".

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 8

[12] 3GPP TS 25.133: "Requirements for support of radio resource management (FDD)".

[13] 3GPP TS 25.214: "Physical layer procedures (FDD)".

[14] 3GPP TS 25.123: "Requirements for support of radio resource management (TDD)".

[15] 3GPP TS 33.105: "Cryptographic Algorithm Requirements".

[16] 3GPP TS 25.212: "Multiplexing and Channel Coding (FDD)".

[17] 3GPP TS 25.215: "Physical layer - Measurements (FDD)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given below and in [9] and [1] apply.

3.1.1 HS-DSCH Specific Definitions

3.1.2 E-DCH Specific Definitions

Active Process: HARQ process for which Scheduling Grant are applicable, i.e. scheduled data can be sent.

E-DCH: The Enhanced Dedicated Channel (E-DCH) is an uplink transport channel.

E-DCH active set: The set of cells which carry the E-DCH for one UE.

HARQ profile: One HARQ profile consists of a power offset attribute and maximum number of transmissions.

Inactive Process: HARQ process for which Scheduling Grants are not applicable, i.e. scheduled data cannot be sent.

INACTIVE: Absolute Grant value that can be sent by the serving cell's scheduler on the E-AGCH to deactivate a process or to switch the UE to its secondary E-RNTI.

Minimum_Grant: The value Minimum_Grant corresponds to the minimum E-DPDCH to DPCCH power ratio that the UE considers. This value is (5/15)^2.

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

Power offset attribute: Represents the power offset between E-DPDCH(s) and reference E-DPDCH power level for a given E-TFC. This power offset attribute is set to achieve the required QoS in this MAC-d flow when carried alone in a MAC-e PDU and subsequently in the corresponding CCTrCh of E-DCH type. Details on the mapping on Beta factors can be found in [13]. The reference E-DPDCH power offset is signaled to the UE for one (or several) reference E-TFC(s) (see details in subclause 11.1).

Primary Absolute Grant: Absolute Grant received with the primary E-RNTI.

Primary_Grant_Available: This state variable is a Boolean, indicating whether the UE's serving grant is only affected by Primary Absolute Grants and Relative Grants (i.e. not by Secondary Absolute Grants).

reference_ETPR: The state variable reference_ETPR holds the E-DPDCH to DPCCH power ratio used as reference for relative grant commands. This variable is set to the E-DPDCH to DPCCH power ratio used for the E-TFC selected for the previous TTI on this HARQ process, excluding any scaling applied according to subclause 5.1.2.6 of [13] and is obtained from the physical layer.

RG_step_size: The parameter step_size indicates the increment by which relative grants can adjust the maximum E-DPDCH to DPCCH power ratio that the UE is allowed to use. This parameter is configured by higher layers.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 9

Secondary Absolute Grant: Absolute Grant received with the secondary E-RNTI.

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

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

Serving_Grant: The state variable Serving_Grant indicates the maximum E-DPDCH to DPCCH power ratio that the UE is allowed to use for scheduled data in the following transmission. The value in the appropriate state variable will be provided to the E-TFC selection function to help in selecting the best format for the upcoming transmission. Possible values are: "Zero_Grant" and numerical values.

Stored_Secondary_Grant: This state variable is used to store the last received Secondary Absolute Grant Value. Possible values are: "Zero_Grant" and numerical values.

3.2 Abbreviations

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

AG	Absolute Grant
ASC	Access Service Class
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
C-	Control-
CCCH	Common Control Channel
DCCH	Dedicated Control Channel
DCH	Dedicated Channel
DL	Downlink
DSCH	Downlink Shared Channel
DTCH	Dedicated Traffic Channel
E-AGCH	E-DCH Absolute Grant Channel
E-DCH	Enhanced Dedicated Transport Channel
E-DPCCH	E-DCH Dedicated Physical Control Channel
E-HICH	E-DCH HARQ Acknowledgement Indicator Channel
E-RGCH	E-DCH Relative Grant Channel
E-RNTI	E-DCH Radio Network Temporary Identifier
E-TFC	E-DCH Transport Format Combination
E-TFCI	E-DCH Transport Format Combination Indicator
FACH	Forward Link Access Channel
FDD	Frequency Division Duplex
HARQ	Hybrid Automatic Repeat Request
HCSN	HS-SCCH Cyclic Sequence Number
HSDPA	High Speed Downlink Packet Access
HS-DSCH	High Speed Downlink Shared Channel
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
MAC	Medium Access Control
MBMS	Multimedia Broadcast Multicast Service
MCCH	MBMS point-to-multipoint Control Channel
MTCH	MBMS point-to-multipoint Traffic Channel
MSCH	MBMS point-to-multipoint Scheduling Channel
PCCH	Paging Control Channel
PCH	Paging Channel
PDU	Protocol Data Unit
PHY	Physical layer
PhyCH	Physical Channels
RACH	Random Access Channel
RG	Relative Grant
RLC	Radio Link Control
RLS	Radio Link Set

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 10

RNC	Radio Network Controller
RNS	Radio Network Subsystem
RNTI	Radio Network Temporary Identity
RRC	Radio Resource Control
RSN	Retransmission Sequence Number
SAP	Service Access Point
SDU	Service Data Unit
SHCCH	Shared Channel Control Channel
SRNC	Serving Radio Network Controller
SRNS	Serving Radio Network Subsystem
TDD	Time Division Duplex
TFCI	Transport Format Combination Indicator
TFI	Transport Format Indicator
TSN	Transmission Sequence Number
U-	User-
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
USCH	Uplink Shared Channel
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

4 General

4.1 Objective

The objective is to describe the MAC architecture and the different MAC entities from a functional point of view.

4.2 MAC architecture

The description in this subclause is a model and does not specify or restrict implementations.

According to the RRC functions the RRC is generally in control of the internal configuration of the MAC.

4.2.1 MAC Entities

The diagrams that describe the MAC architecture are constructed from MAC entities.

The entities are assigned the following names.

- MAC-b is the MAC entity that handles the following transport channels:
  - broadcast channel (BCH)
- MAC-c/sh/m, is the MAC entity that handles the following transport channels:
  - paging channel (PCH)
  - forward access channel (FACH)
  - random access channel (RACH)
  - downlink shared channel (DSCH). The DSCH exists only in TDD mode.
  - uplink shared channel (USCH). The USCH exists only in TDD mode.
- MAC-d is the MAC entity that handles the following transport channels:
  - dedicated transport channel (DCH)

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 11

- MAC-hs is the MAC entity that handles the following transport channels:
  - high speed downlink shared channel (HS-DSCH)
- MAC-m is the MAC entity that handles the following transport channels:
  - forward access channel (FACH).
- MAC-e/es are the MAC entities that handle the following transport channels:
  - enhanced dedicated transport channel (E-DCH).

The exact functions completed by the entities are different in the UE from those completed in the UTRAN.

NOTE: When a UE is allocated resources for exclusive use by the bearers that it supports the MAC-d entities dynamically share the resources between the bearers and are responsible for selecting the TFI/ TFCI that is to be used in each transmission time interval.

4.2.2 MAC-b

The following diagram illustrates the connectivity of the MAC-b entity in a UE and in each cell of the UTRAN.

MAC-b represents the control entity for the broadcast channel (BCH).

There is one (current cell) or multiple (current and neighbour cells) MAC-b entities in each UE and one MAC-b in the UTRAN for each cell.

The MAC Control SAP is used to transfer Control information to MAC-b.

The MAC-b entity is located in the Node B.

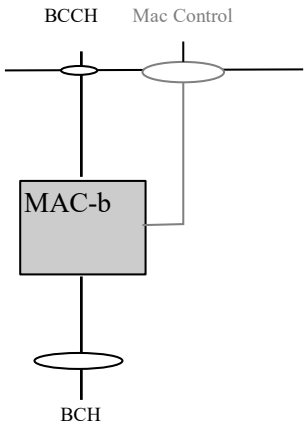

Figure 4.2.2.1: UE side and UTRAN side architecture

4.2.3 Traffic Related Architecture - UE Side

Figure 4.2.3.1 illustrates the connectivity of MAC entities.

The MAC-c/sh/m controls access to all common transport channels, except the HS-DSCH transport channel.

The MAC-d controls access to all dedicated transport channels, to MAC-c/sh/m and MAC-hs.

The MAC-hs controls access to the HS-DSCH transport channel.

The MAC-e/es controls access to the E-DCH transport channel.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 12

In case of selective combining of MTCH channels from multiple cells, the MAC-m controls access to the FACH transport channels used to carry MTCH and MSCH.

In the downlink, if logical channels of dedicated type are mapped to common transport channels then MAC-d receives the data from MAC-c/sh/m or MAC-hs via the illustrated connection between the functional entities.

In the uplink, if logical channels of dedicated type are mapped to common transport channels then MAC-d submits the data to MAC-c/sh/m via the illustrated connection between the functional entities.

The mapping of logical channels on transport channels depends on the multiplexing that is configured by RRC.

The MAC Control SAP is used to transfer Control information to each MAC entity.

The associated signalling shown in the figure illustrates the exchange of information between layer 1 and layer 2 provided by primitives shown in [3].

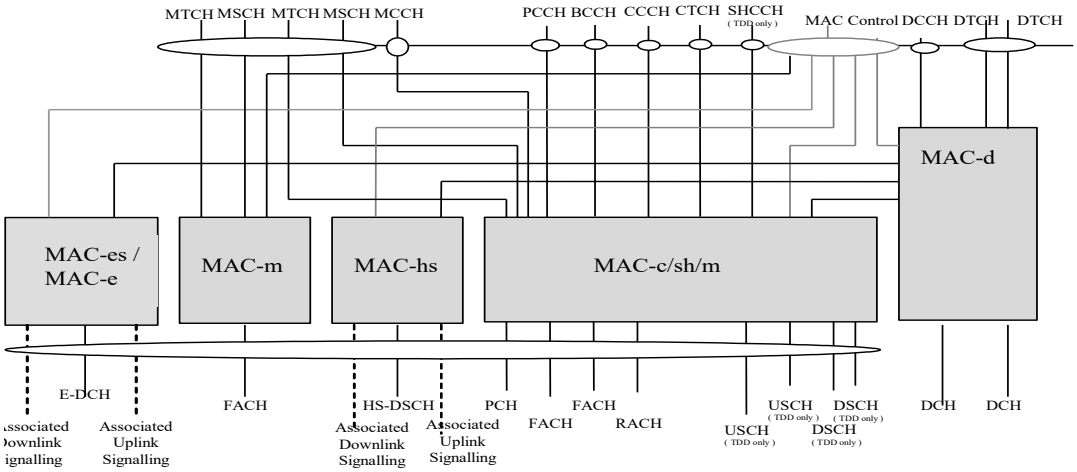

Figure 4.2.3.1: UE side MAC architecture

4.2.3.1 MAC-c/sh/m entity – UE Side

Figure 4.2.3.1.1 shows the UE side MAC-c/sh/m entity.

The following functionality is covered:

- TCTF MUX:
  - this function represents the handling (insertion for uplink channels and detection and deletion for downlink channels) of the TCTF field in the MAC header, and the respective mapping between logical and transport channels.
    The TCTF field indicates the common logical channel type, or if a dedicated logical channel is used;
- add/read UE Id:
  - the UE Id is added for RACH transmissions;
  - the UE Id, when present, identifies data to this UE.
- read MBMS Id:
  - the MBMS Id is read in case of MTCH reception;
  - the MBMS Id identifies received data to an MBMS service.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 13

- UL: TF selection:
  - in the uplink, the possibility of transport format selection exists.
- ASC selection:
  - For RACH, MAC indicates the ASC associated with the PDU to the physical layer. This is to ensure that RACH messages associated with a given Access Service Class (ASC) are sent on the appropriate signature(s) and time slot(s). MAC also applies the appropriate back-off parameter(s) associated with the given ASC. When sending an RRC CONNECTION REQUEST message, RRC will determine the ASC; in all other cases MAC selects the ASC;
- scheduling /priority handling
  - this functionality is used to transmit the information received from MAC-d on RACH based on logical channel priorities. This function is related to TF selection.
- TFC selection
  - transport format and transport format combination selection according to the transport format combination set (or transport format combination subset) configured by RRC is performed,

The RLC provides RLC-PDUs to the MAC, which fit into the available transport blocks on the transport channels.

There is one MAC-c/sh/m entity in each UE.

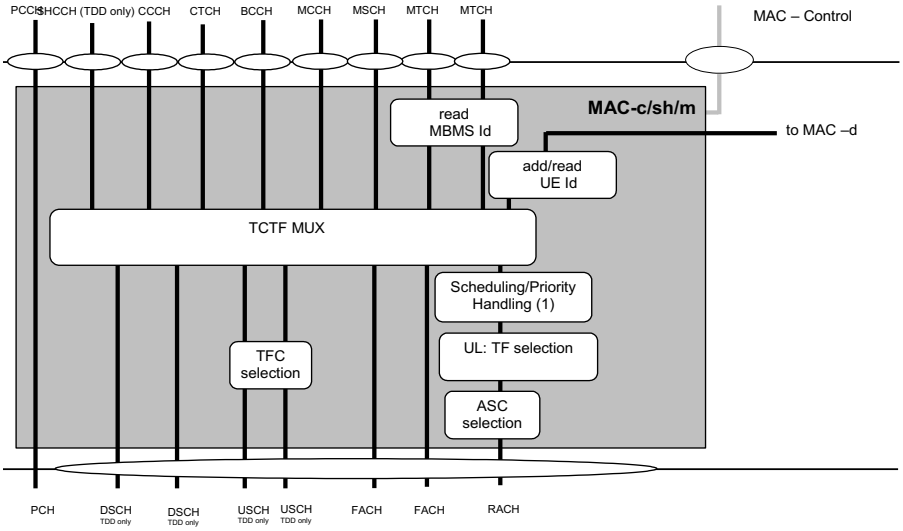

Figure 4.2.3.1.1: UE side MAC architecture / MAC-c/sh/m details

4.2.3.1b MAC-m entity – UE Side

Figure 4.2.3.1b.1 shows the UE side MAC-m entity.

The following functionality is covered:

- TCTF DEMUX:

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 14

  - this function represents the handling (detection and deletion for downlink channels) of the TCTF field in the MAC header, and the respective mapping between logical and transport channels.
    The TCTF field indicates the common logical channel type;

- read MBMS Id
  - the MBMS Id is read in case of MTCH reception;
  - the MBMS Id identifies received data to an MBMS service.

The MAC Control SAP is used to transfer control information to MAC-m.

If MTCH channels are selectively combined, the MAC-m entity exists in the UE. Otherwise, the MAC-m entity does not exist.

In case of selective combining of MTCH channels from multiple cells, there are one MAC-c/sh/m for the current cell and one MAC-m entity for each neighboring cell in the UE.

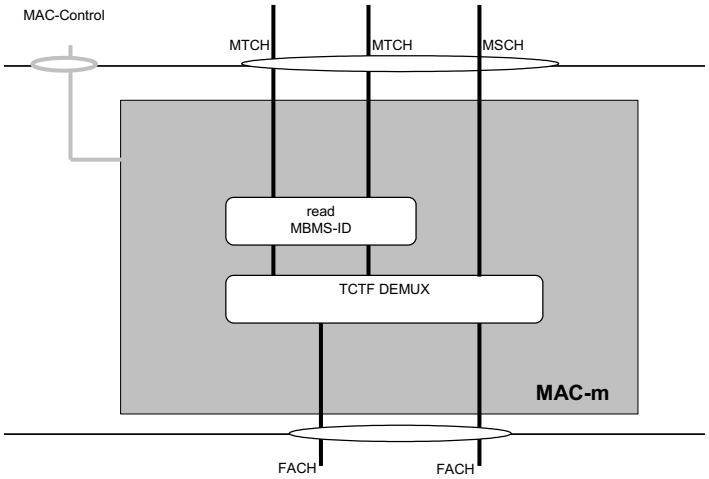

Figure 4.2.3.1b.1: UE side MAC architecture / MAC-m details

4.2.3.2 MAC-d entity – UE Side

Figure 4.2.3.2.1 shows the UE side MAC-d entity.

The following functionality is covered:

- Transport Channel type switching
  - Transport Channel type switching is performed by this entity, based on decision taken by RRC. This is related to a change of radio resources. If requested by RRC, MAC shall switch the mapping of one designated logical channel between common and dedicated transport channels.
- C/T MUX:
  - The C/T MUX is used when multiplexing of several dedicated logical channels onto one transport channel (other than HS-DSCH) or one MAC-d flow (HS-DSCH) is used. An unambiguous identification of the logical channel is included.
- Ciphering:
  - Ciphering for transparent mode data to be ciphered is performed in MAC-d. Details about ciphering can be found in [10].
- Deciphering:

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 15

- Deciphering for ciphered transparent mode data is performed in MAC-d. Details about ciphering can be found in [10].

- UL TFC selection:

  - Transport format and transport format combination selection according to the transport format combination set (or transport format combination subset) configured by RRC is performed.

The MAC-d entity is responsible for mapping dedicated logical channels for the uplink either onto dedicated transport channels or to transfer data to MAC-c/sh/m to be transmitted via common channels.

One dedicated logical channel can be mapped simultaneously onto DCH and DSCH in TDD mode.

One dedicated logical channel can be simultaneously mapped onto DCH and HS-DSCH.

The MAC-d entity has a connection to the MAC-c/sh/m entity. This connection is used to transfer data to the MAC-c/sh/m to transmit data on transport channels that are handled by MAC-c/sh/m (uplink) or to receive data from transport channels that are handled by MAC-c/sh/m (downlink).

The MAC-d entity has a connection to the MAC-hs entity. This connection is used to receive data from the HS-DSCH transport channel which is handled by MAC-hs (downlink).

The MAC-d entity has a connection to the MAC-e/es entity. This connection is used to transmit data on the E-DCH transport channel which is handled by the MAC-e/es (uplink).

There is one MAC-d entity in the UE.

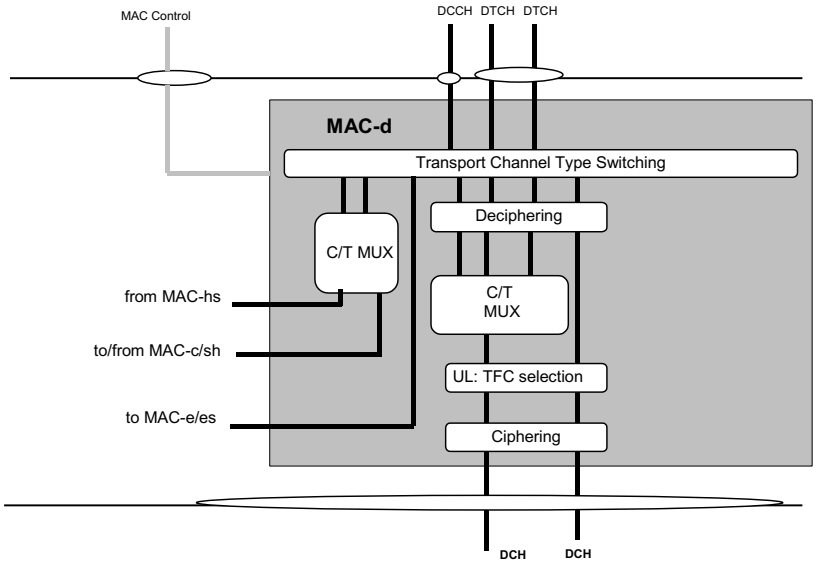

Figure 4.2.3.2.1: UE side MAC architecture / MAC-d details

4.2.3.3 MAC-hs entity – UE Side

The MAC-hs handles the HSDPA specific functions. In the model below the MAC-hs comprises the following entities:

- HARQ:
  The HARQ entity is responsible for handling the MAC functions relating to the HARQ protocol. The HARQ functional entity handles all the tasks that are required for hybrid ARQ. It is responsible for generating ACKs or NACKs. The detailed configuration of the hybrid ARQ protocol is provided by RRC over the MAC-Control SAP.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 16

- Reordering Queue distribution:
  The reordering queue distribution function routes the MAC-hs PDUs to the correct reordering buffer based on the Queue ID.

- Reordering:
  The reordering entity reorders received MAC-hs PDUs according to the received TSN. MAC-hs PDUs with consecutive TSNs are delivered to the disassembly function upon reception. MAC-hs PDUs are not delivered to the disassembly function if MAC-hs PDUs with lower TSN are missing. There is one reordering entity for each Queue ID configured at the UE.

- Disassembly:
  The disassembly entity is responsible for the disassembly of MAC-hs PDUs. When a MAC-hs PDU is disassembled the MAC-hs header is removed, the MAC-d PDUs are extracted and any present padding bits are removed. Then the MAC-d PDUs are delivered to higher layer.

The associated signalling shown in the figure illustrates the exchange of information between layer 1 and layer 2 provided by primitives shown in [3].

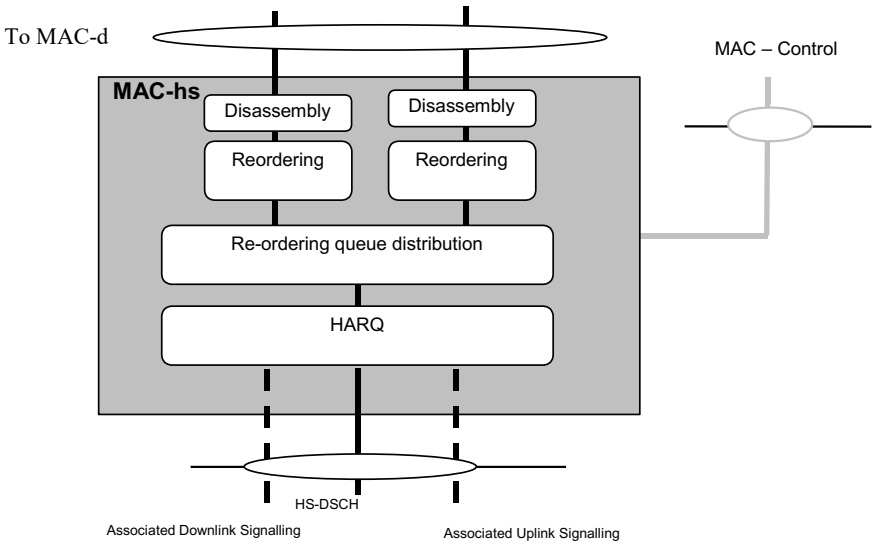

Figure 4.2.3.3.1: UE side MAC architecture / MAC-hs details

4.2.3.4 MAC-e/es entity – UE Side

The MAC-es/e handles the E-DCH specific functions. The split between MAC-e and MAC-es in the UE is not detailed. In the model below the MAC-e/es comprises the following entities:

- HARQ:
  The HARQ entity is responsible for handling the MAC functions relating to the HARQ protocol. It is responsible for storing MAC-e payloads and re-transmitting them. The detailed configuration of the hybrid ARQ protocol is provided by RRC over the MAC-Control SAP. The HARQ entity provides the E-TFC, the retransmission sequence number (RSN), and the power offset to be used by L1. Redundancy version (RV) of the HARQ transmission is derived by L1 from RSN, CFN and in case of 2 ms TTI from the sub-frame number.

- Multiplexing and TSN setting:
  The multiplexing and TSN setting entity is responsible for concatenating multiple MAC-d PDUs into MAC-es PDUs, and to multiplex one or multiple MAC-es PDUs into a single MAC-e PDU, to be transmitted in the next TTI, as instructed by the E-TFC selection function. It is also responsible for managing and setting the TSN per logical channel for each MAC-es PDU.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 17

- E-TFC selection:
  This entity is responsible for E-TFC selection according to the scheduling information (Relative Grants and Absolute Grants) received from UTRAN via L1, and for arbitration among the different flows mapped on the E-DCH. The detailed configuration of the E-TFC entity is provided by RRC over the MAC-Control SAP. The E-TFC selection function controls the multiplexing function.

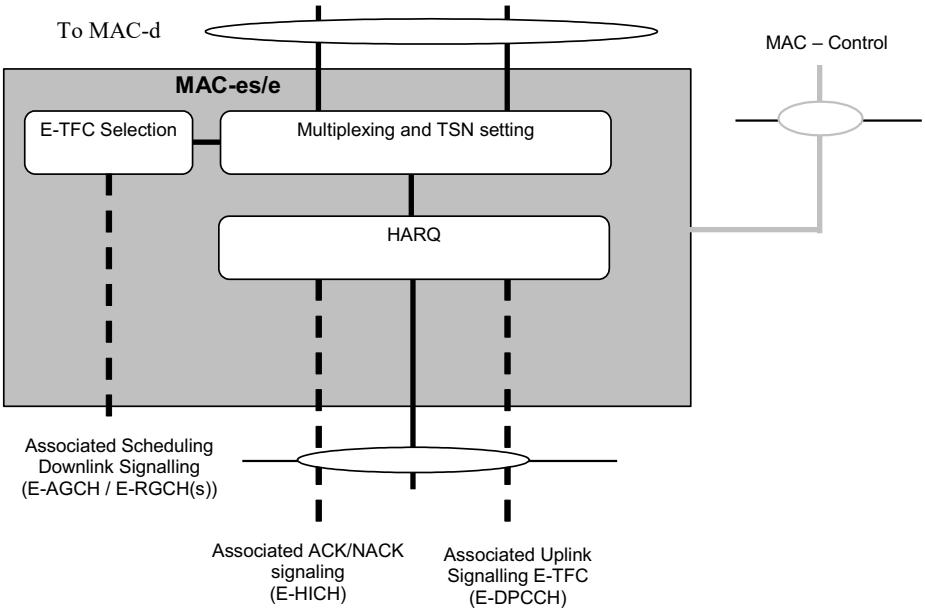

Figure 4.2.3.4.1: UE side MAC architecture / MAC-e/es details

4.2.4 Traffic Related Architecture - UTRAN Side

Figure 4.2.4.1 illustrates the connectivity between the MAC entities from the UTRAN side.

