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Contents

Foreword

This Technical Specification 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.

1 Scope

The present document specifies the X2 user plane protocol being used over the X2 interface.

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 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[3] 3GPP TS 29.281: "General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply.
A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Master eNB: as defined in TS 36.300 [2].

Secondary eNB: as defined in TS 36.300 [2].

Split bearer: as defined in TS 36.300 [2].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply.
An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

DC	Dual Connectivity
DL	Downlink
E-RAB	E-UTRAN Radio Access Bearer
MeNB	Master eNB
SeNB	Secondary eNB
UL	Uplink
UP	User Plane
X2 UP	X2 User Plane

4 General

4.1 General aspects

The X2 user plane (X2 UP) protocol is located in the User Plane of the Radio Network layer over the X2 interface.

The X2 UP protocol is used to convey control information related to the user data flow management of E-RABs.

Each X2 UP protocol instance is associated to one E-RAB only.

This version of the present document defines the X2 UP protocol in the context of dual connectivity only, more specifically, only for X2 user data bearers setup for E-RABs configured with the split bearer option.

If configured, X2 UP protocol instances exist at the eNBs between which the X2 user data bearers are setup, specifically for dual connectivity between the MeNB and the SeNB.

NOTE: X2 user data bearers may be setup for data forwarding purposes during X2 HO or during DC related mobility, however, these X2 user data bearers do not require the execution of any additional E-RAB related UP protocol functions related to an X2 UP protocol instance.

In this version of the present document, X2 UP protocol data is conveyed by GTP-U protocol means, more specifically, by means of the "RAN Container" GTP-U extension header as defined in TS 29.281 [3].

5 X2 user plane protocol

5.1 General

The X2 UP protocol layer is using services of the transport network layer in order to allow flow control of user data packets transferred over the X2 interface.

5.2 X2 user plane protocol layer services

The following functions are provided by the X2 UP protocol:

- Provision of X2 UP specific sequence number information for user data transferred from the MeNB to the SeNB for a specific E-RAB configured with the split bearer option;
- Information of successful in sequence delivery of PDCP PDUs to the UE from SeNB for user data associated with a specific E-RAB configured with the split bearer option;
- Information of PDCP PDUs that were not delivered to the UE;
- Information of the currently desired buffer size at the SeNB for transmitting to the UE user data associated with a specific E-RAB configured with the split bearer option;
- Information of the currently minimum desired buffer size at the SeNB for transmitting to the UE user data associated with all E-RABs configured with the split bearer option.

5.3 Services expected from the X2 Transport Network Layer

The X2 user plane protocol layer expects the following services from the Transport Network Layer:

- Transfer of user data.

5.4 Elementary procedures

5.4.1 Transfer of Downlink User Data

5.4.1.1 Successful operation

The purpose of the Transfer of Downlink User Data procedure is to provide X2-U specific sequence number information at the transfer of user data carrying at least one DL PDCP PDU from the MeNB to the SeNB via the X2-U interface.

An X2 user plane instance making use of the Transfer of Downlink User Data procedure is associated to a single E-RAB only. The Transfer of Downlink User Data procedure is invoked whenever user data for that particular E-RAB needs to be sent across the X2-U interface.

The MeNB shall assign consecutive X2-U sequence numbers to each transferred X2-U packet.

The SeNB shall detect whether an X2-U packet was lost and memorise the respective sequence number after it has declared the respective X2-U packet as being "lost".

The SeNB shall transfer the remaining PDCP PDUs towards the UE and memorise the highest PDCP PDU sequence number of that X2-U packet from which all contained PDCP PDUs were successfully delivered in sequence towards the UE.

NOTE: The Transfer of Downlink User Data procedure and the associated feedback of lost X2-U packets assist the MeNB in avoiding PDCP HFN de-synchronisation. If an E-UTRAN deployment decides to not use the Transfer of Downlink User Data procedure, PDCP HFN synchronization should be ensured by other means.

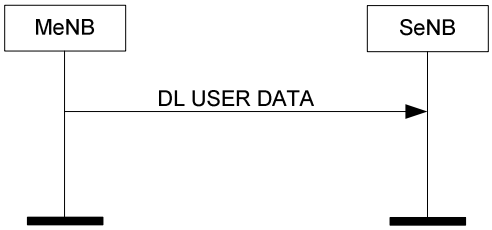

Figure 5.4.1.1-1: Successful Transfer of Downlink User Data

5.4.1.2 Unsuccessful operation

Void.

5.4.2 Downlink Data Delivery Status

5.4.2.1 Successful operation

The purpose of the Downlink Data Delivery Status procedure is to provide feedback from the SeNB to the MeNB to allow the MeNB to control the downlink user data flow via the SeNB for the respective E-RAB. The SeNB may also transfer uplink user data for the concerned E-RAB to the MeNB together with a DL DATA DELIVERY STATUS frame within the same GTP-U PDU.