It is similar to the UE case with the exception that there will be one MAC-d for each UE and each UE (MAC-d) that is associated with a particular cell may be associated with that cell's MAC-c/sh/m.

MAC-c/sh/m is located in the controlling RNC while MAC-d is located in the serving RNC. MAC-hs is located in the Node B. The MAC-d PDUs to be transmitted are transferred from MAC-c/sh/m to the MAC-hs via the Iub interface in case of configuration with MAC-c/sh/m, or from the MAC-d via Iur/Iub in case of configuration without MAC-c/sh/m.

For each UE that uses E-DCH, one MAC-e entity per Node-B and one MAC-es entity in the SRNC are configured. MAC-e, located in the Node B, controls access to the E-DCH and is connected to MAC-es, located in the SRNC. MAC-es is further connected to MAC-d. There is one transport bearer set up per E-DCH MAC-d flow.

The MAC Control SAP is used to transfer Control information to each MAC entity belonging to one UE.

The associated signalling shown in the figure illustrates the exchange of information between layer 1 and layer 2 provided by primitives shown in [3].

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 18

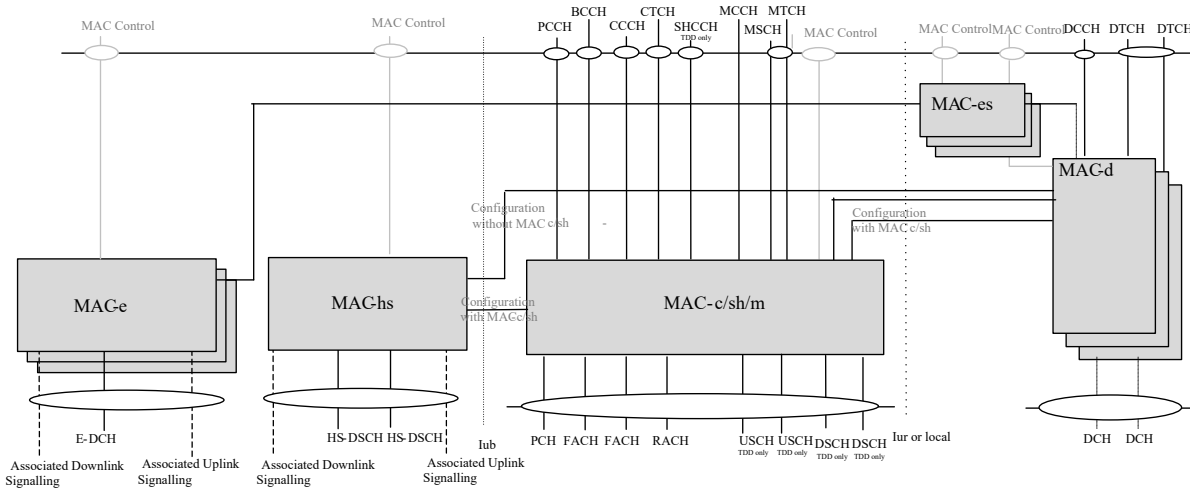

Figure 4.2.4.1: UTRAN side MAC architecture

4.2.4.1 MAC-c/sh/m entity – UTRAN Side

Figure 4.2.4.1.1 shows the UTRAN side MAC-c/sh/m entity. The following functionality is covered:

- Scheduling – Buffering – Priority Handling;
  - this function manages FACH and for TDD DSCH resources between the UEs and between data flows according to their priority and delay requirements set by higher layers.
- TCTF MUX
  - this function represents the handling (insertion for downlink channels and detection and deletion for uplink channels) of the TCTF field in the MAC header, and the respective mapping between logical and transport channels.
    The TCTF field indicates the common logical channel type, or if a dedicated logical channel is used;
- UE Id Mux;
  - for dedicated type logical channels, the UE Id field in the MAC header is used to distinguish between UEs;
- MBMS Id Mux;
  - for MTCH channels, the MBMS Id field in the MAC header is used to distinguish between MBMS services;
- TFC selection:
  - in the downlink, transport format combination selection is done for FACH and PCH and for TDD DSCHs;
- Demultiplex;
  - for TDD operation the demultiplex function is used to separate USCH data from different UEs, i.e. to be transferred to different MAC-d entities;
- DL code allocation;
  - for TDD this function is used to indicate the code used on the DSCH;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 19

- Flow control;
  - a flow control function exists toward MAC-d to limit buffering between MAC-d and MAC-c/sh/m entities. a flow control function also exists towards MAC-hs in case of configuration with MAC-c/sh/m.

The RLC provides RLC-PDUs to the MAC, which fit into the available transport blocks on the transport channels.

There is one MAC-c/sh/m entity in the UTRAN for each cell;

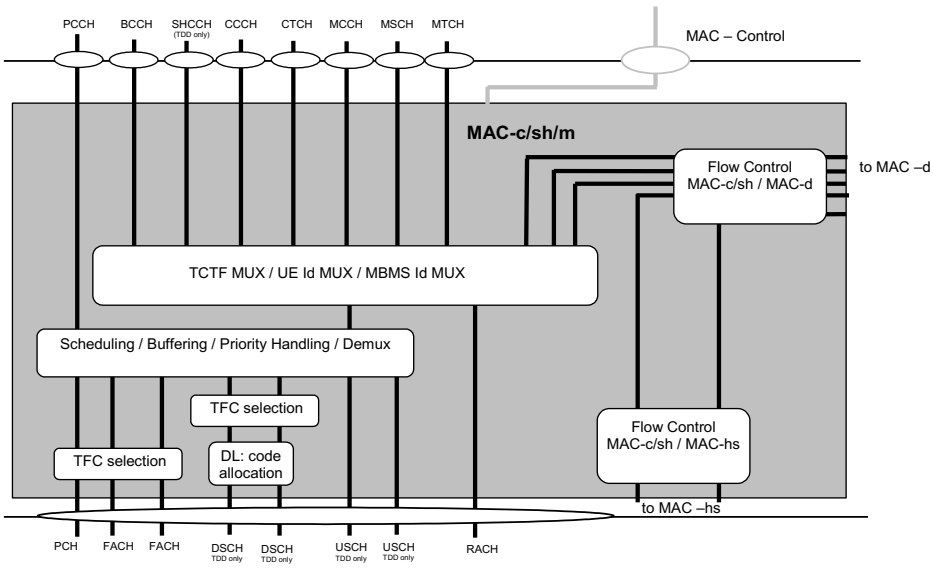

Figure 4.2.4.1.1: UTRAN side MAC architecture / MAC-c/sh/m details

4.2.4.2 MAC-d entity – UTRAN Side

Figure 4.2.4.2.1 shows the UTRAN side MAC-d entity.

The following functionality is covered:

- Transport Channel type switching:
  - Transport Channel type switching is performed by this entity, based on decision taken by RRC; this is related to a change of radio resources. If requested by RRC, MAC shall switch the mapping of one designated logical channel between common and dedicated transport channels.
- C/T MUX box;
  - the function includes the C/T field when multiplexing of several dedicated logical channels onto one transport channel (other than HS-DSCH) or one MAC-d flow (HS-DSCH) is used.
- Priority setting;
  - This function is responsible for priority setting on data received from DCCH / DTCH;
- Ciphering;
  - Ciphering for transparent mode data to be ciphered is performed in MAC-d. Details about ciphering can be found in [10].

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 20

- Deciphering;
  - Deciphering for ciphered transparent mode data is performed in MAC-d. Details about ciphering can be found in [10].
- DL Scheduling/Priority handling;
  - in the downlink, scheduling and priority handling of transport channels is performed within the allowed transport format combinations of the TFCS assigned by the RRC.
- Flow Control;
  - a flow control function exists toward MAC-c/sh/m to limit buffering between MAC-d and MAC-c/sh/m entities. This function is intended to limit layer 2 signalling latency and reduce discarded and retransmitted data as a result of FACH or for TDD DSCH congestion. For the Iur interface this is specified in [11]. A flow control function also exists towards MAC-hs in case of configuration without MAC-c/sh/m, see subclause 4.2.4.2.

A MAC-d entity using common channels other than the high speed downlink shared channel is connected to a MAC-c/sh/m entity that handles the scheduling of the common channels to which the UE is assigned and DL (FACH) priority identification to MAC-c/sh/m;

A MAC-d entity using downlink shared channel is connected to a MAC-c/sh/m entity that handles the shared channels to which the UE is assigned and indicates the level of priority of each PDU to MAC-c/sh/m;

A MAC-d entity using the high speed downlink shared channel may be connected to a MAC-c/sh/m entity that in turn is connected to the MAC-hs entity in the Node B (configuration with MAC-c/sh/m); alternately, a MAC-d entity using the high speed downlink shared channel may be connected to the MAC-hs entity in the Node B in case of configuration without MAC-c/sh/m.

A MAC-d entity using the enhanced dedicated transport channel (Uplink only) is connected to a MAC-es entity that handles the re-ordering and combining of data received from different Node Bs. Given that the MAC-es is collocated in the SRNC, it is not necessary to flow control this connection. The MAC-es indicates the logical channel for which the data is intended, to allow the MAC-d to route it appropriately.

A MAC-d entity is responsible for mapping dedicated logical channels onto the available dedicated transport channels or routing the data received on a DCCH or DTCH to MAC-c/sh/m or to MAC-hs.

One dedicated logical channel can be mapped simultaneously on DCH and DSCH in TDD mode. Different scheduling mechanisms apply for DCH and DSCH. One dedicated logical channel can be mapped simultaneously on DCH and HS-DSCH.

There is one MAC-d entity in the UTRAN for each UE that has one or more dedicated logical channels to or from the UTRAN.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 21

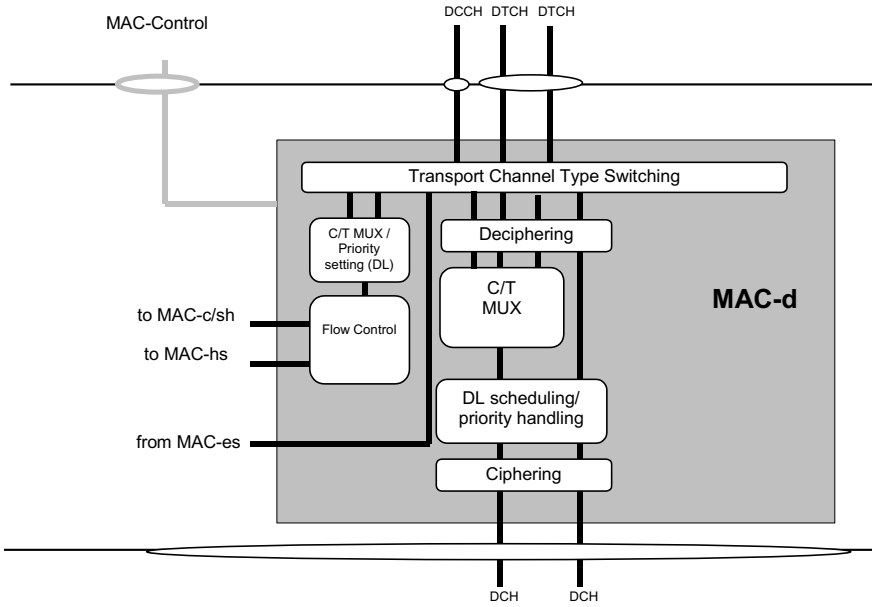

Figure 4.2.4.2.1: UTRAN side MAC architecture / MAC-d details

4.2.4.3 MAC-hs entity – UTRAN Side

There is one MAC-hs entity in the UTRAN for each cell that supports HS-DSCH transmission. The MAC-hs is responsible for handling the data transmitted on the HS-DSCH. Furthermore it is responsible for the management of the physical resources allocated to HSDPA. MAC-hs receives configuration parameters from the RRC layer via the MAC-Control SAP. There should be priority handling per MAC-d PDU in the MAC-hs. The MAC-hs is comprised of four different functional entities:

- Flow Control:
  This is the companion flow control function to the flow control function in the MAC-c/sh/m in case of configuration with MAC-c/sh/m and MAC-d in case of configuration without MAC-c/sh/m. Both entities together provide a controlled data flow between the MAC-c/sh/m and the MAC-hs (Configuration with MAC-c/sh/m) or the MAC-d and MAC-hs (Configuration without MAC-c/sh/m) taking the transmission capabilities of the air interface into account in a dynamic manner. This function is intended to limit layer 2 signalling latency and reduce discarded and retransmitted data as a result of HS-DSCH congestion. Flow control is provided independently by MAC-d flow for a given MAC-hs entity.

- Scheduling/Priority Handling:
  This function manages HS-DSCH resources between HARQ entities and data flows according to their priority. Based on status reports from associated uplink signalling either new transmission or retransmission is determined. Further it determines the Queue ID and TSN for each new MAC-hs PDU being serviced, and in the case of TDD the HCSN is determined. A new transmission can be initiated instead of a pending retransmission at any time to support the priority handling.

- HARQ:
  One HARQ entity handles the hybrid ARQ functionality for one user. One HARQ entity is capable of supporting multiple instances (HARQ process) of stop and wait HARQ protocols. There shall be one HARQ process per HS-DSCH per TTI.

- TFRC selection:
  Selection of an appropriate transport format and resource for the data to be transmitted on HS-DSCH.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 22

The associated signalling shown in the figure illustrates the exchange of information between layer 1 and layer 2 provided by primitives shown in [3].

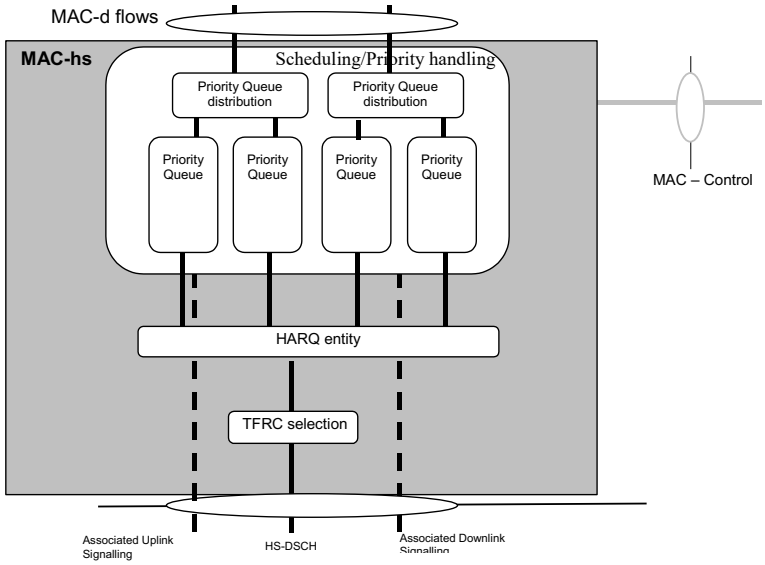

Figure 4.2.4.3.1: UTRAN side MAC architecture / MAC-hs details

4.2.4.4 MAC-es entity – UTRAN Side

For each UE, there is one MAC-es entity in the SRNC. The MAC-es sublayer handles E-DCH specific functionality, which is not covered in the MAC-e entity in Node B. In the model below, the MAC-es comprises the following entities:

- Reordering Queue Distribution:
  The reordering queue distribution function routes the MAC-es PDUs to the correct reordering buffer based on the SRNC configuration.

- Reordering:
  This function reorders received MAC-es PDUs according to the received TSN and Node-B tagging i.e. (CFN, subframe number). MAC-es PDUs with consecutive TSNs are delivered to the disassembly function upon reception. Mechanisms for reordering MAC-es PDUs received out-of-order are left up to the implementation. There is one Re-ordering Process per logical channel.

- Macro diversity selection:
  The function is performed in the MAC-es, in case of soft handover with multiple Node-Bs (The soft combining for all the cells of a Node-B takes place in the Node-B). This means that the reordering function receives MAC-es PDUs from each Node-B in the E-DCH active set. The exact implementation is not specified. However the model below is based on one Reordering Queue Distribution entity receiving all the MAC-d flow from all the Node-Bs, and one MAC-es entity per UE.

- Disassembly:
  The disassembly function is responsible for disassembly of MAC-es PDUs. When a MAC-es PDU is disassembled the MAC-es header is removed, the MAC-d PDU's are extracted and delivered to MAC-d.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 23

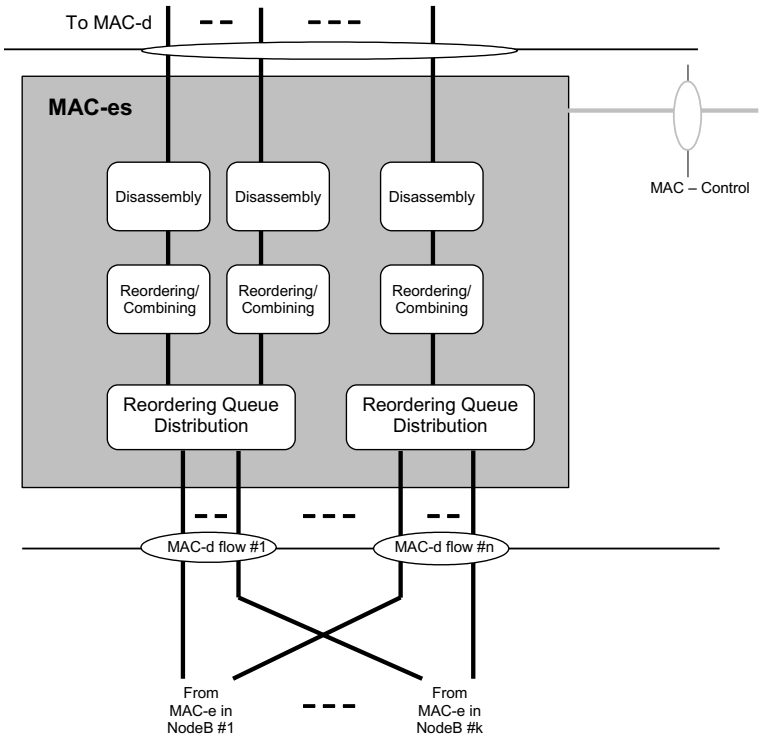

Figure 4.2.4.4-1: UTRAN side MAC architecture / MAC-es details (SHO case)

4.2.4.5 MAC-e entity – UTRAN Side

There is one MAC-e entity in the Node B for each UE and one E-DCH scheduler function in the Node-B. The MAC-e and E-DCH scheduler handle HSUPA specific functions in the Node B. In the model below, the MAC-e and E-DCH scheduler comprises the following entities:

- E-DCH Scheduling:
  This function manages E-DCH cell resources between UEs. Based on scheduling requests, Scheduling Grants are determined and transmitted. The general principles of the E-DCH scheduling are described in subclause 11.8.2.3 below. However implementation is not specified (i.e. depends on RRM strategy).

- E-DCH Control:
  The E-DCH control entity is responsible for reception of scheduling requests and transmission of Scheduling Grants. The general principles of the E-DCH schedulling are described in subclause 11.8.2.3 below.

- De-multiplexing:
  This function provides de-multiplexing of MAC-e PDUs. MAC-es PDUs are forwarded to the associated MAC-d flow.

- HARQ:
  One HARQ entity is capable of supporting multiple instances (HARQ processes) of stop and wait HARQ protocols. Each process is responsible for generating ACKs or NACKs indicating delivery status of E-DCH transmissions. The HARQ entity handles all tasks that are required for the HARQ protocol.

The associated signalling shown in the figure illustrates the exchange of information between layer 1 and layer 2 provided by primitives.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 24

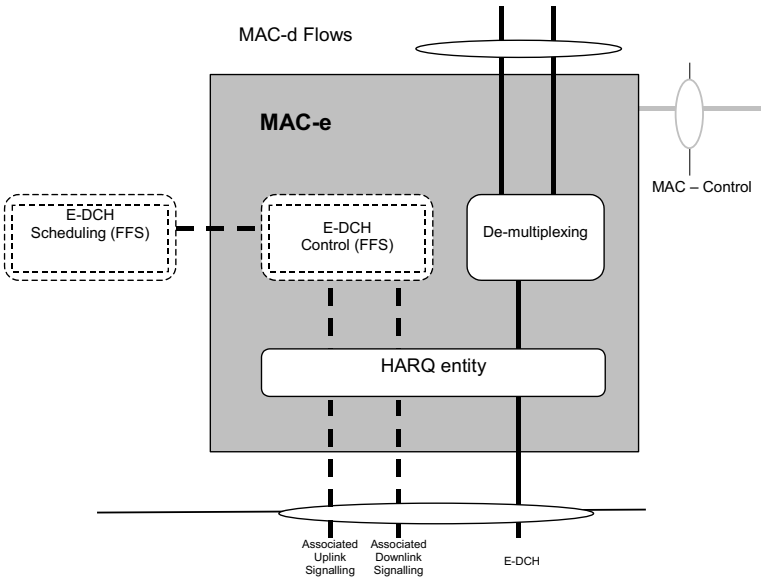

Figure 4.2.4.5-1: UTRAN side MAC architecture / MAC-e details

4.3 Channel structure

The MAC operates on the channels defined below; the transport channels are described between MAC and Layer 1, the logical channels are described between MAC and RLC.

The following subclauses provide an overview, the normative description can be found in [2] and [3] respectively.

4.3.1 Transport channels

Common transport channel types are:

- Random Access Channel(s) (RACH);
- Forward Access Channel(s) (FACH);
- Downlink Shared Channel(s) (DSCH), for TDD operation only;
- High Speed Downlink Shared Channel(s) (HS-DSCH);
- Uplink Shared Channel(s) (USCH), for TDD operation only;
- Broadcast Channel (BCH);
- Paging Channel (PCH).

Dedicated transport channel types are:

- Dedicated Channel (DCH);
- Enhanced Dedicated Channel (E-DCH) for UL FDD operation only.

4.3.2 Logical Channels

The MAC layer provides data transfer services on logical channels. A set of logical channel types is defined for different kinds of data transfer services as offered by MAC.

Each logical channel type is defined by what type of information is transferred.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 25

4.3.2.1 Logical channel structure

The configuration of logical channel types is depicted in figure 4.3.2.1.

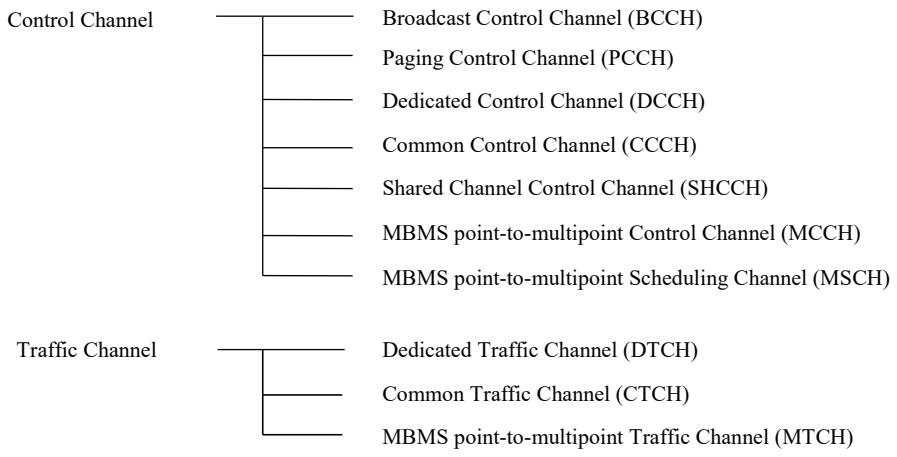

Figure 4.3.2.1: Logical channel structure

4.3.2.2 Control Channels

Following control channels are used for transfer of control plane information only:

- Broadcast Control Channel (BCCH);
- Paging Control Channel (PCCH);
- Common Control Channel (CCCH);
- Dedicated Control Channel (DCCH);
- Shared Channel Control Channel (SHCCH);
- MBMS point-to-multipoint Control Channel (MCCH);
- MBMS point-to-multipoint Scheduling Channel (MSCH)

4.3.2.3 Traffic Channels

Following traffic channels are used for the transfer of user plane information only:

- Dedicated Traffic Channel (DTCH);
- Common Traffic Channel (CTCH);
- MBMS point-to-multipoint Traffic Channel (MTCH).

5 Services provided to upper layers

This clause describes the different services provided by the MAC to higher layers. For a detailed description of the following functions see [2].

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 26

5.1 Description of Services provided to upper layers

- Data transfer: This service provides unacknowledged transfer of MAC SDUs between peer MAC entities without data segmentation.
- Reallocation of radio resources and MAC parameters: This service performs on request of RRC execution of radio resource reallocation and change of MAC parameters.
- Reporting of measurements: Local measurements are reported to RRC.

6 Functions

6.1 Description of the MAC functions

The functions of MAC include:

- mapping between logical channels and transport channels;
- selection of appropriate Transport Format for each Transport Channel depending on instantaneous source rate;
- priority handling between data flows of one UE;
- priority handling between UEs by means of dynamic scheduling;
- identification of UEs on common transport channels;
- identification of MBMS services on common transport channels;
- multiplexing/demultiplexing of upper layer PDUs into/from transport blocks delivered to/from the physical layer on common transport channels;
- multiplexing/demultiplexing of upper layer PDUs into/from transport block sets delivered to/from the physical layer on dedicated transport channels;
- traffic volume measurement;
- Transport Channel type switching;
- ciphering for transparent mode RLC;
- Access Service Class selection for RACH transmission;
- control of HS-DSCH transmission and reception including support of HARQ;
- HS-DSCH Provided Bit Rate measurement;
- control of E-DCH transmission and reception including support of HARQ;
- generation of uplink scheduling information to assist with E-DCH resource allocation;
- E-DCH Provided Bit-rate measurement.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 27

6.2 Relation between MAC Functions and Transport Channels

6.2.1 Relation between MAC Functions and Transport Channels in UTRAN

Table 6.2.1.1: UTRAN MAC functions corresponding to the transport channel

Associated MAC Functions	Logical Ch	Transport Ch	TF Selection	Priority handling between UEs	Priority handling (one UE)	Scheduling	Identification of UEs or MBMS services	Mux/ Demux on common transport channels	Mux/ Demux on dedicated transport channels	HARQ support
Uplink (Rx)	CCCH	RACH						X		
	DCCH	RACH					X	X		
	DCCH	DCH							X	
	DTCH	RACH					X	X		
	DTCH	DCH							X	
	SHCCH	RACH					X	X		
	SHCCH	USCH						X		
	DTCH	USCH						X		
	DCCH	USCH						X		
	DTCH	E-DCH				X			X	X
	DCCH	E-DCH				X			X	X
Downlink (Tx)	BCCH	BCH				X				
	BCCH	FACH	X			X		X		
	PCCH	PCH	X			X				
	CCCH	FACH	X	X		X		X		
	CTCH	FACH	X			X		X		
	MCCH	FACH	X			X		X		
	MSCH	FACH	X			X		X		
	MTCH	FACH	X			X	X	X		
	CTCH	FACH	X			X		X		
	DCCH	FACH	X	X		X	X	X		
	DCCH	DSCH	X	X			X	X		
	DCCH	DCH	X		X				X	
	DCCH	HS-DSCH	X (1)	X	X	X	X	X		X
	DTCH	FACH	X	X		X	X	X		
	DTCH	DSCH	X	X			X	X		
	DTCH	DCH	X		X				X	
	DTCH	HS-DSCH	X (1)	X	X	X	X	X		X
	SHCCH	FACH	X	X		X		X		
	SHCCH	DSCH	X	X				X		

NOTE 1: In case of HS-DSCH the TF selection is replaced by TFRC selection.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 28

6.2.2 Relation of MAC Functions and Transport Channels in UE

Table 6.2.2.1: UE MAC functions corresponding to the transport channel

Associated MAC Functions	Logical Ch	Transport Ch	TF Selection	Priority handling (one UE)	Identification	Mux/Demux on common transport channels	Mux/Demux on dedicated transport channels	HARQ support
Uplink (Tx)	CCCH	RACH				X		
	DCCH	RACH	X	X	X	X		
	DCCH	DCH	X	X			X	
	DTCH	RACH	X	X	X	X		
	DTCH	DCH	X	X			X	
	SHCCH	RACH				X		
	SHCCH	USCH	X	X		X		
	DCCH	USCH	X	X		X		
	DTCH	USCH	X	X		X		
	DCCH	E-DCH	X	X			X	X
	DTCH	E-DCH	X	X			X	X
Downlink (Rx)	BCCH	BCH						
	BCCH	FACH				X		
	PCCH	PCH						
	CCCH	FACH				X		
	CTCH	FACH				X		
	MCCH	FACH				X		
	MSCH	FACH				X		
	MTCH	FACH			X	X		
	DCCH	FACH			X	X		
	DCCH	DSCH				X		
	DCCH	DCH					X	
	DCCH	HS-DSCH			X	X		X
	DTCH	FACH			X	X		
	DTCH	DSCH				X		
	DTCH	DCH					X	
	DTCH	HS-DSCH			X	X		X
	SHCCH	FACH				X		
	SHCCH	DSCH				X		

7 Services expected from physical layer

The physical layer offers information transfer services to MAC. For detailed description, see [3].

8 Elements for layer-to-layer communication

The interaction between the MAC layer and other layers are described in terms of primitives where the primitives represent the logical exchange of information and control between the MAC layer and other layers. The primitives shall not specify or constrain implementations. The MAC is connected to layer 1, RLC and RRC. The following subclauses describe the primitives between these layers.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 29

8.1 Primitives between layers 1 and 2

8.1.1 Primitives

The primitives are described in [3].

8.1.2 Parameters

a) Transport Format Resource Indicator (TFRI) for HS-DSCH:

- For HS-DSCH the Transport Block size is derived from the TFRI value signalled on the HS-SCCH. The mapping between TFRI value and Transport Block size is specified in subclause 9.2.3.

b) HARQ information for E-DCH:

- ACK/NACK information (details specified in subclause 9.2.5.1).
- RSN information (details specified in subclause 9.2.5.1).
- Power offset (details specified in subclause 11.8.1.4).
- E-TFCI (details specified in subclause 11.8.1.4).

c) Relative Grant information for E-DCH:

- Serving Relative Grant information (details specified in subclause 9.2.5.2.1).
- Non-serving Relative Grant information (details specified in subclause 9.2.5.2.1).

d) Absolute Grant information for E-DCH (details specified in subclause 9.2.5.2.2).

- Identity Type for E-DCH.
- Absolute Grant Value.
- Absolute Grant Scope.

e) Happy Bit (details specified in subclause 9.2.5.2.2).

8.2 Primitives between MAC and RLC

8.2.1 Primitives

The primitives between MAC layer and RLC layer are shown in table 8.2.1.1.

Table 8.2.1.1: Primitives between MAC layer and RLC layer

Generic Name	Parameter			
	Request	Indication	Response	Confirm
MAC-DATA	Data, BO, UE-ID type indicator, RLC Entity Info	Data, No_TB, TD (note), Error indication		
MAC-STATUS		No_PDU, PDU_Size, TX status, Status_Report_REQ	BO, RLC Entity Info	
NOTE: TDD only.				

MAC-DATA-Req/Ind:

- MAC-DATA-Req primitive is used to request that an upper layer PDU be sent using the procedures for the information transfer service;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 30

- MAC-DATA-Ind primitive indicates the arrival of upper layer PDUs received within one transmission time interval by means of the information transfer service.

MAC-STATUS-Ind/Resp:

- MAC-STATUS-Ind primitive indicates to RLC for each logical channel the rate at which it may transfer data to MAC. Parameters are the number of PDUs that can be transferred in each transmission time interval and the PDU size; it is possible that MAC would use this primitive to indicate that it expects the current buffer occupancy of the addressed logical channel in order to provide for optimised TFC selection on transport channels with long transmission time interval. At the UE, MAC-STATUS-Ind primitive is also used to indicate from MAC to RLC that MAC has requested data transmission by PHY (i.e. PHY-DATA-REQ has been submitted, see Fig. 11.2.2.1), or that transmission of an RLC PDU on RACH has failed due to exceeded preamble ramping cycle counter.
- MAC-STATUS-Resp primitive enables RLC to acknowledge a MAC-STATUS-Ind. It is possible that RLC would use this primitive to indicate that it has nothing to send or that it is in a suspended state or to indicate the current buffer occupancy to MAC.

8.2.2 Parameters

a) Data:

- it contains the RLC layer messages (RLC-PDU) to be transmitted, or the RLC layer messages that have been received by the MAC sub-layer.

b) Number of transmitted transport blocks (No_TB) :

- indicates the number of transport blocks transmitted by the peer entity within the transmission time interval, based on the TFI value.

c) Buffer Occupancy (BO):

- the parameter Buffer Occupancy (BO) indicates for each logical channel the amount of data in number of bytes that is available for transmission and retransmission in RLC layer. When MAC is connected to an AM RLC entity, control PDUs to be transmitted and RLC PDUs outside the RLC Tx window shall also be included in the BO. RLC PDUs that have been transmitted but not negatively acknowledged by the peer entity shall not be included in the BO.

d) RX Timing Deviation (TD), TDD only:

- it contains the RX Timing Deviation as measured by the physical layer for the physical resources carrying the data of the Message Unit. This parameter is optional and only for Indication. It is needed for the transfer of the RX Timing Deviation measurement of RACH transmissions carrying CCCH data to RRC.

e) Number of PDU (No_PDU):

- specifies the number of PDUs that the RLC is permitted to transfer to MAC within a transmission time interval.

f) PDU Size (PDU_Size):

- specifies the size of PDU that can be transferred to MAC within a transmission time interval.

g) UE-ID Type Indicator:

- indicates the UE-ID type to be included in MAC for a DCCH and DTCH when they are mapped onto a common transport channel (i.e. FACH, RACH in FDD). On the UE side UE-ID Type Indicator shall always be set to C-RNTI.

h) TX status:

- when set to value "transmission unsuccessful" this parameter indicates to RLC that transmission of an RLC PDU failed in the previous Transmission Time Interval, when set to value "transmission successful" this parameter indicates to RLC that the requested RLC PDU(s) has been submitted for transmission by the physical layer.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 31

i) RLC Entity Info

- indicates to MAC the configuration parameters that are critical to TFC selection depending on its mode and the amount of data that could be transmitted at the next TTI. This primitive is meant to insure that MAC can perform TFC selection (see subclause 11.4).

j) Error indication

- When a MAC SDU is delivered to upper layer, an error indication is given for the SDU to upper layer if an error indication for the SDU has been received from lower layer.

k) Status_Report_REQ

- indicates to all AM RLC entities mapped on HS-DSCH to generate a status report when the MAC-hs resets.

8.3 Primitives between MAC and RRC

8.3.1 Primitives

The primitives between MAC and RRC are shown in table 8.3.1.1.

Table 8.3.1.1: Primitives between MAC sub-layer and RRC

Generic Name	Parameter			
	Request	Indication	Response	Confirm
CMAC-CONFIG	UE information elements, RB information elements, TrCH information elements, RACH transmission control elements, Ciphering elements, MBMS information elements			
CMAC-MEASUREMENT	Measurement information elements	Measurement result		
CMAC-STATUS		Status info		

CMAC-CONFIG-Req:

- CMAC-CONFIG-Req is used to request for setup, release and configuration of a logical channel, e.g. RNTI allocation, switching the connection between logical channels and transport channels, TFCS update or scheduling priority of logical channel.

CMAC-MEASUREMENT-Req/Ind:

- CMAC-MEASUREMENT-Req is used by RRC to request MAC to perform measurements, e.g. traffic volume measurements;

- CMAC-MEASUREMENT-Ind is used to notify RRC of the measurement result.

CMAC-STATUS-Ind:

- CMAC-STATUS-Ind primitive notifies RRC of status information.

8.3.2 Parameters

See [7] for a detailed description of the UE, RB and TrCH information elements.

a) UE information elements
S-RNTI
SRNC identity
C-RNTI
Activation time

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 32

Primary E-RNTI configured
Secondary E-RNTI configured

b) RB information elements
RB multiplexing info (Transport channel identity, Logical channel identity, MAC logical channel priority)
DDI mapping table for E-DCH transmission
Indication whether the Logical channel is considered when the Scheduling Information is generated

c) TrCH information elements
Transport Format Combination Set
MAC-hs reset indicator
Re-ordering release timer (T1)
HARQ Profile parameters (power offset, maximum number of re-transmissions)
E-DCH TTI duration
Allowed combinations for multiplexing of MAC-d flows into MAC-e PDUs
E-DCH grant type of MAC-d flows (scheduled or non-scheduled)
List of HARQ processes on which non-scheduled grants are allowed (if the grant type is non-scheduled and the E-DCH TTI duration is 2ms)

d) Measurement information elements
Reporting Quantity identifiers
Time interval to take an average or a variance (applicable when Average or Variance is Reporting Quantity)

e) Measurement result
Reporting Quantity

f) Status info
when set to value ""transmission unsuccessful"" this parameter indicates to RRC that transmission of a TM RLC PDU failed (due to e.g. Maximum number of preamble ramping cycles reached for RACH in FDD), when set to value "transmission successful" this parameter indicates to RRC that the requested TM RLC PDU(s) has been submitted for transmission by the physical layer.

g) RACH transmission control elements
Set of ASC parameters (identifier for PRACH partitions, persistence values)
Maximum number of preamble ramping cycles (FDD) or synchronisation attempts (1.28 Mcps TDD) M_{max}
Minimum and maximum number of time units between two preamble ramping cycles, N_{BO1min} and N_{BO1max} (FDD only)
ASC for RRC CONNECTION REQUEST message

h) Ciphering elements
Ciphering mode
Ciphering key
Ciphering sequence number

i) (Void)

j) MBMS information elements
MBMS Id

k) E-DCH configuration elements
E-DPCCH to DPCCH power offset
Happy bit delay condition
E-TFCI table index
minimum set E-TFCI
Reference E-TFCI
Periodicities for Scheduling Information with and without grant
Scheduling Information power offset
List of HARQ processes on which scheduled grants are allowed (if the E-DCH TTI duration is 2ms)
Initial Serving Grant value and type

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 33

9 Elements for peer-to-peer communication

9.1 Protocol data units

9.1.1 General

A MAC PDU is a bit string, with a length not necessarily a multiple of 8 bits. In the drawings in clause 9.1, bit strings are represented by tables in which the first bit is the leftmost one on the first line of the table, the last bit is the rightmost on the last line of the table, and more generally the bit string is to be read from left to right and then in the reading order of the lines.

Depending on the provided service, MAC SDUs are bit strings with any non-null length, or bit strings with an integer number of octets in length. An SDU is included into a MAC PDU from first bit onward.

In the UE for the uplink, all MAC PDUs delivered to the physical layer within one TTI are defined as Transport Block Set (TBS). It consists of one or several Transport Blocks, each containing one MAC PDU. The Transport Blocks, shall be transmitted in the order as delivered from RLC. When multiplexing of RLC PDUs from different logical channels is performed on MAC, the order of all Transport Blocks originating from the same logical channel shall be the same as the order of the sequence delivered from RLC. The order of the different logical channels in a TBS is set by the MAC protocol.

9.1.2 MAC PDU (not HS-DSCH or E-DCH)

A MAC PDU consists of an optional MAC header and a MAC Service Data Unit (MAC SDU), see figure 9.1.2.1. Both the MAC header and the MAC SDU are of variable size.

The content and the size of the MAC header depends on the type of the logical channel, and in some cases none of the parameters in the MAC header are needed.

The size of the MAC-SDU depends on the size of the RLC-PDU, which is defined during the setup procedure.

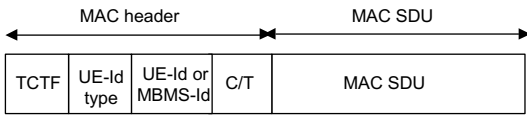

Figure 9.1.2.1: MAC PDU

9.1.3 MAC-d PDU (HS-DSCH)

For HS-DSCH the MAC-d PDU format equals the MAC PDU format for the non HS-DSCH case.

9.1.4 MAC PDU (HS-DSCH)

In case of HS-DSCH a MAC PDU consists of one MAC-hs header and one or more MAC-hs SDUs where each MAC-hs SDU equals a MAC-d PDU. A maximum of one MAC-hs PDU can be transmitted in a TTI per UE. The MAC-hs header is of variable size. The MAC-hs SDUs in one TTI belongs to the same reordering queue.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 34

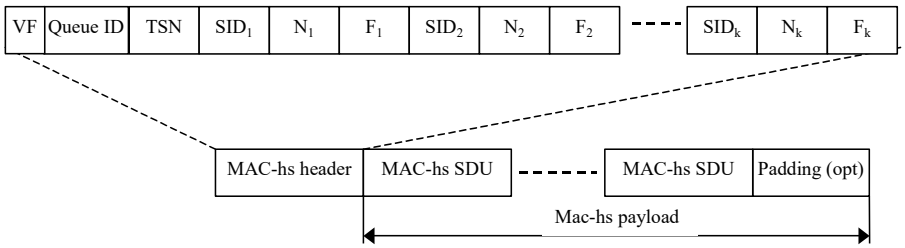

Figure 9.1.4.1: MAC-hs PDU

9.1.5 MAC PDU (E-DCH)

In the case of E-DCH there are two MAC sublayers, MAC-e and MAC-es. MAC-es sits on top of MAC-e and receives PDUs directly from MAC-d. MAC-es SDUs (i.e. MAC-d PDUs) of the same size, coming from a particular logical channel can be multiplexed together into a single MAC-es payload. To this payload is prepended the MAC-es header (see subclause 9.2.4.1). The number of PDUs, as well as the DDI value identifying the logical channel, the MAC-d flow and the MAC-es SDU size are included as part of the MAC-e header. In case sufficient space is left in the E-DCH transport block or if Scheduling Information needs to be transmitted, an SI will be included at the end of the MAC-e PDU (see subclause 9.2.4.2). Multiple MAC-es PDUs, but only one MAC-e PDU can be transmitted in a TTI.

In the example MAC-e PDU shown in figure 9.1.5.2, the field DDI_0 is referring to the specific DDI value that indicates that there is an SI included in the MAC-e PDU (see subclause 9.2.4.2). This header will not be associated with a new MAC-es payload.

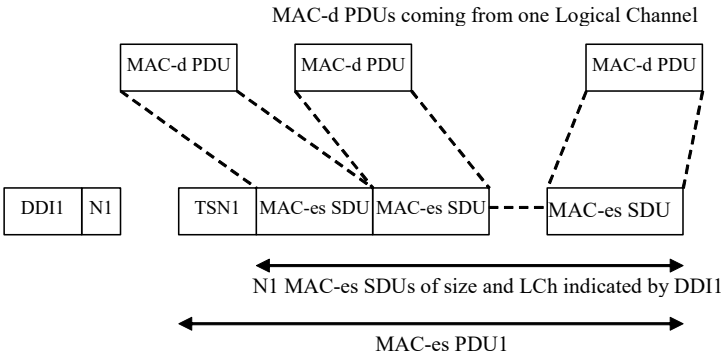

Figure 9.1.5.1 MAC-es PDU

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 35

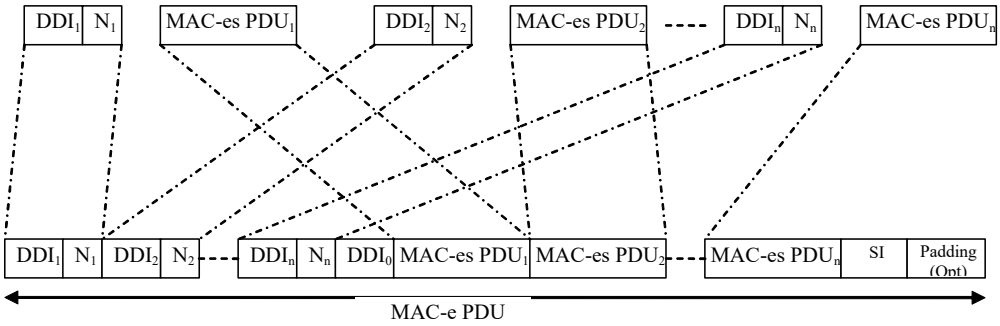

Figure 9.1.5.2: MAC-e PDU

9.2 Formats and parameters

NOTE: MAC header field encodings as specified in this clause with designation "Reserved" are forbidden to be used by a sender in this version of the protocol.

9.2.1 MAC PDU: Parameters of the MAC PDU header (not HS-DSCH or E-DCH) and MAC-d PDU header (HS-DSCH and E-DCH)

The following fields are defined for the MAC header for transport channels other than HS-DSCH and for the MAC-d PDU header for HS-DSCH:

- Target Channel Type Field
  The TCTF field is a flag that provides identification of the logical channel class on FACH, USCH (TDD only), DSCH (TDD only) and RACH transport channels, i.e. whether it carries BCCH, CCCH, CTCH, SHCCH, MCCH, MTCH, MSCH or dedicated logical channel information. The size and coding of TCTF for FDD and TDD are shown in tables 9.2.1.1, 9.2.1.2, 9.2.1.3, 9.2.1.4 and 9.2.1.5. Note that the size of the TCTF field of FACH for FDD is 2,4 or 8 bits and for TDD is either 3 or 5 bits depending on the value of the 3 most significant bits. The TCTF of the RACH for TDD is either 2 or 4 bits depending on the value of the 2 most significant bits.

Table 9.2.1.1: Coding of the Target Channel Type Field on FACH for TDD

TCTF	Designation
000	BCCH
001	CCCH
010	CTCH
01100	DCCH or DTCH over FACH
01101	MCCH
01110	MTCH
01111	MSCH
100	SHCCH
101-111	Reserved (PDUs with this coding will be discarded by this version of the protocol)

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 36

Table 9.2.1.2: Coding of the Target Channel Type Field on FACH for FDD

TCTF	Designation
00	BCCH
01000000	CCCH
01000001-01001111	Reserved (PDUs with this coding will be discarded by this version of the protocol)
01010000	MCCH
01010001-01011110	Reserved (PDUs with this coding will be discarded by this version of the protocol)
01011111	MSCH
0110	MTCH
0111	Reserved (PDUs with this coding will be discarded by this version of the protocol)
10000000	CTCH
10000001-10111111	Reserved (PDUs with this coding will be discarded by this version of the protocol)
11	DCCH or DTCH over FACH

Table 9.2.1.3: Coding of the Target Channel Type Field on USCH or DSCH (TDD only)

TCTF	Designation
0	SHCCH
1	DCCH or DTCH over USCH or DSCH

Table 9.2.1.4: Coding of the Target Channel Type Field on RACH for FDD

TCTF	Designation
00	CCCH
01	DCCH or DTCH over RACH
10-11	Reserved (PDUs with this coding will be discarded by this version of the protocol)

Table 9.2.1.5: Coding of the Target Channel Type Field on RACH for TDD

TCTF	Designation
00	CCCH
0100	DCCH or DTCH Over RACH
0101-0111	Reserved (PDUs with this coding will be discarded by this version of the protocol)
10	SHCCH
11	Reserved (PDUs with this coding will be discarded by this version of the protocol)

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 37

- C/T field
  The C/T field provides identification of the logical channel instance when multiple logical channels are carried on the same transport channel (other than HS-DSCH) or same MAC-d flow (HS-DSCH). The C/T field is used also to provide identification of the logical channel type on dedicated transport channels and on FACH and RACH when used for user data transmission. The size of the C/T field is fixed to 4 bits for both common transport channels and dedicated transport channels. Table 9.2.1.5a shows the 4-bit C/T field.

Table 9.2.1.5a: Structure of the C/T field

C/T field	Designation
0000	Logical channel 1
0001	Logical channel 2
...	...
1110	Logical channel 15
1111	Reserved (PDUs with this coding will be discarded by this version of the protocol)

- UE-Id
  The UE-Id field provides an identifier of the UE on common transport channels. The following types of UE-Id used on MAC are defined:

  - UTRAN Radio Network Temporary Identity (U-RNTI) may be used in the MAC header of DCCH using RLC UM (SRB1), when mapped onto common transport channels in downlink direction; the U-RNTI is never used in uplink direction;

  - Cell Radio Network Temporary Identity (C-RNTI) is used on DTCH and DCCH in uplink, and may be used on DCCH in downlink and is used on DTCH in downlink when mapped onto common transport channels, except when mapped onto DSCH transport channel in TDD;

Table 9.2.1.6: Lengths of UE Id field

UE Id type	Length of UE Id field
U-RNTI	32 bits
C-RNTI	16 bits

- UE-Id Type
  The UE-Id Type field is needed to ensure correct decoding of the UE-Id field in MAC Headers.

Table 9.2.1.7: UE-Id Type field definition

UE-Id Type field 2 bits	UE-Id Type
00	U-RNTI
01	C-RNTI
10	Reserved (PDUs with this coding will be discarded by this version of the protocol)
11	Reserved (PDUs with this coding will be discarded by this version of the protocol)

  - MBMS-Id
    The MBMS-Id field provides an identifier of MTCH for an MBMS service carried on FACH. The MBMS-Id is used in the MAC header of MTCH mapped onto FACH in downlink direction; the MBMS-Id is never used in uplink direction. The MBMS Id to be used by MAC is configured through the MAC control SAP. The length of the MBMS-Id field is 4 bits. Table 9.2.1.7a shows the 4-bit MBMS-Id field.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 38

Table 9.2.1.8: Structure of the MBMS-Id field

MBMS-Id field	Designation
0000	MBMS service 1
0001	MBMS service 2
...	...
1110	MBMS service 15
1111	Reserved (PDUs with this coding will be discarded by this version of the protocol)

9.2.1.1 MAC header for DTCH and DCCH (not mapped on HS-DSCH or E-DCH)

a) DTCH or DCCH mapped to DCH, no multiplexing of dedicated channels on MAC:

- no MAC header is required.

b) DTCH or DCCH mapped to DCH, with multiplexing of dedicated channels on MAC:

- C/T field is included in MAC header.

c) DTCH or DCCH mapped to RACH/FACH:

- TCTF field, C/T field, UE-Id type field and UE-Id are included in the MAC header. For FACH, the UE-Id type field used is the C-RNTI or U-RNTI. For RACH, the UE-Id type field used is the C-RNTI.

d) DTCH or DCCH mapped to DSCH or USCH:

- the TCTF field is included in the MAC header. The C/T field is included if multiplexing on MAC is applied.

e) DTCH or DCCH mapped to DSCH or USCH where DTCH or DCCH are the only logical channels:

- The C/T field is included in the MAC header if multiplexing on MAC is applied.

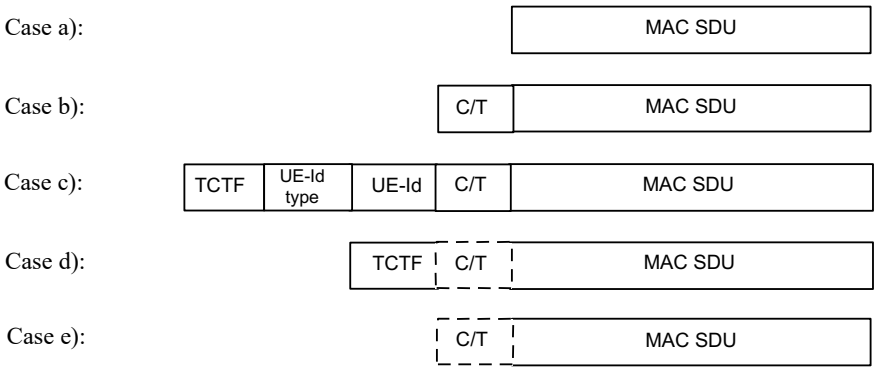

Figure 9.2.1.1.1: MAC PDU formats for DTCH and DCCH

9.2.1.1a MAC-d Header for DTCH and DCCH (mapped on HS-DSCH)

The MAC-d PDU header for DTCH and DCCH mapped on HS-DSCH is as shown in figure 9.2.1.1a.1.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 39

- C/T field is included in the MAC-d PDU header if multiplexing on MAC is applied.

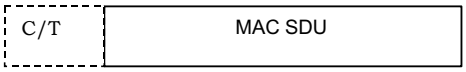

Figure 9.2.1.1a.1 MAC-d PDU format for DTCH and DCCH mapped on HS-DSCH

9.2.1.1b MAC-d Header for DTCH and DCCH (mapped on E-DCH)

For DTCH and DCCH mapped on E-DCH there is no need for a MAC-d header. Therefore, the MAC-d PDU is as shown in figure 9.2.1.1b.1.

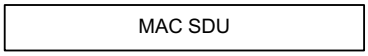

Figure 9.2.1.1b.1 MAC-d PDU format for DTCH and DCCH mapped on E-DCH

9.2.1.2 MAC header for BCCH

a) BCCH mapped to BCH:

- no MAC header is included.

b) BCCH mapped to FACH:

- the TCTF field is included in MAC header.

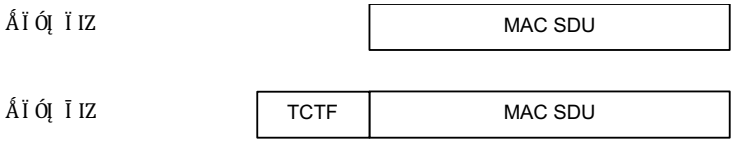

Figure 9.2.1.2.1: MAC PDU formats for BCCH

9.2.1.3 MAC header for PCCH

There is no MAC header for PCCH.

9.2.1.4 MAC header for CCCH

CCCH mapped to RACH/FACH:

- TCTF field is included in MAC header.

Figure 9.2.1.4.1: MAC PDU formats for CCCH

9.2.1.5 MAC Header for CTCH

The TCTF field is included as MAC header for CTCH as shown in figure 9.2.1.5.1.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 40

TCTF	MAC SDU

Figure 9.2.1.5.1: MAC PDU format for CTCH

9.2.1.6 MAC Header for SHCCH

The MAC header for SHCCH is as shown in figure 9.2.1.6.1.

a) SHCCH mapped to RACH and USCH/FACH and DSCH:

- TCTF has to be included.

b) SHCCH mapped to RACH and USCH/FACH and DSCH, where SHCCH is the only channel.

Case a):

TCTF	MAC SDU

Case b):

MAC SDU

Figure 9.2.1.6.1: MAC PDU format for SHCCH

9.2.1.7 MAC Header for MCCH

The MAC PDU format for MCCH is as shown in figure 9.2.1.7.1.

a) If the MAC header for MCCH is not configured through the MAC control SAP:

- there is no MAC header for MCCH.

b) If the MAC header for MCCH is configured through the MAC control SAP:

- TCTF field is included in the MAC header for MCCH.

NOTE: If MCCH is not the only channel on the FACH, the MAC header shall be configured for the MCCH.

ÅÏ Ó¡ Ï IZ

MAC SDU

ÅÏ Ó¡ Ï IZ

TCTF	MAC SDU

Figure 9.2.1.7.1: MAC PDU format for MCCH

9.2.1.8 MAC Header for MTCH

The TCTF field and MBMS-Id field are included in the MAC header for MTCH as shown in figure 9.2.1.8.1.

TCTF	MBMS-Id	MAC SDU

Figure 9.2.1.8.1: MAC PDU format for MTCH

9.2.1.9 MAC Header for MSCH

The MAC PDU format for MSCH is as shown in figure 9.2.1.9.1.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 41

a) If the MAC header for MSCH is not configured through the MAC control SAP:

- there is no MAC header for MSCH.

b) If the MAC header for MSCH is configured through the MAC control SAP:

- TCTF field is included in the MAC header for MSCH.

NOTE: If MSCH is not the only channel on the FACH, the MAC header shall be configured for the MSCH.

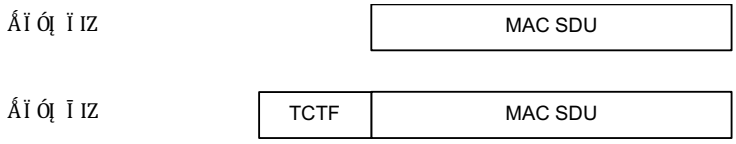

Figure 9.2.1.9.1: MAC PDU format for MSCH

9.2.2 MAC PDU: Parameters of the MAC header (HS-DSCH)

- Version Flag (VF):
  The VF field is a one bit flag providing extension capabilities of the MAC-hs PDU format. The VF field shall be set to zero and the value one is reserved in this version of the protocol.

- Queue identifier (Queue ID):
  The Queue ID field provides identification of the reordering queue in the receiver, in order to support independent buffer handling of data belonging to different reordering queues. The length of the Queue ID field is 3 bit.

- Transmission Sequence Number (TSN):
  The TSN field provides an identifier for the transmission sequence number on the HS-DSCH. The TSN field is used for reordering purposes to support in-sequence delivery to higher layers. The length of the TSN field is 6 bit.

- Size index identifier (SID):
  The SID fields identifies the size of a set of consecutive MAC-d PDUs. The MAC-d PDU size for a given SID is configured by higher layers and is independent for each Queue ID. The length of the SID field is 3 bit.

- Number of MAC-D PDUs (N):
  The number of consecutive MAC-d PDUs with equal size is identified with the N field. The length of the N field is 7 bits. In FDD mode, the maximum number of PDUs transmitted in a single TTI shall be assumed to be 70. In 1.28 Mcps TDD mode, the maximum number of PDUs transmitted in a single TTI shall be assumed to be 45. In 3.84 Mcps TDD mode, the maximum number of PDUs transmitted in a single TTI shall be assumed to be 318. If more PDUs than the defined maximum number of PDUs for the corresponding mode are received, the UE behaviour is unspecified.

- Flag (F):
  The F field is a flag indicating if more fields are present in the MAC-hs header or not. If the F field is set to "0" the F field is followed by an additional set of SID, N and F fields. If the F field is set to "1" the F field is followed by a MAC-d PDU. The maximum number of MAC-hs header extensions, i.e. number of fields F set to “0”, in a single TTI shall be assumed to be 7. If more extensions than the maximum defined for the corresponding mode are included in a TTI, the UE behaviour is unspecified.

9.2.2.1 MAC header for DTCH and DCCH

a) DTCH or DCCH mapped to HS-DSCH:

- The Queue ID field and TSN field are always included in the MAC-hs header. One SID field, N field and F field is included for each MAC-d PDU size included in the MAC-hs PDU. Padding is not explicitly indicated but is included in the end of the MAC-hs PDU if the total size of the MAC-hs payload plus the MAC-hs header is smaller than the transport block set size.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 42

9.2.3 Signalling of Transport Block size for HS-DSCH

For HS-DSCH the transport block size is derived from the TFRI value signalled on the HS-SCCH. The mapping between the TFRI value and the transport block size for each mode is specified below:

9.2.3.1 Transport block size for FDD

For all transmissions of a transport block, the transport block size is derived from the TFRI value as specified below, except only in those cases of retransmissions where the Node-B selects a combination for which no mapping exists between the original transport block size and the selected combination of channelisation Code set and modulation type. In such cases, the transport block size index value signalled to the UE shall be set to 111111, i.e., k_i=63.

Let k_i be the TFRI signalled on the HS-SCCH value and let $k_{0,i}$ be the value in the table 9.2.3.1 corresponding to the modulation and the number of codes signalled on the HS-SCCH. Let k_t be the sum of the two values: $k_t = k_i + k_{0,i}$. The transport block size $L(k_t)$ can be obtained by accessing the position k_t in the table in Annex A (normative) or by using the formula below (informative):

If $k_t < 40$

$$L(k_t) = 125 + 12 \cdot k_t$$

else

$$L(k_t) = \lfloor L_{\min} p^{k_t} \rfloor$$
$$p = 2085 / 2048$$
$$L_{\min} = 296$$

end

Table 9.2.3.1: Values of $k_{0,i}$ for different numbers of channelization codes and modulation schemes

Combination *i*	Modulation scheme	Number of channelization codes	$k_{0,i}$
0	QPSK	1	1
1		2	40
2		3	63
3		4	79
4		5	92
5		6	102
6		7	111
7		8	118
8		9	125
9		10	131
10		11	136
11		12	141
12		13	145
13		14	150
14		15	153
15	16QAM	1	40
16		2	79
17		3	102
18		4	118
19		5	131
20		6	141

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 43

21		7	150
22		8	157
23		9	164
24		10	169
25		11	175
26		12	180
27		13	184
28		14	188
29		15	192

9.2.3.2 Transport block size for 3.84 Mcps TDD

Let k be the signalled TFRI value, then the corresponding HS-DSCH transport block size L_k is given by :

If k=1..510

$$L_k = \lfloor L_{\min} p^k \rfloor$$

$$p = \frac{8313}{8192}$$

$$L_{\min} = 57$$

If k = 511

L_k = 102000

If k=0, L_k indicates NULL and shall not be used to signal a transport block size in the TFRI.

Transport block sizes calculated by this formula shall equal the values indicated in Table 9.2.3.2.1

Table 9.2.3.2.1: HSDPA Transport Block Sizes for 3.84 Mcps TDD

TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]
0	NULL	128	372	256	2432	384	15890
1	57	129	377	257	2468	385	16124
2	58	130	383	258	2504	386	16362
3	59	131	389	259	2541	387	16604
4	60	132	394	260	2579	388	16849
5	61	133	400	261	2617	389	17098
6	62	134	406	262	2656	390	17351
7	63	135	412	263	2695	391	17607
8	64	136	418	264	2735	392	17867
9	65	137	424	265	2775	393	18131
10	66	138	431	266	2816	394	18399
11	66	139	437	267	2858	395	18671
12	67	140	443	268	2900	396	18946
13	68	141	450	269	2943	397	19226
14	69	142	457	270	2986	398	19510
15	71	143	463	271	3030	399	19798
16	72	144	470	272	3075	400	20091
17	73	145	477	273	3121	401	20388

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 44

18	74	146	484	274	3167	402	20689
19	75	147	491	275	3213	403	20994
20	76	148	499	276	3261	404	21304
21	77	149	506	277	3309	405	21619
22	78	150	514	278	3358	406	21938
23	79	151	521	279	3408	407	22263
24	81	152	529	280	3458	408	22591
25	82	153	537	281	3509	409	22925
26	83	154	545	282	3561	410	23264
27	84	155	553	283	3613	411	23607
28	85	156	561	284	3667	412	23956
29	87	157	569	285	3721	413	24310
30	88	158	578	286	3776	414	24669
31	89	159	586	287	3832	415	25033
32	91	160	595	288	3888	416	25403
33	92	161	604	289	3946	417	25778
34	93	162	613	290	4004	418	26159
35	95	163	622	291	4063	419	26545
36	96	164	631	292	4123	420	26938
37	98	165	640	293	4184	421	27335
38	99	166	650	294	4246	422	27739
39	100	167	659	295	4309	423	28149
40	102	168	669	296	4372	424	28565
41	103	169	679	297	4437	425	28987
42	105	170	689	298	4502	426	29415
43	107	171	699	299	4569	427	29849
44	108	172	709	300	4636	428	30290
45	110	173	720	301	4705	429	30738
46	111	174	730	302	4774	430	31192
47	113	175	741	303	4845	431	31652
48	115	176	752	304	4916	432	32120
49	116	177	763	305	4989	433	32594
50	118	178	775	306	5063	434	33076
51	120	179	786	307	5138	435	33564
52	122	180	798	308	5213	436	34060
53	123	181	809	309	5290	437	34563
54	125	182	821	310	5369	438	35074
55	127	183	834	311	5448	439	35592
56	129	184	846	312	5528	440	36117
57	131	185	858	313	5610	441	36651
58	133	186	871	314	5693	442	37192
59	135	187	884	315	5777	443	37742
60	137	188	897	316	5862	444	38299
61	139	189	910	317	5949	445	38865
62	141	190	924	318	6037	446	39439
63	143	191	937	319	6126	447	40021
64	145	192	951	320	6217	448	40613
65	147	193	965	321	6308	449	41212
66	150	194	980	322	6402	450	41821
67	152	195	994	323	6496	451	42439
68	154	196	1009	324	6592	452	43066

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 45

69	156	197	1024	325	6689	453	43702
70	159	198	1039	326	6788	454	44347
71	161	199	1054	327	6889	455	45002
72	163	200	1070	328	6990	456	45667
73	166	201	1085	329	7094	457	46342
74	168	202	1101	330	7198	458	47026
75	171	203	1118	331	7305	459	47721
76	173	204	1134	332	7413	460	48426
77	176	205	1151	333	7522	461	49141
78	178	206	1168	334	7633	462	49867
79	181	207	1185	335	7746	463	50603
80	184	208	1203	336	7860	464	51351
81	186	209	1221	337	7976	465	52109
82	189	210	1239	338	8094	466	52879
83	192	211	1257	339	8214	467	53660
84	195	212	1276	340	8335	468	54453
85	198	213	1294	341	8458	469	55257
86	201	214	1313	342	8583	470	56073
87	204	215	1333	343	8710	471	56901
88	207	216	1353	344	8839	472	57742
89	210	217	1373	345	8969	473	58595
90	213	218	1393	346	9102	474	59460
91	216	219	1413	347	9236	475	60338
92	219	220	1434	348	9373	476	61230
93	222	221	1456	349	9511	477	62134
94	226	222	1477	350	9652	478	63052
95	229	223	1499	351	9794	479	63983
96	232	224	1521	352	9939	480	64928
97	236	225	1543	353	10086	481	65887
98	239	226	1566	354	10235	482	66860
99	243	227	1589	355	10386	483	67848
100	246	228	1613	356	10539	484	68850
101	250	229	1637	357	10695	485	69867
102	254	230	1661	358	10853	486	70899
103	258	231	1685	359	11013	487	71946
104	261	232	1710	360	11176	488	73009
105	265	233	1736	361	11341	489	74087
106	269	234	1761	362	11508	490	75182
107	273	235	1787	363	11678	491	76292
108	277	236	1814	364	11851	492	77419
109	281	237	1840	365	12026	493	78563
110	285	238	1868	366	12204	494	79723
111	290	239	1895	367	12384	495	80901
112	294	240	1923	368	12567	496	82095
113	298	241	1952	369	12752	497	83308
114	303	242	1981	370	12941	498	84539
115	307	243	2010	371	13132	499	85787
116	312	244	2039	372	13326	500	87054
117	316	245	2070	373	13523	501	88340
118	321	246	2100	374	13722	502	89645
119	326	247	2131	375	13925	503	90969

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 46

120	331	248	2163	376	14131	504	92313
121	336	249	2195	377	14340	505	93676
122	340	250	2227	378	14551	506	95060
123	346	251	2260	379	14766	507	96464
124	351	252	2293	380	14984	508	97889
125	356	253	2327	381	15206	509	99335
126	361	254	2362	382	15430	510	100802
127	366	255	2397	383	15658	511	102000

9.2.3.3 Transport block size for 1.28 Mcps TDD

The mapping of transport block size, in bits, to TFRI value is dependent upon the UE's HS-DSCH capability class.

If k is the signalled TFRI value then the corresponding HS-DSCH transport block size L_k is given by:

If k = 1..62

$$L_k = \lfloor L_{\min} p^{k-1} \rfloor$$

where

$p = \frac{1340}{1269}$ if the HS-DSCH physical layer category is between 1 and 6 inclusively,

$p = \frac{1755}{1652}$ if the HS-DSCH physical layer category is between 7 and 12 inclusively,

$p = \frac{2345}{2196}$ if the HS-DSCH physical layer category is between 13 and 15 inclusively,

and

$$L_{\min} = 240$$

If k = 63 then,

L_k = 7008 if the HS-DSCH physical layer category is between 1 and 6 inclusively,

10204 if the HS-DSCH physical layer category is between 7 and 12 inclusively,

14043 if the HS-DSCH physical layer category is between 13 and 15 inclusively.

If k=0, L_k indicates NULL and shall not be used to signal a transport block size in the TFRI.

Transport block sizes calculated by this formula shall equal the values indicated in the following tables: –

Table 9.2.3.3.1: HSDPA Transport Block Sizes for 1.28 Mcps TDD, for HS-DSCH physical layer category [1,6]

TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]
0	NULL	16	543	32	1297	48	3100
1	240	17	573	33	1370	49	3274
2	253	18	605	34	1446	50	3457
3	267	19	639	35	1527	51	3650
4	282	20	675	36	1613	52	3854

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 47

5	298	21	712	37	1703	53	4070
6	315	22	752	38	1798	54	4298
7	332	23	794	39	1899	55	4538
8	351	24	839	40	2005	56	4792
9	370	25	886	41	2118	57	5060
10	391	26	936	42	2236	58	5344
11	413	27	988	43	2361	59	5643
12	436	28	1043	44	2493	60	5958
13	461	29	1102	45	2633	61	6292
14	487	30	1163	46	2780	62	6644
15	514	31	1228	47	2936	63	7008

Table 9.2.3.3.2: HSDPA Transport Block Sizes for 1.28 Mcps TDD, for HS-DSCH physical layer category [7,12]

TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]
0	NULL	16	594	32	1564	48	4118
1	240	17	631	33	1662	49	4375
2	254	18	671	34	1766	50	4648
3	270	19	712	35	1876	51	4938
4	287	20	757	36	1993	52	5246
5	305	21	804	37	2117	53	5573
6	324	22	854	38	2249	54	5920
7	344	23	908	39	2389	55	6289
8	366	24	964	40	2538	56	6681
9	389	25	1024	41	2697	57	7098
10	413	26	1088	42	2865	58	7541
11	439	27	1156	43	3043	59	8011
12	466	28	1228	44	3233	60	8510
13	495	29	1305	45	3435	61	9041
14	526	30	1386	46	3649	62	9605
15	559	31	1473	47	3877	63	10204

Table 9.2.3.3.3 : HSDPA Transport Block Sizes for 1.28 Mcps TDD, for HS-DSCH physical layer category [13,15]

TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]	TB index (k)	TB size [bits]
0	NULL	16	642	32	1836	48	5250
1	240	17	686	33	1961	49	5606
2	256	18	732	34	2094	50	5987
3	273	19	782	35	2236	51	6393
4	292	20	835	36	2388	52	6827
5	312	21	892	37	2550	53	7290
6	333	22	952	38	2723	54	7785
7	355	23	1017	39	2908	55	8313
8	380	24	1086	40	3105	56	8877
9	405	25	1160	41	3316	57	9479
10	433	26	1238	42	3541	58	10123
11	462	27	1322	43	3781	59	10809
12	494	28	1412	44	4037	60	11543
13	527	29	1508	45	4311	61	12326
14	563	30	1610	46	4604	62	13162
15	601	31	1719	47	4916	63	14043

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 48

9.2.4 MAC PDU: Parameters of the MAC header (E-DCH)

9.2.4.1 MAC-es header parameters

- Transmission Sequence Number (TSN):
  The TSN field provides the transmission sequence number for the MAC-es PDU. This information is used for reordering purposes to support in-sequence delivery to higher layers. The length of the TSN field is 6 bits.

9.2.4.2 MAC-e header parameters

- Data description indicator (DDI):
  The DDI field identifies the logical channel, MAC-d flow and size of the MAC-d PDUs concatenated into the associated MAC-es PDU. The mapping between the DDI values and the logical channel ID, MAC-d flow and PDU size is provided by higher layers. The length of the DDI field is 6 bits. When, due to the quantization in the transport block sizes that can be supported or triggering of the Scheduling Information, the size of the data plus header is less than or equal to the TB size of the E-TFC selected by the UE minus 24 bits, the DDI value [111111] shall be appended at the end of the MAC-e header to indicate that there is a Scheduling Information concatenated in this MAC-e PDU. If the size of the data plus header is less than or equal to the TB size of the E-TFC selected by the UE minus 18 bits, a Scheduling Information shall be concatenated into this MAC-e PDU. In any other case it is understood that another MAC-es PDU or Scheduling Information does not fit and it is therefore not necessary to reserve room in the transport block for an additional DDI field.

- Number of MAC-d PDUs (N):
  The number of consecutive MAC-d PDUs corresponding to the same DDI value. The length of the N field is 6 bits.

9.2.5 Signaling of control information for E-DCH

9.2.5.1 HARQ information

This control information is used in support of the uplink hybrid ARQ functionality.

- ACK/NACK information:
  Transmitted on downlink on the E-HICH from each cell in the E-DCH active set, the ACK/NACK information indicates the successful or un-successful decoding of the corresponding uplink transmission. This information allows the UE to know whether to make another transmission for the same MAC-e PDU or to start the transmission of a new one. The length of the ACK/NACK field is 1 bit.

- RSN:
  Transmitted on the E-DPCCH, the RSN is used to convey the uplink HARQ transmission number. Because of the limitation in the field size, the RSN saturates to the maximum value once that is reached. The combination of the RSN and the transmission timing allows the receiver to determine the exact transmission number (see [16]). The length of the RSN field is 2 bits.

9.2.5.2 DL Scheduling information

This control information is used by Node-Bs in a UE's E-DCH active set in order to control its use of E-DCH system resources.

9.2.5.2.1 Relative Grants

- Serving Relative Grant:
  Transmitted on downlink on the E-RGCH from all cells in the serving E-DCH RLS, the serving relative grant allows the Node B scheduler to incrementally adjust the serving grant of UEs under its control. By definition, there can only be one serving relative grant command received at any one time. This indication can take three different values, "UP", "DOWN" or "HOLD".

- Non-serving Relative Grant:
  Transmitted on downlink on the E-RGCH from a non-serving E-DCH RL, the non-serving relative grant allows neighboring Node Bs to adjust the transmitted rate of UEs that are not under their control in order to avoid

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 49

overload situations. By definition, there could be multiple non-serving relative grant commands received by MAC at any time. This indication can take two different values, "DOWN" or "HOLD".

The handling of the Relative Grant signalling is based on the Scheduling Grant table shown in Table 9.2.5.2.1.1.

Table 9.2.5.2.1.1: Scheduling Grant Table (SG-table)

Index	Scheduled Grant
37	$(168/15)^2*6$
36	$(150/15)^2*6$
35	$(168/15)^2*4$
34	$(150/15)^2*4$
33	$(134/15)^2*4$
32	$(119/15)^2*4$
31	$(150/15)^2*2$
30	$(95/15)^2*4$
29	$(168/15)^2$
28	$(150/15)^2$
27	$(134/15)^2$
26	$(119/15)^2$
25	$(106/15)^2$
24	$(95/15)^2$
23	$(84/15)^2$
22	$(75/15)^2$
21	$(67/15)^2$
20	$(60/15)^2$
19	$(53/15)^2$
18	$(47/15)^2$
17	$(42/15)^2$
16	$(38/15)^2$
15	$(34/15)^2$
14	$(30/15)^2$
13	$(27/15)^2$
12	$(24/15)^2$
11	$(21/15)^2$
10	$(19/15)^2$
9	$(17/15)^2$
8	$(15/15)^2$
7	$(13/15)^2$
6	$(12/15)^2$
5	$(11/15)^2$
4	$(9/15)^2$
3	$(8/15)^2$
2	$(7/15)^2$
1	$(6/15)^2$
0	$(5/15)^2$

When the Serving_Grant needs to be determined due to E-RGCH signalling (see subsection 11.8.1.3.2), the UE shall:

- Determine the lowest power ratio in the SG-table (table 9.2.5.2.1.1) that is equal or higher to the reference_ETPR, and determine the corresponding index in the SG-table: $SG_{LUPR;}$
- If the UE received a Serving Relative Grant “UP”,determine the Serving_Grant as follows:
  - Serving_Grant = $SG[MIN(SG_{LUPR} + 1 , 37)]$.
- If the UE received a Serving Relative Grant “DOWN”, determine the Serving_Grant:
  - Serving_Grant = $SG[MAX(SG_{LUPR} -1 , 0)]$.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 50

- If the UE received a Non-serving Relative Grant “DOWN”, determine the Serving_Grant:
  - Serving_Grant = SG[MAX(SG_{LUPR} -1 , 0)].

9.2.5.2.2 Absolute Grant

The absolute grant message is sent on downlink, on the configured E-AGCH, from the serving E-DCH cell and allows the Node B scheduler to directly adjust the granted rate of UEs under its control.

The E-AGCH is a shared channel that uses an E-RNTI specific CRC in order to address messages to specific users (see [6]). The RRC may configure the MAC-e with two different E-RNTIs, one primary and one secondary. Based on the identity that is used, the following information will be conveyed implicitly when an absolute grant message is received:

- Identity Type:
  This variable will take the value "Primary" or "Secondary" respectively based on whether the message was addressed to the primary or the secondary E-RNTI.

The absolute grant message itself includes multiple fields that are multiplexed together into 6 bits inside the MAC-e of the Node B and then submitted to the physical layer for transmission on the E-AGCH. These fields are:

- Absolute Grant Value:
  This field indicates the maximum E-DCH traffic to pilot ratio (E-DPDCH/DPCCH) that the UE is allowed to use in the next transmission. The length of the Absolute Grant Value field is [5] bits.

- Absolute Grant Scope:
  This field indicates the applicability of the Absolute Grant. It can take two different values, "Per HARQ process" or "All HARQ processes", allowing to indicate whether the HARQ process activation/de-activation will affect one or all processes. The Absolute Grant Scope is encoded in 1 bit. When the E-DCH is configured with 10ms TTI, only the value "All HARQ processes" is valid (see subclause 10).

9.2.5.3 UL Scheduling information

This control information is used by UEs to indicate to their serving E-DCH Node-B the amount of resources they require.

9.2.5.3.1 Happy Bit

The happy bit is a single bit field that is passed from MAC to the physical layer for inclusion on the E-DPCCH. This field takes two values, “Not Happy” and “Happy” indicating respectively whether the UE could use more resources or not. The setting of the Happy Bit is defined in subclause 11.8.1.5.

9.2.5.3.2 Scheduling Information

The Scheduling Information is located at the end of the MAC-e PDU and is used to provide the serving Node B with a better view of the amount of system resources needed by the UE and the amount of resources it can actually make use of. The transmission of this information will be initiated due to the quantization of the transport block sizes that can be supported or based on the triggers defined in subclause 11.8.1.6. When a Scheduling Information is transmitted, its contents shall always be updated. The logical channels for which a non-scheduled grant is configured shall never be taken into account when putting together this information. In addition, the RRC may restrict applicability for logical channels for which no non-scheduled grant was configured.

This information includes the following fields:

- Highest priority Logical channel ID (HLID):
  The HLID field identifies unambiguously the highest priority logical channel with available data. If multiple logical channels exist with the highest priority, the one corresponding to the highest buffer occupancy will be reported. The length of the HLID is 4 bits. In case the TEBS is indicating index 0 (0 bits), the HLID shall indicate the value "0000".

- Fields related to amount of available data:
  - Total E-DCH Buffer Status (TEBS):
    The TEBS field identifies the total amount of data available across all logical channels for which reporting

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 51

has been requested by the RRC. The reported total amount of data available across all logical channels for which reporting has been requested by RRC shall be rounded up to the nearest TEBS value. The length of this field is 5 bits. The values taken by TEBS are shown in Table 9.2.5.3.2-1.

Table 9.2.5.3.2-1: TEBS Values

Index	TEBS Value (bits)
0	0
1	80
2	100
3	123
4	153
5	189
6	234
7	290
8	360
9	446
10	552
11	684
12	848
13	1051
14	1303
15	1614
16	2000
17	2479
18	3073
19	3808
20	4719
21	5849
22	7248
23	8983
24	11133
25	13798
26	17100
27	21193
28	26266
29	32553
30	40344
31	50000

- Highest priority Logical channel Buffer Status (HLBS):

  The HLBS field indicates the amount of data available from the logical channel identified by HLID, relative to the buffer size reported by TEBS. The reported relative amount of data available from the logical channel identified by HLID shall be rounded up to the nearest HLBS value. The length of HLBS is 4 bits. The values taken by HLBS are shown in table 9.2.5.3.2-2. In case the TEBS field is indicating index 0 (0 bits), the HLBS field shall indicate index 0.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 52

Table 9.2.5.3.2-2: HLBS Values

Index	HLBS values (%)
0	5
1	7
2	8
3	10
4	12
5	14
6	17
7	21
8	25
9	31
10	37
11	45
12	55
13	68
14	82
15	100

- UE Power Headroom (UPH):
  The UPH field indicates the ratio of the maximum UE transmission power and the corresponding DPCCH code power defined in [17].. The length of UPH is [4 or 5] bits.

9.2.5.4 Transport block size

RRC can configure the MAC-e to use one of two Transport block size sets for each TTI duration. The normative description of the mapping between the E-TFC index and the corresponding transport block size is provided in Annex B:

- If the UE is configured with E-TFCI table 0 (see [7]) and 2ms TTI, it shall use the mapping defined in Annex B.1
- If the UE is configured with E-TFCI table 1 (see [7]) and 2ms TTI, it shall use the mapping defined in Annex B.2
- If the UE is configured with E-TFCI table 0 (see [7]) and 10ms TTI, it shall use the mapping defined in Annex B.3
- If the UE is configured with E-TFCI table 1 (see [7]) and 10ms TTI, it shall use the mapping defined in Annex B.4

The mapping in Transport block size table 0 for 2ms TTI (see table in Annex B.1) can also be obtained using the formula below.

Let k be the chosen E-TFC index, then the corresponding E-DCH transport block size L_k is given by the following formula (informative):

$$L_0 = 18$$

$$\textit{if } k = 0..126$$

$$L_{k+1} = \lfloor 120 * (\rho)^k \rfloor$$

$$\textit{where}$$

$$\rho = \left(\frac{11484}{120}\right)^{\frac{1}{127-1}}$$

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 53

The mapping in Transport block size table 0 for 10ms TTI (see table in Annex B.3) can also be obtained using the formula below.

Let k be the chosen E-TFC index, then the corresponding E-DCH transport block size L_k is given by the following formula (informative):

$$L_0 = 18$$
$$if\ \ k = 0..126$$
$$L_{k+1} = \lfloor 120 * (\rho)^k \rfloor$$
$$where$$
$$\rho = \left(\frac{20000}{120}\right)^{\frac{1}{127-1}}$$

10 Handling of unknown, unforeseen and erroneous protocol data

The list of error cases is reported below:

a) Use of reserved coding in the MAC header

If the MAC entity receives a MAC PDU with a header field using a value marked as reserved for this version of the protocol, it shall discard the PDU, unless explicitly mentioned otherwise.

b) Inconsistent MAC header

If the MAC entity receives a MAC PDU with a header inconsistent with the configuration received from RRC, it shall discard the PDU. E.g.: In case DTCH is mapped to RACH/FACH, the MAC entity shall discard a PDU with a C/T field indicating a logical channel number that is not configured.

c) Erroneous MAC header fields

The MAC PDU shall be discarded if the lower layer gives an error indication for a MAC PDU and a MAC header is included in the MAC PDU.

d) Inconsistent information received on MAC control channels

If the MAC entity receives inconsistent information on the E-AGCH, it shall ignore the entire message. The following conditions constitute inconsistent information:

- The Absolute Grant Scope is "Per HARQ process" and the E-DCH TTI is configured to 10ms.
- The Identity Type is "Secondary" and the Absolute Grant Value is "INACTIVE".

11 Specific functions

11.1 Traffic volume measurement for dynamic radio bearer control

Dynamic radio bearer control is performed by RRC, based on the traffic volume measurements reported by MAC. Traffic volume information is measured in MAC layer and the results are reported from MAC layer to RRC layer.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 54

At least every TTI, the MAC layer shall receive from each RLC entity the value of its Buffer Occupancy (BO), expressed in bytes. RRC can configure MAC to keep track of statistics (i.e. raw BO, average of BO and variance of BO) on the BO (see [7]) values of all Radio Bearers mapped onto a given transport channel. When the average or variance are requested, an averaging interval duration will also be provided.

Every time the BO values are reported to MAC, the UE shall verify whether an event was triggered or if a periodic report is required (see [7]). If reporting is required (multiple reports may be triggered in a single TTI), the MAC shall deliver to RRC the reporting quantities required for the corresponding RBs. In the case of average and variance of BO, the averaging should be performed for the interval with the configured duration ending at the time when the event was triggered.

RRC requests MAC measurement report with the primitive CMAC-Measure-REQ including following parameters.

Measurement information elements.

- Reporting Quantity identifiers
  Indicates what should be reported to RRC layer
  For each RB, BO (optional), Average of BO (optional), or Variance of BO(optional)

- Time interval to take an average or a variance (applicable when Average or Variance is Reporting Quantity)
  Indicates time interval to take an average or a variance of BO
  The calculation of average and variance of BO shall be based on one sample of BO per 10ms during the time interval given in this information element. All samples taken in the time interval shall have equal weight in the calculation.

MAC receives RLC PDUs with the primitive MAC-Data-REQ including following parameters.

- Buffer Occupancy (BO)
  The parameter Buffer Occupancy (BO) indicates for each logical channel the amount of data in number of bytes that is available for transmission and retransmission in RLC layer. When MAC is connected to an AM RLC entity, control PDUs to be transmitted and RLC PDUs outside the RLC Tx window shall also be included in the BO. RLC PDUs that have been transmitted but not negatively acknowledged by the peer entity shall not be included in the BO.

11.2 Control of RACH transmissions

The MAC sublayer is in charge of controlling the timing of RACH transmissions on transmission time interval level (the timing on access slot level is controlled by L1). Note that retransmissions in case of erroneously received RACH message part are under control of higher layers, i.e. RLC, or RRC for CCCH (and SHCCH for TDD).

11.2.1 Access Service Class selection

The physical RACH resources (i.e. access slots and preamble signatures for FDD, timeslot and channelisation code for 3.84 Mcps TDD, SYNC1 code for 1.28 Mcps TDD) may be divided between different Access Service Classes in order to provide different priorities of RACH usage. It is possible for more than one ASC or for all ASCs to be assigned to the same access slot/signature space or SYNC1 code.

Access Service Classes are numbered in the range $0 \le i \le \text{NumASC} \le 7$ (i.e. the maximum number of ASCs is 8). An ASC is defined by an identifier i that defines a certain partition of the PRACH resources and an associated persistence value P_i. A set of ASC parameters consists of NumASC+1 such parameters (i, P_i), $i = 0, \ldots, \text{NumASC}$. The PRACH partitions and the persistence values P_i are derived by the RRC protocol from system information (see [7]). The set of ASC parameters is provided to MAC with the CMAC-Config-REQ primitive. The ASC enumeration is such that it corresponds to the order of priority (ASC 0 = highest priority, ASC 7 = lowest priority). ASC 0 shall be used in case of Emergency Call or for reasons with equivalent priority.

At radio bearer setup/reconfiguration each involved logical channel is assigned a MAC Logical channel Priority (MLP) in the range 1,…,8. When the MAC sublayer is configured for RACH transmission in the UE, these MLP levels shall be employed for ASC selection on MAC.

The following ASC selection scheme shall be applied, where NumASC is the highest available ASC number and MinMLP the highest logical channel priority assigned to one logical channel:

- in case all TBs in the TB set have the same MLP, select ASC = min(NumASC, MLP);

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 55

- in case TBs in a TB set have different priority, determine the highest priority level MinMLP and select ASC = min(NumASC, MinMLP).

When an RRC CONNECTION REQUEST message is sent RRC determines ASC by means of the access class [7]. The ASC to be used in these circumstances is signalled to MAC by means of the CMAC-CONFIG-REQ message.

If MAC has knowledge of a U-RNTI then the ASC is determined in the MAC entity. If no U-RNTI has been indicated to MAC then MAC will use the ASC indicated in the CMAC-CONFIG-REQ primitive.

11.2.2 Control of RACH transmissions for FDD mode

The RACH transmissions are controlled by the UE MAC sublayer as outlined in figure 11.2.2.1.

NOTE: The figure shall illustrate the operation of the transmission control procedure as specified below. It shall not impose restrictions on implementation. MAC controls the timing of each initial preamble ramping cycle as well as successive preamble ramping cycles in case that none or a negative acknowledgement is received on AICH.

NOTE: In Cell-FACH state, the UE should co-ordinate the UL transmission schedule with the measurement schedule in FACH measurement occasions so as to minimise any delays associated with inter-frequency measurements.

MAC receives the following RACH transmission control parameters from RRC with the CMAC-CONFIG-Req primitive:

- a set of Access Service Class (ASC) parameters, which includes for each ASC, i=0,…,NumASC an identification of a PRACH partition and a persistence value P_i (transmission probability);
- maximum number of preamble ramping cycles M_{max};
- range of backoff interval for timer T_{BO1}, given in terms of numbers of transmission 10 ms time intervals N_{BO1max} and N_{BO1min}, applicable when negative acknowledgement on AICH is received.

When there is data to be transmitted, MAC selects the ASC from the available set of ASCs, which consists of an identifier *i* of a certain PRACH partition and an associated persistence value P_i. The procedure to be applied for ASC selection is described in subclause 11.2.1.

Based on the persistence value P_i, the UE decides whether to start the L1 PRACH transmission procedure (see [13]) in the present transmission time interval or not. If transmission is allowed, the PRACH transmission procedure (starting with a preamble power ramping cycle) is initiated by sending of a PHY-ACCESS-REQ primitive. MAC then waits for access information from L1 via PHY-ACCESS-CNF primitive. If transmission is not allowed, a new persistency check is performed in the next transmission time interval. The persistency check is repeated until transmission is permitted.

When the preamble has been acknowledged on AICH, L1 access information with parameter value "ready for data transmission" is indicated to MAC with PHY-ACCESS-CNF primitive. Then data transmission is requested with PHY-DATA-REQ primitive, and the PRACH transmission procedure shall be completed with transmission of the PRACH message part according to L1 specifications. Successful completion (TX status) of the MAC transmission control procedure shall be indicated to higher layer.

When PHY indicates that no acknowledgement on AICH is received while the maximum number of preamble retransmissions is reached (defined by parameter Preamble_Retrans_Max on L1), a new persistency test is performed in the next transmission time interval. The timer T_2 ensures that two successive persistency tests are separated by at least one 10 ms time interval.

In case that a negative acknowledgement has been received on AICH a backoff timer T_{BO1} is started. After expiry of the timer, persistence check is performed again. Backoff timer T_{BO1} is set to an integer number N_{BO1} of 10 ms time intervals, randomly drawn within an interval $0 \leq N_{BO1min} \leq N_{BO1} \leq N_{BO1max}$ (with uniform distribution). N_{BO1min} and N_{BO1max} may be set equal when a fixed delay is desired, and even to zero when no delay other than the one due to persistency is desired.

Before a persistency test is performed it shall be checked whether any new RACH transmission control parameters have been received from RRC with CMAC-CONFIG-Req primitive. The latest set of RACH transmission control parameters shall be applied.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 56

If the maximum number of preamble ramping cycles M_{max} is exceeded, failure of RACH transmission shall be reported to higher layer.

Both, transmission failure and successful completion of the MAC transmission control procedure, shall be indicated individually for each logical channel of which data was included in the transport block set of that access attempt. When transparent mode RLC is employed (i.e. for CCCH), transmission status is reported to RRC with CMAC-STATUS-Ind primitive. For logical channels employing acknowledged or unacknowledged mode RLC, transmission status is reported to RLC with MAC-STATUS-Ind primitive.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 57

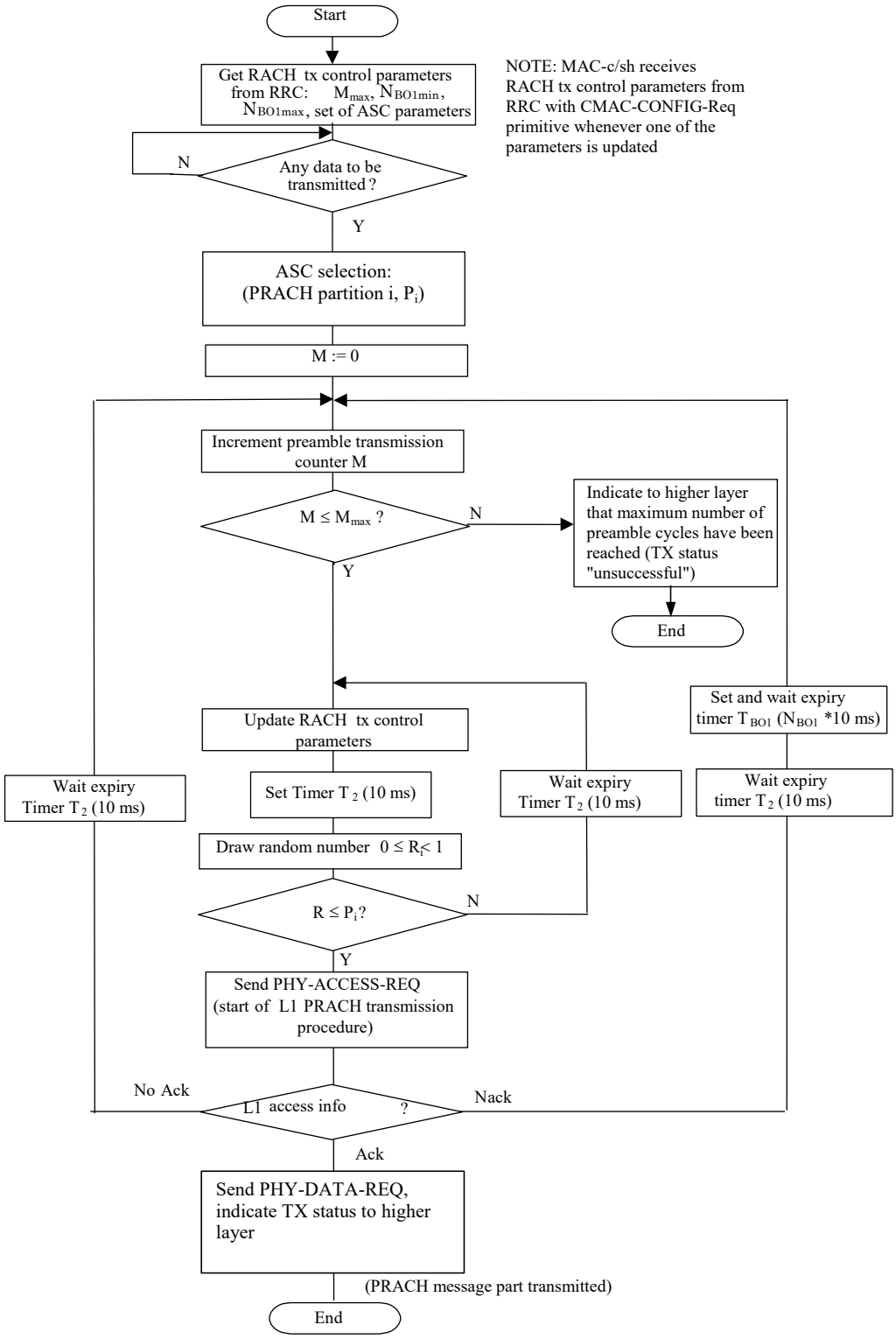

Figure 11.2.2.1: RACH transmission control procedure (UE side, informative)

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 58

11.2.3 Control of RACH transmissions for TDD

11.2.3.1 Control of RACH transmissions for 3.84 Mcps TDD

The RACH transmissions are performed by the UE as shown in figure 11.2.3.2.

NOTE: The figure shall illustrate the operation of the transmission control procedure as specified below. It shall not impose restrictions on implementation.

MAC receives the following RACH transmission control parameters from RRC with the CMAC-Config-REQ primitive:

- a set of Access Service Class (ASC) parameters, which includes for each ASC, i=0,…,NumASC an identification of a PRACH partition and a persistence value P_i (transmission probability).

When there is data to be transmitted, MAC selects the ASC from the available set of ASCs, which consists of an identifier *i* of a certain PRACH partition and an associated persistence value P_i. The procedure to be applied for ASC selection is described in subclause 11.2.1.

In order to separate different ASCs each PRACH has N sub-channels associated with it (numbered from 0 to N-1). N may be assigned the value 1,2,4, or 8 by higher layer signalling. Sub-channel i for a PRACH defined in timeslot k is defined as the k:th slot in the frames where SFN mod N = i. Therefore follows the definition:

- Sub-channel i associated to a PRACH defined in timeslot k is defined as the k:th timeslot in the frames where SFN mod N = i.

Figure 11.2.3.1 illustrates the eight possible subchannels for the case, N=8. For illustration, the figure assumes that the PRACH is assigned timeslot 3.

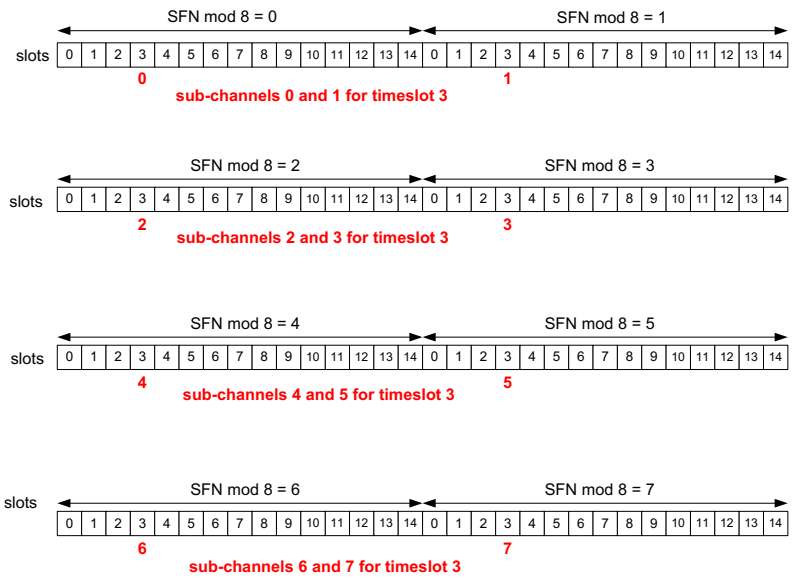

Figure 11.2.3.1 Eight sub-channels for timeslot 3

Based on the persistence value P, the UE decides whether to send the message on the RACH. If transmission is not allowed, a new persistency check is performed in the next transmission time interval. The persistency check is repeated until transmission is permitted. If transmission is allowed, a subchannel is randomly selected from the set of available subchannels for this ASC. The random subchannel selection shall be such that each of the allowed selections is chosen with equal probability. If an available subchannel is not found, the persistency check and subchannel assignment is repeated for the next subchannel period. If an available subchannel is found the PRACH transmission procedure is initiated by sending of a PHY-Data-REQ primitive.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 59

Successful completion (TX status) of the MAC transmission control procedure shall be indicated to higher layer individually for each logical channel of which data was included in the transport block set of that access attempt. When transparent mode RLC is employed (i.e. for CCCH), transmission status is reported to RRC with CMAC-STATUS-Ind primitive. For logical channels employing acknowledged or unacknowledged mode RLC, transmission status is reported to RLC with MAC-STATUS-Ind primitive.

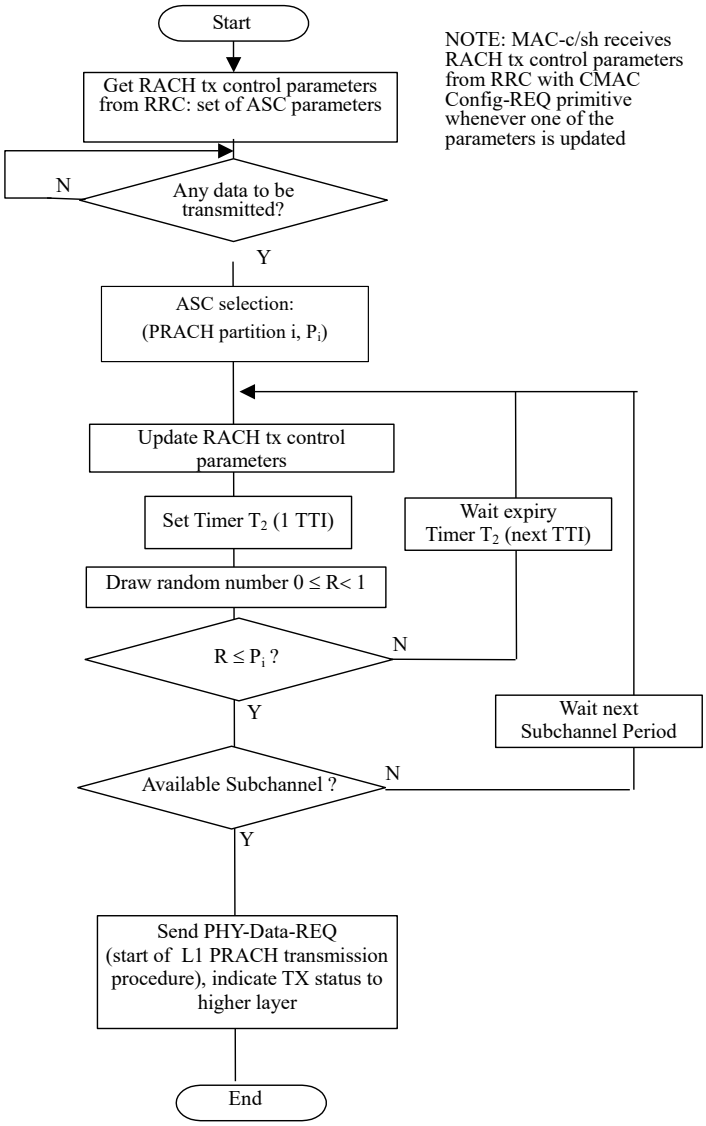

Figure 11.2.3.2: RACH transmission control procedure for TDD (UE side, informative)

11.2.3.2 Control of RACH Transmissions for 1.28 Mcps TDD

The RACH transmissions are performed by the UE as shown in figure 11.2.3.3.

NOTE: The figure shall illustrate the operation of the transmission control procedure as specified below. It shall not impose restrictions on implementation.

UE MAC receives the following RACH transmission control parameters from RRC with the CMAC-Config-REQ primitive:

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 60

- a set of Access Service Class (ASC) parameters, which includes for each ASC, i=0,…,NumASC an identification of a PRACH partition and a persistence value P_i (transmission probability),
- maximum number of synchronisation attempts Mmax.

When there is data to be transmitted, MAC selects the ASC from the available set of ASCs, which consists of an identifier *i* of a certain PRACH partition and an associated persistence value P_i.

Based on the persistence value P_i, MAC decides whether to start the L1 PRACH procedure in the present transmission time interval or not. If transmission is allowed, the PRACH transmission procedure (starting with the SYNC_UL/FPACH power ramping sequence) is initiated by the sending of a PHY-ACCESS-REQ primitive. MAC then waits for access information from L1 via the PHY-ACCESS-CNF primitive. If transmission is not allowed, a new persistency check is performed in the next transmission time interval. The persistency check is repeated until transmission is permitted.

If a synchronisation burst has been acknowledged on its associated FPACH, PHY will inform MAC by a PHY-ACCESS-CNF primitive indicating "ready for RACH data transmission". Then MAC requests data transmission with a PHY-DATA-REQ primitive, and the PRACH transmission procedure will be completed with transmission on the PRACH resources associated with the FPACH.

Successful completion of the MAC procedure is indicated to higher layer individually for each logical channel of which data was included in the transport block set of that access attempt. When transparent mode RLC is employed (i.e. for CCCH), transmission status is reported to RRC with CMAC-STATUS-Ind primitive. For logical channels employing acknowledged or unacknowledged mode RLC, transmission status is reported to RLC with MAC-STATUS-Ind primitive.

If no synchronisation burst received an acknowledgement on the FPACH within the maximum number of transmissions permitted in a power ramping cycle, PHY will inform MAC by a PHY-ACCESS-CNF primitive indicating "no response received on FPACH". If the maximum number of synchronisation attempts permitted, Mmax, has not been exceeded, then MAC commences a new persistency test sequence in the next transmission time interval and the PHY-ACCESS-REQ procedure is repeated. The timer T_2 ensures that two successive persistency tests are separated by at least one transmission time interval. If the maximum number of synchronisation attempts is exceeded then MAC abandons the RACH procedure. Failure to complete the MAC procedure is indicated to higher layer by the CMAC-STATUS-Ind or MAC-STATUS-Ind primitives.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 61

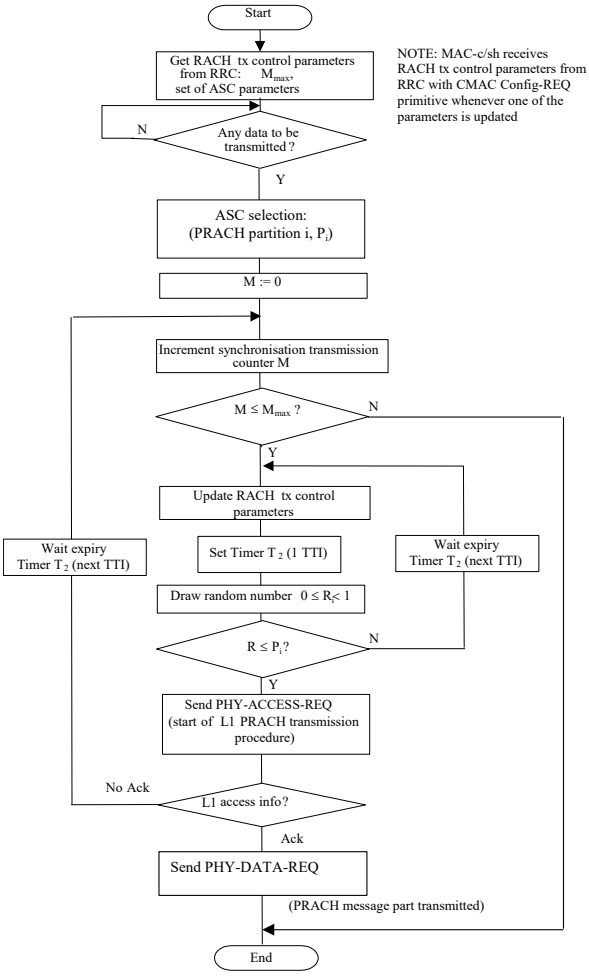

Figure 11.2.3.3: RACH transmission control procedure for 1.28 Mcps TDD (UE side, informative)

11.3 Void

11.4 Transport format combination selection in UE (non E-DCH)

RRC can control the scheduling of uplink data by giving each logical channel a priority between 1 and 8, where 1 is the highest priority and 8 the lowest. TFC selection in the UE shall be done in accordance with the priorities indicated by RRC. Logical channels have absolute priority, i.e. the UE shall maximise the transmission of higher priority data.

If the uplink TFCS or TFC Subset configured by UTRAN follows the guidelines described in [7] the UE shall perform the TFC selection according to the rules specified below. If these guidelines are not followed then the UE behaviour is not specified.

A given TFC can be in any of the following states:

- Supported state;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 62

- Excess-power state;
- Blocked state.

TDD mode UEs in CELL_FACH state using the USCH transport channel and UEs in CELL_DCH state using a DCH shall continuously monitor the state of each TFC based on its required transmit power versus the maximum UE transmit power (see [7]). The state transition criteria and the associated requirements are described in [12, 14]. The UE shall consider that the Blocking criterion is never met for TFCs included in the minimum set of TFCs (see [7]).

The following diagram illustrates the state transitions for the state of a given TFC:

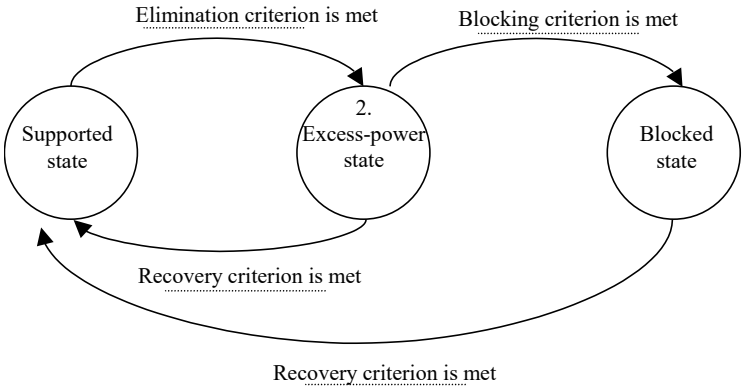

Figure 11.4.1: State transitions for the state of a given TFC

FDD Mode UEs in CELL_FACH state may estimate the channel path loss and set to excess power state all the TFCs requiring more power than the Maximum UE transmitter power (see [7]). All other TFCs shall be set to Supported state.

Every time the set of supported TFCs changes, the available bitrate shall be indicated to upper layers for each logical channel in order to facilitate the adaptation of codec data rates when codecs supporting variable-rate operation are used. The details of the computation of the available bitrate and the interaction with the application layer are not further specified.

Before selecting a TFC, i.e. at every boundary of the shortest TTI, or prior to each transmission on PRACH the set of valid TFCs shall be established. All TFCs in the set of valid TFCs shall:

1. belong to the TFCS.

1a. not be restricted by higher layer signalling (e.g. TFC Control, see [7]).

2. not be in the Blocked state.

3. be compatible with the RLC configuration.

4. not require RLC to produce padding PDUs (see [6] for definition).

5. not carry more bits than can be transmitted in a TTI (e.g. when compressed mode by higher layer scheduling is used and the presence of compressed frames reduces the number of bits that can be transmitted in a TTI using the Minimum SF configured).

The UE may remove from the set of valid TFCs, TFCs in Excess-power state in order to maintain the quality of service for sensitive applications (e.g. speech). However, this shall not apply to TFCs included in the minimum set of TFCs (see [7]). Additionally, if compressed frames are present within the longest configured TTI to which the next transmission belongs, the UE may remove TFCs from the set of valid TFCs in order to account for the higher power requirements.

The chosen TFC shall be selected from within the set of valid TFCs and shall satisfy the following criteria in the order in which they are listed below:

1. No other TFC shall allow the transmission of more highest priority data than the chosen TFC.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 63

2. No other TFC shall allow the transmission of more data from the next lower priority logical channels. Apply this criterion recursively for the remaining priority levels.

3. No other TFC shall have a lower bit rate than the chosen TFC.

In FDD mode the above rules for TFC selection in the UE shall apply to DCH, and the same rules shall apply for TF selection on RACH.

In 3.84 Mcps TDD mode the above rules for TFC selection in the UE shall apply to DCH and USCH.

11.5 Ciphering

The ciphering function is performed in MAC (i.e. only in MAC-d) if a radio bearer is using the transparent RLC mode. The part of the MAC PDU that is ciphered is the MAC SDU and this is shown in Figure 11.5.1 below.

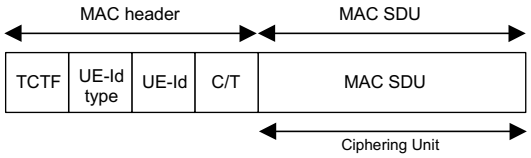

Figure 11.5.1: Ciphered part unit for a MAC PDU

In case a TTI contains multiple MAC PDUs for a given Transparent mode RB, the ciphering unit for this RB is the bitstring concatenation of all the MAC SDUs, resulting in the PLAINTEXT BLOCK, as defined in [15]. In case there is only one MAC PDU for a given Transparent mode RB, the ciphering unit is the MAC SDU, resulting in the PLAINTEXT BLOCK. The concatenation order is the same as the order of transmission of the Transport Blocks between MAC and Physical layer.

The KEYSTREAM BLOCK as defined in [10] is applied to the PLAINTEXT BLOCK, and the end result, CIPHERTEXT BLOCK, becomes the ciphered part for the MAC PDU, in case there is only one MAC PDU per RB. In case there is more than one MAC PDU per RB, the CIPHERTEXT BLOCK is split into the corresponding ciphered parts for each MAC PDU. The split order is the same as the order of transmission of the Transport Blocks between MAC and Physical layer.

The ciphering algorithm and key to be used are configured by upper layers [7] and the ciphering method shall be applied as specified in [10].

The parameters that are required by MAC for ciphering are defined in [10] and are input to the ciphering algorithm. The parameters required by MAC which are provided by upper layers [7] are listed below:

- MAC-d HFN (Hyper frame number for radio bearers that are mapped onto transparent mode RLC)
- BEARER defined as the radio bearer identifier in [10]. It will use the value RB identity –1 as in [7])
- CK (Ciphering Key)

If the TTI consists of more than one 10 ms radio frame, the CFN of the first radio frame in the TTI shall be used as input to the ciphering algorithm for all the data in the TTI.

11.6 Control of HS-DSCH transmission and reception

11.6.1 Network operation

The following are the functions of the various functional entities at the network in support of the HARQ protocol used on HS-DSCH.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 64

11.6.1.1 Scheduler

The scheduler performs the following functions:

- Schedules all UEs within a cell;
- Services priority queues:
  - The scheduler schedules MAC-hs SDUs based on information from upper layers. One UE may be associated with one or more MAC-d flows. Each MAC-d flow contains HS-DSCH MAC-d PDUs for one or more priority queues.
- Determines the HARQ Entity and the queue to be serviced;
- Sets the TSN for new data blocks being transferred from the selected queue;
  - set the TSN to value 0 for the first MAC-hs PDU transmitted for each Queue ID within an HS-DSCH;
  - increment the TSN with one for each transmitted MAC-hs PDU on each Queue ID within an HS-DSCH.

NOTE: The scheduler may re-use TSNs by toggling the NDI bit in order to resume pre-empted transmissions or to force the UE to flush the soft buffer. In this case the content of the payload may be changed but care should be taken to preserve the higher layer data order.

- Indicates the Queue ID and TSN to the HARQ entity for each MAC-hs PDU to be transmitted;
- Schedules new transmissions and retransmissions:
  - Based on the status reports from HARQ Processes the scheduler determines if either a new transmission or a retransmission should be made. A new transmission can however be initiated on a HARQ process at any time. Based on a delay attribute provided by upper layers, the scheduler may decide to discard any 'out-of-date' MAC-hs SDU.
- Determines the redundancy version:
  - The scheduler determines a suitable redundancy version for each transmitted and retransmitted MAC-hs PDU and indicates the redundancy version to lower layer.
- Determines the TDD HCSN;
  - Increment UE specific HCSN for each HS-SCCH transmission.

11.6.1.2 HARQ entity

- There is one HARQ entity per UE in UTRAN.
- The HARQ entity sets the Queue ID in transmitted MAC-hs PDUs to the value indicated by the UTRAN scheduler.
- The HARQ entity sets the transmission sequence number (TSN) in transmitted MAC-hs PDUs to the value indicated by the UTRAN scheduler.
- The HARQ entity sets the HARQ process identifier in transmitted MAC-hs PDUs. UTRAN should:
  - determine a suitable HARQ process to service the MAC-hs PDU and set the HARQ process identifier accordingly.

11.6.1.3 HARQ process

- The HARQ process sets the New data indicator in transmitted MAC-hs PDUs. UTRAN should:
  - set the New Data Indicator to the value "0" for the first MAC-hs PDU transmitted by a HARQ process;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 65

  - not increment the New Data Indicator for retransmissions of a MAC-hs PDU;
  - increment the New Data Indicator with one for each transmitted MAC-hs PDU containing new data.
- The HARQ process processes received status messages. UTRAN should:
  - deliver received status messages to the scheduler.

11.6.2 UE operation

The UE operation in support of the HARQ protocol used on HS-DSCH is split among the following four functional units with their associated functions.

11.6.2.1 HARQ Entity

There is one HARQ entity at the UE which processes the HARQ process identifiers received on the HS-SCCH transmissions associated with MAC-hs PDUs received on the HS-DSCH.

A number of parallel HARQ processes are used in the UE to support the HARQ entity. The number of HARQ processes is configured by upper layers:

- Each received MAC-hs PDU shall be allocated to the HARQ process indicated by the HARQ process identifier of the MAC-hs PDU.

11.6.2.2 HARQ process

The HARQ process processes the New Data Indicator indicated by lower layers for each received MAC-hs PDU.

The UE may:

- for FDD, if the MAC-hs PDU is received within 5 sub-frames from the reception of the previous MAC-hs PDU intended for this HARQ process; or
- for TDD, if the MAC-hs PDU is received before generation of feedback resulting from reception of a previous MAC-hs PDU for the same H-ARQ process:
  - discard the MAC-hs PDU.

The UE shall:

- if the New Data Indicator has been incremented compared to the value in the previous received transmission in this HARQ process or this is the first received transmission in the HARQ process:
  - replace the data currently in the soft buffer for this HARQ process with the received data.
  - if the Transport Block Size index value is equal to 111111 (FDD only):
    - generate a positive acknowledgement (ACK) of the data in this HARQ process;
    - discard the received data;
    - assume that the data has been successfully decoded.
- if the New Data Indicator is identical to the value used in the previous received transmission in the HARQ process:
  - if the Transport Block Size index value is equal to 111111 (FDD only):
    - assume that the transport block size is identical to the last valid transport block size signalled for this HARQ process.
  - if the data has not yet been successfully decoded:
    - combine the received data with the data currently in the soft buffer for this HARQ process.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 66

  - if the transport block size is different from the last valid transport block size signalled for this HARQ process:
    - the UE may replace the data currently in the soft buffer for this HARQ process with the received data.
- if the data in the soft buffer has been successfully decoded and no error was detected:
  - deliver the decoded MAC-hs PDU to the reordering entity;
  - generate a positive acknowledgement (ACK) of the data in this HARQ process.
- else:
  - generate a negative acknowledgement (NAK) of the data in this HARQ process;
- schedule the generated positive or negative acknowledgement for transmission and the time of transmission relative to the reception of data in a HARQ process is configured by upper layer.

The HARQ process processes the Queue ID in the received MAC-hs PDUs. The UE shall:

- arrange the received MAC-hs PDUs in queues based on the Queue ID.

11.6.2.3 Reordering entity

11.6.2.3.1 Definitions

In the functions described in this section the following definitions apply:

Parameters

- Transmitter window size (TRANSMIT_WINDOW_SIZE)
  TRANSMIT_WINDOW_SIZE is the size of the transmitter window according to the definition below. This is a parameter in the Node B and the value of the parameter is configured by higher layers.
- Receiver window size (RECEIVE_WINDOW_SIZE)
  RECEIVE_WINDOW_SIZE is the size of the receiver window according to the definition below. This is a parameter in the UE and the value of the parameter is configured by higher layers.

State variables

All state variables are non-negative integers. MAC-hs PDUs are numbered by modulo integer Transmission sequence numbers (TSN) cycling through the field 0 to 63. All arithmetic operations contained in the present document on next_expected_TSN, RcvWindow_UpperEdge, T1_TSN and TSN_flush are affected by the 64 modulus. When performing arithmetic comparisons of state variables or Transmission sequence number values a 64 modulus base shall be used. This modulus base is subtracted (within the appropriate field) from all the values involved and then an absolute comparison is performed. RcvWindow_UpperEdge – RECEIVE_WINDOW_SIZE + 1 shall be assumed to be the modulus base.

- next_expected_TSN:
  The next_expected_TSN is the Transmission sequence number (TSN) following the TSN of the last in-sequence MAC-hs PDU received. It shall be updated according to the procedures given in subclauses 11.6.2.3.2, 11.6.2.5 and 11.6.2.6. The initial value of next_expected_TSN =0.
- RcvWindow_UpperEdge:
  The RcvWindow_UpperEdge represents the TSN, which is at the upper edge of the receiver window. After the first MAC-hs PDU has been received successfully, it also corresponds to the MAC-hs PDU with the highest TSN of all received MAC-hs PDUs. The initial RcvWindow_UpperEdge equals 63. RcvWindow_UpperEdge is updated based on the reception of new MAC-hs PDU according to the procedure given below.
- T1_TSN:
  The TSN of the latest MAC-hs PDU that cannot be delivered to the disassembly entity, when the timer T1 is started.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 67

Timers

- Re-ordering release timer (T1):
  The Re-ordering release timer T1 controls the stall avoidance in the UE reordering buffer as described below. The value of T1 is configured by upper layers.

Other definitions

- Receiver window:
  The receiver window defines TSNs of those MAC-hs PDUs that can be received in the receiver without causing an advancement of the receiver window according to the procedure below. The size of the receiver window equals RECEIVE_WINDOW_SIZE and spans TSNs going from RcvWindow_UpperEdge – RECEIVE_WINDOW_SIZE + 1 to RcvWindow_UpperEdge included.

11.6.2.3.2 Reordering functionality

If no timer T1 is active:

- the timer T1 shall be started when a MAC-hs PDU with TSN > next_expected_TSN is correctly received.
- T1_TSN shall be set to the TSN of this MAC-hs PDU.

If a timer T1 is already active:

- no additional timer shall be started, i.e. only one timer T1 may be active at a given time.

The timer T1 shall be stopped if:

- the MAC-hs PDU with TSN = T1_TSN can be delivered to the disassembly entity before the timer expires.

When the timer T1expires and T1_TSN > next_expected_TSN:

- all correctly received MAC-hs PDUs with TSN > next_expected_TSN up to and including T1_TSN-1 shall be delivered to the disassembly entity;
- all correctly received MAC-hs PDUs up to the next not received MAC-hs PDU shall be delivered to the disassembly entity.
- next_expected_TSN shall be set to the TSN of the next not received MAC-hs PDU.

When the timer T1 is stopped or expires, and there still exist some received MAC-hs PDUs that can not be delivered to higher layer:

- timer T1 is started
- set T1_TSN to the highest TSN among those of the MAC-hs PDUs that can not be delivered.

Transmitter operation:

After the transmitter has transmitted a MAC-hs PDU with TSN=SN, any MAC-hs PDU with TSN ≤ SN – TRANSMIT_WINDOW_SIZE should not be retransmitted to avoid sequence number ambiguity in the receiver.

Receiver operation:

When a MAC-hs PDU with TSN = SN is received:

- if SN is within the receiver window:
  - if SN < next_expected_TSN, or this MAC-hs PDU has previously been received:
    - the MAC-hs PDU shall be discarded;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 68

    - else:
        - the MAC-hs PDU shall be placed in the reordering buffer at the place indicated by the TSN.

- if SN is outside the receiver window:
    - the received MAC-hs PDU shall be placed above the highest received TSN in the reordering buffer, at the position indicated by SN;
    - RcvWindow_UpperEdge shall be set to SN thus advancing the receiver window;
    - any MAC-hs PDUs with TSN ≤ RcvWindow_UpperEdge – RECEIVE_WINDOW_SIZE, i.e. outside the receiver window after its position is updated, shall be removed from the reordering buffer and be delivered to the disassembly entity;
    - if next_expected_TSN is below the updated receiver window:
        - next_expected_TSN shall be set to RcvWindow_UpperEdge – RECEIVE_WINDOW_SIZE + 1;
- if the MAC-hs PDU with TSN = next_expected_TSN is stored in the reordering buffer:
    - all received MAC-hs PDUs with consecutive TSNs from next_expected_TSN (included) up to the first not received MAC-hs PDU shall be delivered to the disassembly entity;
    - next_expected_TSN shall be advanced to the TSN of this first not received MAC-hs PDU.

In case a UE has insufficient memory to process a received MAC-hs PDU, it shall perform the following set of operations:

- select TSN_flush such that: next_expected_TSN < TSN_flush ≤ RcvWindow_UpperEdge + 1;
- deliver all correctly received MAC-hs PDUs with TSN < TSN_flush to the disassembly entity;
- if the MAC-hs PDU with TSN=TSN_flush has previously been received:
    - deliver all received MAC-hs PDUs with consecutive TSNs from TSN_flush (included) up to the first not received MAC-hs PDU to the disassembly entity;
    - advance next_expected_TSN to the TSN of this first not received MAC-hs PDU.
- else:
    - set next_expected_TSN to TSN_flush.

11.6.2.4 Disassembly entity

For each MAC-hs PDU that is delivered to the disassembly entity, the UE shall:

- remove any padding bits if present;
- remove the MAC-hs header;
- deliver the MAC-d PDUs in the MAC-hs PDU to MAC-d.

11.6.2.5 MAC-hs Reset

If a reset of the MAC-hs entity is requested by upper layers, the UE shall:

- flush soft buffer for all configured HARQ processes;
- stop all active re-ordering release timer (T1) and set all timer T1 to their initial value;
- start TSN with value 0 for the next transmission on every configured HARQ process;
- initialise the variables RcvWindow_UpperEdge and next_expected_TSN to their initial values;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 69

- disassemble all MAC-hs PDUs in the re-ordering buffer and deliver all MAC-d PDUs to the MAC-d entity;
- flush the re-ordering buffer.

and then:

- indicate to all AM RLC entities mapped on HS-DSCH to generate a status report.

11.6.2.6 Reconfiguration of MAC-hs parameters

The parameters for a MAC-hs entity may be reconfigured (modifed) by upper layers.

When a parameter is reconfigured by the upper layer, the UE shall:

- start using the reconfigured value of the parameter at the activation time indicated by higher layers.

If the parameter T1 is reconfigured for an already existing re-ordering queue, the UE shall:

- start to use the new value of T1 the next time T1 is started.

If the MAC-d PDU size info (i.e. mapping of MAC-d PDU size index to MAC-d PDU size) is reconfigured for an already existing re-ordering queue, at the activation time indicated by higher layers, the UE shall:

- stop timer T1 if running;
- set next_expected_TSN to (highest TSN of received MAC-hs PDU of this re-ordering queue + 1);
- deliver all correctly received MAC-hs PDUs in this re-ordering queue to the disassembly entity and use the old MAC-d PDU size info for these MAC-hs PDUs.

If the parameter RECEIVE_WINDOW_SIZE is reconfigured for a re-ordering queue, the UE shall:

- set RECEIVE_WINDOW_SIZE to the new value;
- remove any MAC-hs PDUs in this re-ordering queue with TSN ≤ RcvWindow_UpperEdge – RECEIVE_WINDOW_SIZE (i.e. outside the receiver window after its size is updated) from the reordering buffer and deliver these MAC-hs PDUs to the disassembly entity;
- if next_expected_TSN is below the receiver window after its size is updated:
  - set next_expected_TSN to RcvWindow_UpperEdge – RECEIVE_WINDOW_SIZE + 1;
  - deliver all received MAC-hs PDUs in this re-ordering queue with consecutive TSNs from next_expected_TSN (included) up to the first not received MAC-hs PDU to the disassembly entity;
  - advance next_expected_TSN to the TSN of this first not received MAC-hs PDU.

If the "Memory Partitioning" (see [7]) for soft buffer is reconfigured, the UE shall:

- flush soft buffer for all configured HARQ processes.

11.7 HS-DSCH Provided Bit Rate measurement

The HS-DSCH Provided Bit Rate measurements is defined as follows:

- for each priority class the MAC-hs entity measures the total number of MAC-d PDU bits whose transmission over the radio interface has been considered successful by MAC-hs in Node-B during the last measurement period, divided by the duration of the measurement period;
- the values reported by MAC-hs shall be raw samples;
- the measurement period shall be [100 ms];
- when the cell portions are defined in a cell, the HS-DSCH Provided Bit Rate shall be measured for each cell portion.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 70

11.8 Control of E-DCH transmission and reception

11.8.1 UE operation

11.8.1.1 HARQ Operation

11.8.1.1.1 HARQ entity

There is one HARQ entity at the UE. A number of parallel HARQ processes are used in the UE to support the HARQ entity, allowing transmissions to take place continuously while waiting for the feedback on the successful or unsuccessful reception of previous transmissions.

At a given TTI, the HARQ entity identifies the HARQ process for which a transmission should take place. Also, based on the timing, it routes the receiver feedback (ACK/NACK information), relayed by the physical layer, to the appropriate HARQ process.

The number of HARQ processes is equal to the HARQ round-trip-time (HARQ_RTT). The HARQ_RTT is equal to 4 for 10ms TTI and 8 for 2ms TTI. The TTI duration shall be configured by the higher layers. Each process is associated with a number from 0 to HARQ_RTT-1.

After each TTI, the HARQ entity shall:

- if the buffer of the HARQ process corresponding to the next TTI is empty:
  - notify the E-TFC selection entity that the next TTI is available for a new transmission;
  - if the "E-TFC Selection" entity indicates the need for a new transmission:
    - obtain the transmission information (i.e. HARQ profile, whether triggered Scheduling Information is included and whether it is sent alone) from the "E-TFC Selection" entity;
    - obtain the MAC-e PDU to transmit from the "Multiplexing and TSN setting" entity;
    - instruct the HARQ process corresponding to this TTI to trigger the transmission of this new payload using the identified HARQ profile parameters.
- else:
  - instruct the HARQ process to generate a re-transmission.

11.8.1.1.2 HARQ process

Each HARQ process is associated with a physical buffer (HARQ buffer).

Each HARQ process maintains the state variable CURRENT_TX_NB, which indicates the number of transmissions that have taken place for the MAC-e PDU currently in the buffer. When the HARQ process is established, CURRENT_TX_NB shall be initialized to 0.

At the time of a new transmission, the HARQ entity provides the HARQ profile to use for all transmissions and re-transmissions of this MAC-e PDU. This HARQ profile includes information on the maximum number of transmissions to perform, and the power offset with which to configure the physical layer.

If the HARQ entity provides a new PDU, the HARQ process shall:

- set CURRENT_TX_NB to 0;
- set CURRENT_RSN to 0;
- store the MAC-e PDU in the associated HARQ buffer;
- generate a transmission as described below.

If the HARQ entity requests a re-transmission, the HARQ process shall:

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 71

- generate a transmission as described below.

To generate a transmission, the HARQ process shall:

- instruct the physical layer to set the RSN field on the E-DPCCH to CURRENT_RSN;
- instruct the physical layer to generate a transmission with the power offset corresponding to the HARQ profile and the redundancy version corresponding to the RSN value and the transmission timing (i.e. the CFN and in the case of 2ms TTI, sub-frame number as described in [16]);
- if CURRENT_RSN < 3
  - increment CURRENT_RSN by 1;
- increment CURRENT_TX_NB by 1;
- if CURRENT_TX_NB ≥ maximum number of transmissions indicated in the transmission HARQ profile:
  - flush the HARQ buffer;

If an ACK is received, the HARQ process shall:

- if the transmission includes a Scheduling Information which was triggered by an event or a timer as per subclause 11.8.1.6 and no ACK was received from the RLS containing the serving cell:
  - if the transmission included higher layer data:
    - notify the Scheduling Information Reporting function that the Scheduling Information was not received by the serving RLS;
    - flush the HARQ buffer;
    - set CURRENT_TX_NB to 0;
    - set CURRENT_RSN to 0.
- else:
  - flush the HARQ buffer;
  - set CURRENT_TX_NB to 0;
  - set CURRENT_RSN to 0.

NOTE: In the case where the Scheduling Information is transmitted alone, without any higher layer data the UE will keep re-transmitting the data until an ACK is received from the serving cell or the maximum number of re-transmissions is received. In the latter case, periodic triggering will be relied upon for reliability.

11.8.1.2 Multiplexing and TSN setting entity

There is one Multiplexing and TSN setting entity at the UE. A number of TSN setting processes are used to support independent numbering of transmissions from different logical channels.

11.8.1.2.1 TSN setting process operation

There is one TSN setting process at the UE for each logical channel. The UE operation in support of the re-ordering functionality consists in generating an explicit sequence number (TSN) for each MAC-es PDU intended for the associated re-ordering queue.

Each TSN setting process maintains the state variable CURRENT_TSN, which indicates the sequence number to be included in the header of the following MAC-es PDU to be generated. When the TSN setting process is established, CURRENT_TSN shall be initialized to 0.

When a new payload needs to be generated for the associated re-ordering queue, the Multiplexing and TSN setting entity shall:

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 72

- set the TSN of the transmission to CURRENT_TSN;

At the end of a TTI for which at least one MAC-es PDU was transmitted for this TSN setting process:

- increment CURRENT_TSN by 1;
- if CURRENT_TSN > 63:
  - set CURRENT_TSN = 0;

11.8.1.3 Serving Grant Update

UEs in CELL_DCH state, configured with an E-DCH transport channel shall maintain a Serving Grant and the list of active HARQ processes based on the absolute and relative grant commands decoded on the configured E-AGCH and E-RGCH(s).

Each Absolute Grant or Relative Grant command is applied at a specific TTI. This association is implicit based on the timing of the E-AGCH and E-RGCH (see [13]). The timing is tight enough that this relationship is un-ambiguous.

The activation/deactivation of one or all processes is only applicable to processes for which transmission of scheduled data is allowed according to RRC signalling

Process activation of an active process does not result in any action taken by the UE.

11.8.1.3.1 Baseline Procedure

The Serving Grant Update procedure shall be applied at every TTI boundary and shall take into account the Absolute Grant message, Serving Relative Grant and non-serving Relative Grants that apply to the TTI.

The UE shall:

1> set reference_ETPR to the E-DPDCH to DPCCH power ratio as defined in subclause 3.1.1;

1> if an Absolute Grant was received for this TTI:

2> if the Identity type is “Primary”, and the Absolute Grant value is set to "INACTIVE":

3> if Absolute Grant Scope indicates "Per HARQ process" and a 2ms TTI is configured:

4> de-activate the process given by the value of CURRENT_HARQ_PROCESS.

3> if Absolute Grant Scope indicates "All HARQ processes" and a secondary E-RNTI was configured by higher layers:

4> activate all HARQ processes;

4> set Serving_Grant = Stored_Secondary_Grant;

4> set Primary_Grant_Available to "False".

2> else if the Absolute Grant Value is different from "INACTIVE":

3> if the Identity Type is "Secondary":

4> set Stored_Secondary_Grant = Absolute Grant Value.

3> if the Identity Type is "Primary" or Primary_Grant_Available is set to "False":

4> set Serving_Grant = Absolute Grant Value.

4> if the Identity Type is "Primary":

5> set Primary_Grant_Available to "True";

5> if Absolute Grant Scope indicates "Per HARQ process":

6> activate the process given by the value of CURRENT_HARQ_PROCESS.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 73

5> if Absolute Grant Scope indicates "All HARQ processes":

6> activate all HARQ processes;

5> ignore any serving RLS E-RGCH signalling for the next HARQ RTT (40ms in the case of 10ms TTI, 16ms in the case of 2ms TTI).

1> else (no Absolute Grant received):

2> if the HARQ process given by the value of CURRENT_HARQ_PROCESS is active; and

2> if Primary_Grant_Available is equal to "True"; and

2> if Serving_Grant <> "Zero_Grant" ; and

2> if there was a transmission in the previous TTI of the HARQ process given by the value of CURRENT_HARQ_PROCESS:

3> if the Serving Relative Grant indicates "UP":

4> determine the Serving_Grant in accordance with subclause 9.2.5.2.1.

3> else, if the Serving Relative Grant indicates "DOWN":

4> determine the Serving_Grant in accordance with subclause 9.2.5.2.1.

1> if any Non-Serving Relative Grants indicate "DOWN" for this TTI and Serving_Grant <> "Zero_Grant":

2> determine the Serving_Grant in accordance with subsection 9.2.5.2.1;

2> ensure that during the next HARQ RTT (40ms in case of a 10ms TTI, 16ms in case of a 2ms TTI), the Serving_Grant will not exceed this Serving_Grant (i.e. due to E-AGCH/E-RGCH signalling the Serving_Grant might be further decreased, but cannot be increased above this Serving_Grant).

11.8.1.3.2 Handling at start of E-DCH transmission

When E-DCH transmission is started (i.e. the RRC variable E_DCH_TRANSMISSION is changed from "false" to "true"), the UE shall:

- activate all HARQ processes;
- if the IE's "Serving Grant" and "Primary/Secondary Grant Selector" are provided by higher layers:
  - set the state variables Serving_Grant and Primary_Grant_Available to the values provided by higher layers;
- else
  - initialise the state variable Serving_Grant to Zero_Grant;
  - initialise the state variable Primary_Grant_Available to "True".
- initialise the state variable Stored_Secondary_Grant to "Zero_Grant";
- initialise the state variables reference_ETPR to "Minimum_Grant".

11.8.1.3.3 Handling at serving cell change

At E-DCH serving cell change, the higher layers shall configure the MAC-e with the grant value to use in the new cell and shall indicate whether the UE should monitor Absolute Grant Messages with the secondary E-RNTI.

The UE shall:

- activate all HARQ processes;
- if the IE's "Serving Grant" and "Primary/Secondary Grant Selector" are provided by higher layers:
  - set the state variables Serving_Grant and Primary_Grant_Available to the values provided by higher layers.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 74

- else
  - continue to use the current values of state variables Serving_Grant and Primary_Grant_Available.
- initialise the state variable Stored_Secondary_Grant to "Zero_Grant".

11.8.1.4 E-TFC Selection

In FDD mode, the rules for E-TFC selection provided below shall apply to UEs in CELL_DCH state with an E-DCH transport channel configured. These UEs shall apply the E-TFC selection procedure when invoked by the HARQ entity (see subclause 11.8.1.1.1). In the case where a 2ms TTI is configured, E-TFC selection shall not be performed for TTIs that overlap with an uplink compressed mode gap. The E-TFC restriction procedure described in [12] shall always be applied before the E-TFC selection process below. Furthermore, for UEs that are also configured with a DCH transport channel on uplink, the TFC selection procedure shall be applied before either of these.

For each MAC-d flow, RRC configures MAC with a HARQ profile and a multiplexing list. Additionally, RRC configures MAC with a power offset for "Control-only" transmissions. This power offset and a maximum number of HARQ transmissions of [16] will be used to define a HARQ profile for “Control-only” transmissions which will be used, in case the Scheduling Information needs to be transmitted without any higher-layer data. The HARQ profile includes the power offset and maximum number of HARQ transmissions to use for this MAC-d flow. The multiplexing list identifies for each MAC-d flow(s), the other MAC-d flows from which data can be multiplexed in a transmission that uses the power offset included in its HARQ profile.

RRC can control the scheduling of uplink data by giving each logical channel a priority between 1 and 8, where 1 is the highest priority and 8 the lowest. E-TFC selection in the UE shall be done in accordance with the priorities indicated by RRC. Logical channels have absolute priority, i.e. the UE shall maximise the transmission of higher priority data.

RRC can allocate non-scheduled transmission grants to individual MAC-d flows in order to reduce the transmission delays. When a 2ms TTI is configured each non-scheduled grant is applicable to the specific set of HARQ processes indicated by RRC. RRC can also restrict the set of HARQ processes to which scheduled grants are applicable when a 2ms TTI is configured.

For each configured MAC-d flow, a given E-TFC can be in any of the following states:

- Supported state;
- Blocked state.

At each TTI boundary, UEs in CELL_DCH state with an E-DCH transport channel configured shall determine the state of each E-TFC for every MAC-d flow configured based on its required transmit power versus the maximum UE transmit power (see [7] and [12]). If no DCH transport channel is configured or if a DCH transport channel is configured and the selected TFC is "empty" (see [3]), the UE shall consider that E-TFCs included in the minimum set of E-TFCs are always in supported state (see [7]).

At every TTI boundary for which a new transmission is requested by the HARQ entity (see subclause 11.8.1.1.1), the UE shall perform the operations described below. UEs configured both with DCH and E-DCH transport channels shall perform TFC selection before performing E-TFC selection.

The Serving Grant Update function provides the E-TFC selection function with the maximum E-DPDCH to DPCCH power ratio that the UE is allowed to allocate for the upcoming transmission for scheduled data (held in the Serving Grant state variable – see subsection 11.8.1.3).

The HARQ process ID for the upcoming transmission is determined using the following formulae:

- For 2ms TTI: CURRENT_HARQ_PROCESS_ID = [5*CFN + subframe number] **mod** HARQ_RTT
- For 10ms TTI: CURRENT_HARQ_PROCESS_ID = [CFN] **mod** HARQ_RTT

Based on this current HARQ process ID and the RRC configuration, the UE shall determine whether to take the scheduled and non-scheduled grants into account in the upcoming transmission. If they are not supposed to be taken into account, then the corresponding grant shall be assumed to not exist. If the variable Serving_Grant has the value "Zero_Grant" after the Serving Grant Update, then the Serving Grant shall not be taken into account in the upcoming transmission.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 75

When Scheduling Information needs to be transmitted, the E-TFC selection and data-allocation process shall assume that a non-scheduled grant is available for its transmission. Furthermore the HARQ process used for the upcoming transmission shall be assumed to be active and not L3 restricted for the transmission of the Scheduling Information, i.e. transmission of Scheduling Information can take place on this process.

The transmission format and data allocation shall follow the requirements below:

- Only E-TFCs from the configured E-TFCS shall be considered for the transmission;
- For all logical channels, if the logical channel belongs to a non-scheduled MAC-d flow, its data shall be considered as available up to the corresponding non-scheduled grant, if the logical channel does not belong to a non-scheduled MAC-d flow, its data shall be considered as available up to the Serving Grant;
- The HARQ profile for the transmission shall be selected among the HARQ profiles of MAC-d flows on which the highest priority logical channels with available data are mapped;
- In case the variable Serving_Grant has the value “Zero_Grant” after the Serving Grant Update function and there is no data available for MAC-d flows for which non-scheduled grants were configured and the transmission of Scheduling Information has been triggered, the “Control-only” HARQ profile configured by the higher layers shall be used.
- The Nominal Power Offset shall be set to the power offset included in the transmission HARQ profile;
- The data allocation shall maximize the transmission of higher priority data;
- The amount of data from MAC-d flows for which non-scheduled grants were configured shall not exceed the value of the non-scheduled grant, the amount of data required to transmit the MAC-e/es headers or the Scheduling Information shall not be taken into account;
- If a 10ms TTI is configured and the TTI for the upcoming transmission overlaps with a compressed mode gap, the Serving_Grant provided by the Serving Grant Update function shall be scaled back as follows:

  $$SG' = SG * (\frac{N_C}{15})$$

  where SG’ represents the modified serving grant considered by the E-TFC selection algorithm and N_C represents the number of non DTX slots in the compressed TTI;
- The maximum amount of data from MAC-d flows for which no non-scheduled grants were configured shall be quantized to the next smaller supported E-TFC based on the Serving Grant (after adjustment for compressed frames) and the power offset from the selected HARQ profile, the power ratio required for the transmission of the MAC-e/es headers and the Scheduling Information shall not be taken into account; In the case a 2ms TTI is configured and the HARQ process is inactive, the UE shall not include any such data in the transmission;
- Only E-TFCs in supported state shall be considered;
- The E-TFC resulting in the smallest amount of padding shall be selected including the case when the Scheduling Information needs to be transmitted.

Once an appropriate E-TFC and data allocation are found according to the rules above, the "Multiplexing and TSN Setting” entity shall generate the corresponding MAC-e PDU.

The E-TFC selection function shall provide this MAC-e PDU and transmission HARQ profile to the HARQ entity. The maximum number of HARQ transmissions and the power offset in this profile, shall be set respectively to the maximum of the Max Number of HARQ Transmissions of the HARQ profiles from all the MAC-d flows from which data is multiplexed into the transmission and to the Nominal Power Offset. The HARQ entity shall also be informed of whether the transmission includes Scheduling Information and whether this information is sent by itself or with higher-layer data.

11.8.1.5 Happy Bit Setting

The Happy Bit is included on the E-DPCCH for every E-DCH transmission. E-DCH transmissions shall not be triggered specifically to allow the transmission of the happy bit.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 76

RRC configures MAC with the duration Happy_Bit_Delay_Condition, over which to evaluate the current grant relative to the total buffer status. The total buffer status is defined as the total amount of data available across all logical channels for which reporting has been requested by the RRC.

The Happy Bit shall be set to "unhappy" if both of the following criteria are met:

- UE has enough power available to transmit at higher E-DPDCH to DPCCH ratios than what is allowed by the current Serving_Grant; and
- Total buffer status would require more than Happy_Bit_Delay_Condition ms to be transmited with the current Serving_Grant.

Otherwise, the Happy Bit shall be set to "happy".

11.8.1.6 Scheduling Information reporting

Scheduling information reports will be triggered differently depending on the value of the variable Serving_Grant after the Serving Grant Update function. The triggering of a report shall be indicated to the E-TFC selection function at the first new transmission opportunity (this process may be delayed in case the HARQ processes are occupied with re-transmissions).

Even if multiple events are triggered by the time a new transmission can take place, only a single scheduling information header will be included in the payload.

The Scheduling Information shall not be transmitted if the Total E-DCH Buffer Status is zero, even if it was triggered by one of the configured triggering mechanisms.

The transmission of Scheduling Information can take place on every HARQ process, even on those processes for which transmission is restricted according to RRC or deactivated by absolute grants, i.e. processes on which scheduled and/or non-scheduled transmission can not take place.

The description of the behaviour in the two cases is provided below.

11.8.1.6.1 Report Triggering when SG = “Zero_Grant” or all processes are deactivated

If the Serving_Grant has the value "Zero_Grant" or all processes are deactivated, and the Total E-DCH Buffer Status becomes larger than zero, the transmission of Scheduling Information shall be triggered.

If data with higher priority than the data already in the transmission buffer arrives, the transmission of a Scheduling Information shall be triggered.

RRC can also configure MAC with periodic Scheduling Information triggering. The periodic trigger timer T_SING (Timer Scheduling Information – "Zero_Grant") shall be started once the Serving_Grant variable becomes “Zero_Grant” or all processes are deactivated.

When T_SING expires, the transmission of a Scheduling Information shall be triggered.

T_SING shall be restarted when the transmission of a Scheduling Information is triggered.

T_SING shall be stopped once the Serving_Grant variable in the Serving Grant Update function takes a value other than "Zero_Grant" and at least one process is activated.

11.8.1.6.2 Report Triggering when SG <> “Zero_Grant” and at least one process is activated

If an E-DCH serving cell change occurs and if the new E-DCH serving cell was not part of the previous Serving E-DCH RLS, the transmission of a Scheduling Information shall be triggered.

RRC can configure MAC with periodic triggering also for the case when the variable Serving_Grant <> "Zero_Grant" and at least one process is activated. The periodic trigger timer T_SIG (Timer Scheduling Information – different from "Zero_Grant") can be configured to a different value than T_SING.

T_SIG shall be started once the Serving_Grant variable becomes <> "Zero_Grant" and at least one process is activated.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 77

When T_SIG expires, the transmission of a new Scheduling Information report shall be triggered. Then, T_SIG shall be restarted at the beginning of the TTI during which the MAC-e PDU containing the Scheduling Information is transmitted.

T_SIG shall be stopped once the Serving_Grant variable in the Serving Grant Update function becomes equal to "Zero_Grant" or all processes are deactivated.

T_SIG shall be restarted when the transmission of a Scheduling Information is triggered.

In addition to this periodic scheme, the transmission of Scheduling Information shall be triggered if the HARQ entity reports that the previous transmission was not received by the serving RLS.

Once the Serving_Grant variable in the Serving Grant Update function becomes equal to “Zero_Grant” or all processes are deactivated and Total E-DCH Buffer Status is larger than zero, the transmission of a Scheduling Information shall be triggered.

11.8.2 Node B operation

11.8.2.1 HARQ Operation

11.8.2.1.1 HARQ entity

There is one HARQ entity per UE in each Node-B in its E-DCH active set. The HARQ entity routes the payload and the associated RSN value to the appropriate HARQ process based on the transmission timing. Based on the outcome of the decoding, the HARQ entity transmits an ACK or a NACK in return.

11.8.2.1.2 HARQ process

The HARQ process uses the RSN and the transmission timing (CFN, sub-frame) to establish the transmission number. Based on this it identifies the transmission redundancy version and attempts to decode the transmission. The outcome of the decoding is reported to the HARQ entity, so that it may be fed back to the UE.

11.8.2.2 De-multiplexing

There is one de-multiplexing entity per UE in the Node B. The SRNC configures the Node B with the mapping between the active DDI values and the corresponding MAC-d flow and PDU size. Also, it provides it with the mapping between MAC-d flow IDs and the corresponding Iub bearer.

The de-multiplexing entity uses the MAC-e header information (DDI, N) to determine the size of each MAC-es PDU and based on this it segments the MAC-e payload into MAC-es PDUs. These are then routed onto the Iub bearer indicated by the DDI value.

With each MAC-es PDU, the Node B will send to the SRNC:

- the associated DDI and N values;
- the CFN and sub-frame numberwhen the payload including the MAC-es PDU was decoded correctly;
- the total number of transmissions that were needed for the MAC-e PDU to be decoded correctly.

11.8.2.3 Scheduler

There is one E-DCH Node B scheduler per Node B. The Node B scheduler is responsible for the following functions:

- Allocating uplink resources to UEs for which it acts as the serving Node B;
- Monitoring other-cell interference and accordingly sending relative grants to UEs for which it does not act as the serving Node B;
- Reporting to the SRNC on the lack of processing resources;

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 78

11.8.2.4 E-DCH Provided Bit Rate measurement

The E-DCH Provided Bit Rate measurement is defined as follows:

- for each priority class the MAC-e function in the Node B measures the total number of MAC-d PDU bits whose transmission over the radio interface has been considered successful by MAC-e in Node-B during the last measurement period, divided by the duration of the measurement period;
- the number of MAC-d PDU bits from UEs in softer handover shall be considered after soft combining;
- the measurement period shall be [100 ms].

11.8.3 RNC operation

11.8.3.1 Re-ordering entity

The re-ordering entity is part of the MAC-es sublayer in the SRNC. There is one re-ordering entity per UE. Each re-ordering entity will support one re-ordering process per logical channel. The DDI value is used to determine the logical channel for which each MAC-es PDU is meant. Based on this information, the MAC-es PDUs are routed to the proper re-ordering process. The re-ordering process may use the explicit TSN indication as well as the timing information provided by the Node B in order to eliminate duplicates and deliver the packets in order to RLC. The details of the re-ordering mechanism are left up to the implementation.

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 79

Annex A (normative): HS-DSCH Transport Block Size Table for FDD

The following table provides the mapping between k_t (as per the definition in subclause 9.2.3.1) and the HS-DSCH Transport Block Size (L(k_t)):

Index	TB Size	Index	TB Size	Index	TB Size
1	137	86	1380	171	6324
2	149	87	1405	172	6438
3	161	88	1430	173	6554
4	173	89	1456	174	6673
5	185	90	1483	175	6793
6	197	91	1509	176	6916
7	209	92	1537	177	7041
8	221	93	1564	178	7168
9	233	94	1593	179	7298
10	245	95	1621	180	7430
11	257	96	1651	181	7564
12	269	97	1681	182	7700
13	281	98	1711	183	7840
14	293	99	1742	184	7981
15	305	100	1773	185	8125
16	317	101	1805	186	8272
17	329	102	1838	187	8422
18	341	103	1871	188	8574
19	353	104	1905	189	8729
20	365	105	1939	190	8886
21	377	106	1974	191	9047
22	389	107	2010	192	9210
23	401	108	2046	193	9377
24	413	109	2083	194	9546
25	425	110	2121	195	9719
26	437	111	2159	196	9894
27	449	112	2198	197	10073
28	461	113	2238	198	10255
29	473	114	2279	199	10440
30	485	115	2320	200	10629
31	497	116	2362	201	10821
32	509	117	2404	202	11017
33	521	118	2448	203	11216
34	533	119	2492	204	11418
35	545	120	2537	205	11625
36	557	121	2583	206	11835
37	569	122	2630	207	12048
38	581	123	2677	208	12266
39	593	124	2726	209	12488
40	605	125	2775	210	12713
41	616	126	2825	211	12943
42	627	127	2876	212	13177
43	639	128	2928	213	13415
44	650	129	2981	214	13657
45	662	130	3035	215	13904

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 80

46	674	131	3090	216	14155
47	686	132	3145	217	14411
48	699	133	3202	218	14671
49	711	134	3260	219	14936
50	724	135	3319	220	15206
51	737	136	3379	221	15481
52	751	137	3440	222	15761
53	764	138	3502	223	16045
54	778	139	3565	224	16335
55	792	140	3630	225	16630
56	806	141	3695	226	16931
57	821	142	3762	227	17237
58	836	143	3830	228	17548
59	851	144	3899	229	17865
60	866	145	3970	230	18188
61	882	146	4042	231	18517
62	898	147	4115	232	18851
63	914	148	4189	233	19192
64	931	149	4265	234	19538
65	947	150	4342	235	19891
66	964	151	4420	236	20251
67	982	152	4500	237	20617
68	1000	153	4581	238	20989
69	1018	154	4664	239	21368
70	1036	155	4748	240	21754
71	1055	156	4834	241	22147
72	1074	157	4921	242	22548
73	1093	158	5010	243	22955
74	1113	159	5101	244	23370
75	1133	160	5193	245	23792
76	1154	161	5287	246	24222
77	1175	162	5382	247	24659
78	1196	163	5480	248	25105
79	1217	164	5579	249	25558
80	1239	165	5680	250	26020
81	1262	166	5782	251	26490
82	1285	167	5887	252	26969
83	1308	168	5993	253	27456
84	1331	169	6101	254	27952
85	1356	170	6211		

Annex B (normative): E-DCH Transport Block Size Tables for FDD

The mapping between the chosen E-TFC index and the corresponding E-DCH transport block size is given in the following tables:

B.1 2ms TTI E-DCH Transport Block Size Table 0

TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)
0	18	30	342	60	1015	90	3008	120	8913
1	120	31	355	61	1053	91	3119	121	9241

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 81

2	124	32	368	62	1091	92	3234	122	9582
3	129	33	382	63	1132	93	3353	123	9935
4	133	34	396	64	1173	94	3477	124	10302
5	138	35	410	65	1217	95	3605	125	10681
6	143	36	426	66	1262	96	3738	126	11075
7	149	37	441	67	1308	97	3876	127	11484
8	154	38	458	68	1356	98	4019		
9	160	39	474	69	1406	99	4167		
10	166	40	492	70	1458	100	4321		
11	172	41	510	71	1512	101	4480		
12	178	42	529	72	1568	102	4645		
13	185	43	548	73	1626	103	4816		
14	192	44	569	74	1685	104	4994		
15	199	45	590	75	1748	105	5178		
16	206	46	611	76	1812	106	5369		
17	214	47	634	77	1879	107	5567		
18	222	48	657	78	1948	108	5772		
19	230	49	682	79	2020	109	5985		
20	238	50	707	80	2094	110	6206		
21	247	51	733	81	2172	111	6435		
22	256	52	760	82	2252	112	6672		
23	266	53	788	83	2335	113	6918		
24	275	54	817	84	2421	114	7173		
25	286	55	847	85	2510	115	7437		
26	296	56	878	86	2603	116	7711		
27	307	57	911	87	2699	117	7996		
28	318	58	944	88	2798	118	8290		
29	330	59	979	89	2901	119	8596		

B.2 2ms TTI E-DCH Transport Block Size Table 1

TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)
0	18	43	2724	86	7252
1	186	44	2742	87	7288
2	204	45	3042	88	7428
3	354	46	3060	89	7464
4	372	47	3078	90	7764
5	522	48	3298	91	7800
6	540	49	3316	92	7908
7	674	50	3334	93	7944
8	690	51	3378	94	8100
9	708	52	3396	95	8136
10	726	53	3414	96	8436
11	858	54	3732	97	8472
12	876	55	3750	98	8564
13	1026	56	3972	99	8600
14	1044	57	3990	100	8772
15	1062	58	4068	101	8808
16	1194	59	4086	102	9108
17	1212	60	4404	103	9144
18	1330	61	4422	104	9220
19	1348	62	4628	105	9256

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 82

20	1362	63	4646	106	9444
21	1380	64	4740	107	9480
22	1398	65	4758	108	9780
23	1530	66	5076	109	9816
24	1548	67	5094	110	9876
25	1698	68	5284	111	9912
26	1716	69	5302	112	10116
27	1734	70	5412	113	10152
28	1866	71	5430	114	10452
29	1884	72	5748	115	10488
30	1986	73	5766	116	10532
31	2004	74	5940	117	10568
32	2022	75	5958	118	10788
33	2034	76	6084	119	10824
34	2052	77	6102	120	11124
35	2070	78	6420	121	11178
36	2370	79	6438	122	11188
37	2388	80	6596	123	11242
38	2406	81	6614	124	11460
39	2642	82	6756	125	11478
40	2660	83	6774		
41	2678	84	7092		
42	2706	85	7110		

B.3 10ms TTI E-DCH Transport Block Size Table 0

TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)
0	18	30	389	60	1316	90	4452	120	15051
1	120	31	405	61	1371	91	4636	121	15675
2	124	32	422	62	1428	92	4828	122	16325
3	130	33	440	63	1487	93	5029	123	17001
4	135	34	458	64	1549	94	5237	124	17706
5	141	35	477	65	1613	95	5454	125	18440
6	147	36	497	66	1680	96	5680	126	19204
7	153	37	517	67	1749	97	5915	127	20000
8	159	38	539	68	1822	98	6161		
9	166	39	561	69	1897	99	6416		
10	172	40	584	70	1976	100	6682		
11	180	41	608	71	2058	101	6959		
12	187	42	634	72	2143	102	7247		
13	195	43	660	73	2232	103	7547		
14	203	44	687	74	2325	104	7860		
15	211	45	716	75	2421	105	8186		
16	220	46	745	76	2521	106	8525		
17	229	47	776	77	2626	107	8878		
18	239	48	809	78	2735	108	9246		
19	249	49	842	79	2848	109	9629		
20	259	50	877	80	2966	110	10028		
21	270	51	913	81	3089	111	10444		
22	281	52	951	82	3217	112	10877		
23	293	53	991	83	3350	113	11328		
24	305	54	1032	84	3489	114	11797		
25	317	55	1074	85	3634	115	12286		

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 83

26	331	56	1119	86	3784	116	12795
27	344	57	1165	87	3941	117	13325
28	359	58	1214	88	4105	118	13877
29	374	59	1264	89	4275	119	14453

B.4 10ms TTI E-DCH Transport Block Size Table 1

TB Index	TB Size (bits)	TB Index	TB Size (bits)	TB Index	TB Size (bits)
0	18	41	5076	82	11850
1	186	42	5094	83	12132
2	204	43	5412	84	12186
3	354	44	5430	85	12468
4	372	45	5748	86	12522
5	522	46	5766	87	12804
6	540	47	6084	88	12858
7	690	48	6102	89	13140
8	708	49	6420	90	13194
9	858	50	6438	91	13476
10	876	51	6756	92	13530
11	1026	52	6774	93	13812
12	1044	53	7092	94	13866
13	1194	54	7110	95	14148
14	1212	55	7428	96	14202
15	1362	56	7464	97	14484
16	1380	57	7764	98	14556
17	1530	58	7800	99	14820
18	1548	59	8100	100	14892
19	1698	60	8136	101	15156
20	1716	61	8436	102	15228
21	1866	62	8472	103	15492
22	1884	63	8772	104	15564
23	2034	64	8808	105	15828
24	2052	65	9108	106	15900
25	2370	66	9144	107	16164
26	2388	67	9444	108	16236
27	2706	68	9480	109	16500
28	2724	69	9780	110	16572
29	3042	70	9816	111	17172
30	3060	71	10116	112	17244
31	3378	72	10152	113	17844
32	3396	73	10452	114	17916
33	3732	74	10488	115	18516
34	3750	75	10788	116	18606
35	4068	76	10824	117	19188
36	4086	77	11124	118	19278
37	4404	78	11178	119	19860
38	4422	79	11460	120	19950
39	4740	80	11514		
40	4758	81	11796		

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 84

Annex C (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
06/1999	RP-04	RP-99312	-		Approved at TSG-RAN #4 and placed under Change Control	-	3.0.0
10/1999	RP-05	RP-99463	001	1	Modified MAC handling of PCH and FACH	3.0.0	3.1.0
	RP-05	RP-99463	002		Modifications of MAC primitives	3.0.0	3.1.0
	RP-05	RP-99463	003	2	RACH/FACH MAC header – Channel type identification	3.0.0	3.1.0
	RP-05	RP-99463	004		Support for USCH/DSCH signalling in TDD	3.0.0	3.1.0
	RP-05	RP-99463	006		Clarification on RACH partitioning and prioritization via access service class (ASC) and relation to back-off algorithm	3.0.0	3.1.0
	RP-05	RP-99463	010	1	Modifications on UE-Id formats	3.0.0	3.1.0
	RP-05	RP-99463	011		CPCH primitives	3.0.0	3.1.0
	RP-05	RP-99463	012		Timing advance for TDD	3.0.0	3.1.0
	RP-05	RP-99463	013	1	Traffic volume measurement report procedure	3.0.0	3.1.0
	RP-05	RP-99463	014		Mapping of BCCH logical channel onto FACH transport channel	3.0.0	3.1.0
	RP-05	RP-99463	015	1	MAC PDU formats for DCCH/DTCH on DSCH and for PCCH	3.0.0	3.1.0
	RP-05	RP-99463	016	1	Informative parts that shall not specify or constrain implementations	3.0.0	3.1.0
	RP-05	RP-99463	017	1	Modification of RACH transmission control procedure	3.0.0	3.1.0
	RP-05	RP-99463	018		Removal of MAC function for system information and paging scheduling	3.0.0	3.1.0
	RP-05	RP-99463	019	1	RACH transmission control procedure on MAC for TDD mod	3.0.0	3.1.0
	RP-05	RP-99463	021	1	Removal of Annex A and B of TS 25.321	3.0.0	3.1.0
12/1999	RP-06	RP-99638	022	3	Modified MAC header field sizes	3.1.0	3.2.0
	RP-06	RP-99638	023		MAC: Multiple shared channels (DSCH/USCH)	3.1.0	3.2.0
	RP-06	RP-99638	024		Parameters for Status Primitive	3.1.0	3.2.0
	RP-06	RP-99638	025	1	Support of shared channel operation in TDD	3.1.0	3.2.0
	RP-06	RP-99638	028		Modification of Cell Broadcast Service (CBS)	3.1.0	3.2.0
	RP-06	RP-99637	030	1	Editorial changes	3.1.0	3.2.0
	RP-06	RP-99638	031	1	Simultaneous mapping of logical channels on	3.1.0	3.2.0
03/2000	RP-07	RP-000039	032		Bit Aligned TDD MAC Headers	3.2.0	3.3.0
	RP-07	RP-000039	035	2	CPCH including Channel Assignment	3.2.0	3.3.0
	RP-07	RP-000039	036		UE-ID type indication	3.2.0	3.3.0
	RP-07	RP-000039	037	1	RACH transmission control procedure	3.2.0	3.3.0
	RP-07	RP-000039	039		CPCH start of message indication	3.2.0	3.3.0
	RP-07	RP-000039	040		Removal of SCH and SCCH	3.2.0	3.3.0
	RP-07	RP-000039	041	1	Clarification of bit order	3.2.0	3.3.0
06/2000	RP-08	RP-000219	042		CPCH correction	3.3.0	3.4.0
	RP-08	RP-000219	043	1	End of CPCH transmission	3.3.0	3.4.0
	RP-08	RP-000219	044	2	Clarification of prioritisation of logical channels in UE	3.3.0	3.4.0
	RP-08	RP-000219	045	1	CPCH MAC procedures	3.3.0	3.4.0
	RP-08	RP-000219	046		Traffic Volume Measurement for dynamic radio bearer control	3.3.0	3.4.0
09/2000	RP-09	RP-000357	047		Movement of primitives text to the correct section	3.4.0	3.5.0
	RP-09	RP-000357	048		Corrections to RACH procedure	3.4.0	3.5.0
	RP-09	RP-000357	049		Clarification on the parameters of the MAC-RLC primitives	3.4.0	3.5.0
	RP-09	RP-000357	051	1	Editorial Cleanup	3.4.0	3.5.0
12/2000	RP-10	RP-000567	053	2	Corrections to logical channel priorities in MAC Protocol	3.5.0	3.6.0
	RP-10	RP-000567	055	1	Removal of FAUSCH	3.5.0	3.6.0
	RP-10	RP-000567	056	2	General MAC clarification	3.5.0	3.6.0
	RP-10	RP-000567	057	1	Error Handling in MAC	3.5.0	3.6.0
	RP-10	RP-000567	058	1	Error handling for MAC RACH and CPCH transmission control procedure	3.5.0	3.6.0
	RP-10	RP-000567	059		Inclusion of stage 3 for ciphering	3.5.0	3.6.0
03/2001	RP-11	RP-010025	061		Removal of FAUSCH	3.6.0	3.7.0
	RP-11	RP-010025	066	3	TFC selection algorithm correction	3.6.0	3.7.0
	RP-11	RP-010025	067	3	Miscellaneous corrections	3.6.0	3.7.0
	RP-11	RP-010025	068	2	Clarification on Traffic Volume Measurement Procedure	3.6.0	3.7.0
	RP-11	RP-010025	070	1	Clarification on parameters of the primitives	3.6.0	3.7.0
	RP-11	RP-010037	064		1.28Mcps TDD	3.7.0	4.0.0
06/2001	RP-12	RP-010308	074		RLC Tr Discard	4.0.0	4.1.0
	RP-12	RP-010308	076		Clarification on compressed mode	4.0.0	4.1.0
	RP-12	RP-010308	078		Correction of relation between MAC functions and transport channels	4.0.0	4.1.0
	RP-12	RP-010308	080		Rate adaptation	4.0.0	4.1.0
	RP-12	RP-010308	082		Cleanup of MAC services and functions	4.0.0	4.1.0
	RP-12	RP-010322	083		Correction to control of RACH Transmissions for 1.28Mcps TDD	4.0.0	4.1.0
09/2001	RP-13	RP-010541	085		Setting of UE Id in MAC	4.1.0	4.2.0
	RP-13	RP-010541	087		MAC ASC selection operation when access class is used to	4.1.0	4.2.0

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 85

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
					determine ASC		
	RP-13	RP-010541	089		Addition of neighbour cell BCH to MAC-b model for the UE	4.1.0	4.2.0
	RP-13	RP-010541	093	1	Clarification on TFC selection	4.1.0	4.2.0
12/2001	RP-14	RP-010760	091	1	Cautionary Note for Interfrequency Measurements in Cell-FACH	4.2.0	4.3.0
	RP-14	RP-010760	095		Correction on Control of RACH Transmissions	4.2.0	4.3.0
	RP-14	RP-010760	097		Correction on Traffic Volume Control	4.2.0	4.3.0
	RP-14	RP-010760	099		General correction on Access Service Class selection	4.2.0	4.3.0
	RP-14	RP-010760	101		TFC selection in compressed mode	4.2.0	4.3.0
03/2002	RP-15	RP-020067	103		Clarification on ciphering	4.3.0	4.4.0
	RP-15	RP-020067	106		TDD MAC Layer Subchannel Assignment	4.3.0	4.4.0
	RP-15	RP-020067	110		Missing DTCH channel type in UE-ID Type Indicator	4.3.0	4.4.0
	RP-15	RP-020067	112		Correction on UE Id for DSCH	4.3.0	4.4.0
	RP-15	RP-020067	114		UE undefined behaviour when padding is required	4.3.0	4.4.0
	RP-15	RP-020094	104	2	Introduction of HSDPA	4.4.0	5.0.0
06/2002	RP-16	RP-020326	117		Update References to include 25.123 (TDD)	5.0.0	5.1.0
	RP-16	RP-020326	120		TFCS selection guideline correction	5.0.0	5.1.0
	RP-16	RP-020341	121		HSDPA related MAC corrections	5.0.0	5.1.0
	RP-16	RP-020341	122		Description for MAC-hs reset	5.0.0	5.1.0
09/2002	RP-17	RP-020538	130		MAC TVM Corrections	5.1.0	5.2.0
	RP-17	RP-020538	133		MAC header for DTCH and DCCH	5.1.0	5.2.0
	RP-17	RP-020556	123		Optional use of a maximum transmission delay for MAC-hs SDUs	5.1.0	5.2.0
	RP-17	RP-020556	124		MAC-hs: Scheduler and HARQ entity functions for TSN	5.1.0	5.2.0
	RP-17	RP-020556	125		Correction on C/T field definition for HS-DSCH	5.1.0	5.2.0
	RP-17	RP-020556	126		Corrections to re-ordering protocol description	5.1.0	5.2.0
	RP-17	RP-020556	127		Limiting of number of PDUs per TTI	5.1.0	5.2.0
	RP-17	RP-020556	134		Signaling of Transport Block Sizes for HS-DSCH	5.1.0	5.2.0
	RP-17	RP-020556	135		Transport block size signalling 3.84 Mcps TDD	5.1.0	5.2.0
	RP-17	RP-020556	136		Static HSDPA Tranport Block Sizes for 1.28 Mcps TDD	5.1.0	5.2.0
12/2002	RP-18	RP-020718	142	1	TFC selection for RACH transmissions	5.2.0	5.3.0
	RP-18	RP-020718	145		RB id in ciphering	5.2.0	5.3.0
	RP-18	RP-020718	148		Correction to TFC selection for TDD	5.2.0	5.3.0
	RP-18	RP-020718	151		Unblockable TFCs in excess power state	5.2.0	5.3.0
	RP-18	RP-020735	137		Generation of RLC Status Reports to coordinate with MAC-hs reset	5.2.0	5.3.0
	RP-18	RP-020735	138		Re-ordering Mechanism	5.2.0	5.3.0
	RP-18	RP-020735	139		Transport Block Size Signalling for 1.28Mcps TDD	5.2.0	5.3.0
	RP-18	RP-020735	153		Limitation on number of PDUs per single TTI for 1.28 Mcps TDD	5.2.0	5.3.0
	RP-18	RP-020735	154		The Number of mac-d pdu's in a single mac-hs PDU for TDD	5.2.0	5.3.0
	RP-18	RP-020851	155		HSDPA Retransmission block Size	5.2.0	5.3.0
	RP-18	RP-020874	158		Ciphering of multiple PDUs per TTI	5.2.0	5.3.0
	RP-19	RP-030100	166		Setting of ciphering activation time for TM bearers	5.3.0	5.4.0
	RP-19	RP-030100	169	1	TFC Control Implementation	5.3.0	5.4.0
	RP-19	RP-030115	159		TDD HCSN determination in MAC-hs	5.3.0	5.4.0
	RP-19	RP-030115	160		Correction to the use of Transport Block Size index equal to 111111 for TDD	5.3.0	5.4.0
	RP-19	RP-030115	163		Editorial changes to MAC-hs	5.3.0	5.4.0
	RP-19	RP-030115	170		Re-ordering entity corrections	5.3.0	5.4.0
06/2003	RP-20	RP-030302	171		Text clean up of the description of the reordering entity	5.4.0	5.5.0
	RP-20	RP-030302	172		MAC header for DTCH and DCCH mapped to HS-DSCH	5.4.0	5.5.0
09/2003	RP-21	RP-030501	178		TFCS selection guidelines for TFC Subset	5.5.0	5.6.0
	RP-21	RP-030536	174	2	MAC-hs Re-ordering Protocol Correction & MAC-hs window re-ordering	5.5.0	5.6.0
	RP-21	RP-030494	175		Addition of HS-DSCH Provided Bit Rate measurement	5.5.0	5.6.0
12/2003	RP-22	RP-030624	179		Corrections Relating to HSDPA TB Sizes for 1.28Mcps TDD	5.6.0	5.7.0
	RP-22	RP-030624	180		HSDPA Transport block size table for 3.84Mcps TDD	5.6.0	5.7.0
	RP-22	RP-030624	181		HSDPA TB size table	5.6.0	5.7.0
	RP-22	RP-030624	182		Unwarranted HARQ re-transmissions	5.6.0	5.7.0
	RP-22	RP-030624	183		MAC-hs Re-ordering Protocol Flushing correction	5.6.0	5.7.0
	RP-22	RP-030624	184		Correction to window based stall avoidance mechanism	5.6.0	5.7.0
	RP-22	-	-		Upgrade to Release 6 - no technical change	5.7.0	6.0.0
03/2004	RP-23	RP-040104	186	1	UE handling of NDI and TBS for HSDPA	6.0.0	6.1.0
	RP-23	RP-040104	188		HSDPA related corrections on MAC-hs reconfiguration	6.0.0	6.1.0
	RP-23	RP-040104	190		Reconfiguration of soft memory buffer partitioning	6.0.0	6.1.0
06/2004	RP-24	RP-040200	194		Use of U-RNTI in downlink	6.1.0	6.2.0
	RP-24	RP-040234	196		State variables arithmetic comparison	6.1.0	6.2.0
12/2004	RP-26	RP-040480	198		MAC-hs header extension	6.2.0	6.3.0
	RP-26	RP-040480	200		Clarification on the C/T field use in the HSDPA Mac-d header	6.2.0	6.3.0
	RP-26	RP-040489	201	1	Introduction of MBMS MAC header	6.2.0	6.3.0
	RP-26	RP-040489	202		Introduction of MBMS	6.2.0	6.3.0
	RP-26	RP-040497	203		Introduction of EUL in MAC specification	6.2.0	6.3.0

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 86

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
03/2005	RP-27	RP-050078	204		Correction to MBMS header for MBMS	6.3.0	6.4.0
06/2005	RP-28	RP-050301	0207		Correction of HSDPA state variable	6.4.0	6.5.0
	RP-28	RP-050319	0208		Corrections to the description of TCTF field	6.4.0	6.5.0
	RP-28	RP-050301	0210		Reconfiguration of MAC-hs parameters	6.4.0	6.5.0
	RP-28	RP-050308	0212		Feature Clean-up: Removal of DSCH (FDD)	6.4.0	6.5.0
	RP-28	RP-050309	0214		Feature Clean Up: Removal of CPCH	6.4.0	6.5.0
	RP-28	RP-050323	0215		HS-DSCH Provided Bit Rate measurement per Cell Portion	6.4.0	6.5.0
	RP-28	RP-050375	0216	2	Additional text on EUL in MAC specification	6.4.0	6.5.0
09/2005	RP-29	RP-050462	0218		Correction of TB size for 1.28 Mcps TDD	6.5.0	6.6.0
	RP-29	RP-050602	0219	5	Additional text on EUL in MAC specification	6.5.0	6.6.0
	RP-29	RP-050452	0220		Definition of UE power Headroom	6.5.0	6.6.0
	RP-29	RP-050457	0222		Feature Clean Up: Removal of CPCH	6.5.0	6.6.0

Ex. 1021 - TCL Comm Tech Holdings Ltd.
TCL Comm Tech Holdings Ltd. v. Mitsubishi Electric Corp. - IPR2023-00957
Page 87