When the SeNB decides to trigger the Feedback for Downlink Data Delivery procedure it shall report:

a) the highest PDCP PDU sequence number successfully delivered in sequence to the UE among those PDCP PDUs received from the MeNB;

b) the desired buffer size in bytes for the concerned E-RAB;

c) the minimum desired buffer size in bytes for the UE;

d) the X2-U packets that were declared as being "lost" by the SeNB and have not yet been reported to the MeNB within the DL DATA DELIVERY STATUS frame.

NOTE: If an E-UTRAN deployment has decided not to use the Transfer of Downlink User Data procedure, d) above is not applicable.

The DL DATA DELIVERY STATUS frame shall also include an indication whether the frame is the last DL status report received in the course of releasing a bearer from the SeNB. When receiving such indication, if applicable, the MeNB considers that no more UL data is to be expected from the SeNB.

The MeNB, when receiving the DL DATA DELIVERY STATUS frame:

- regards the desired buffer size under b) and c) above as the amount of data desired from the SeNB being declared
  - from the PDCP sequence number reported under a) above within the same frame, as well as from the most recently reported PDCP sequence number(s) of all other E-RABs established for the UE;
  - as the momentary desired buffer sizes, independent of buffer sizes indicated in the past.
- is allowed to remove the buffered PDCP PDUs according to the feedback of successfully delivered PDCP PDUs;
- decides upon the actions necessary to take for PDCP PDUs reported other than successfully delivered.

After being reported to the MeNB, the SeNB removes the respective PDCP sequence numbers.

Figure 5.4.2.1-1: Successful Downlink Data Delivery Status

5.4.2.2 Unsuccessful operation

Void.

5.5 Elements for the X2 user plane protocol

5.5.1 General

In the present document the structure of frames are specified by using figures similar to figure 5.5.1-1.

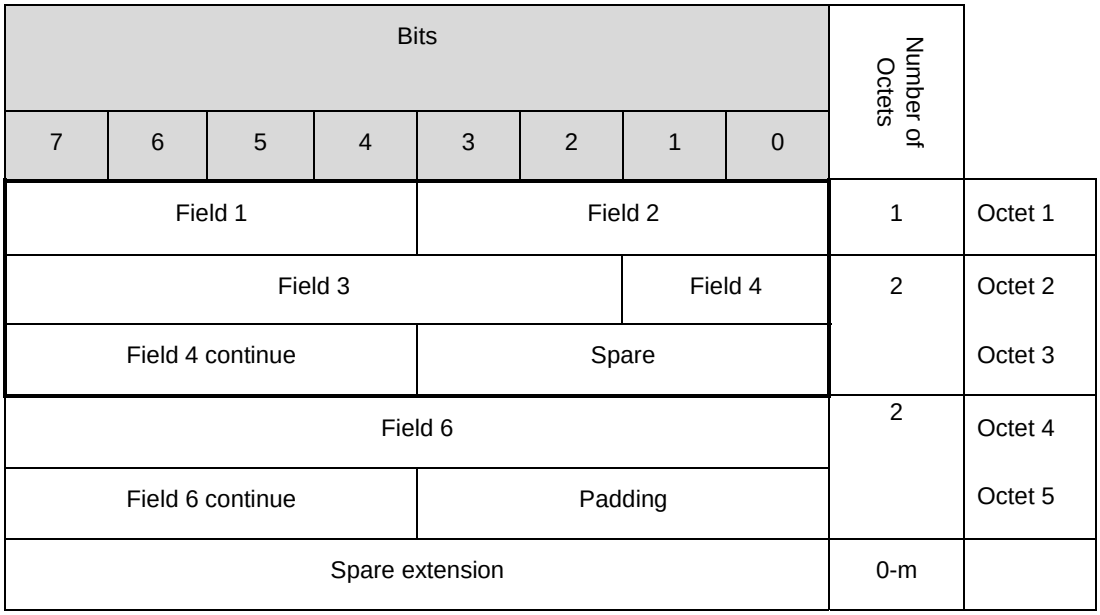

Figure 5.5.1-1: Example frame format

Unless otherwise indicated, fields which consist of multiple bits within an octet have the most significant bit located at the higher bit position (indicated above frame in figure 5.5.1-1). In addition, if a field spans several octets, most significant bits are located in lower numbered octets (right of frame in figure 5.5.1-1).

On the X2 interface, the frame is transmitted starting from the lowest numbered octet. Within each octet, the bits are sent according decreasing bit position (bit position 7 first).

Spare bits should be set to "0" by the sender and should not be checked by the receiver.

The header part of the frame is always an integer number of octets. The payload part is octet aligned (by adding 'Padding' when needed).

The receiver should be able to remove an additional spare extension field that may be present at the end of a frame. See description of Spare extension field.

5.5.2 Frame format for the X2 user plane protocol

5.5.2.1 DL USER DATA (PDU Type 0)

This frame format is defined to allow the SeNB to detect lost X2-U packets and is associated with the transfer of at least one Downlink PDCP PDU over the X2-U interface.

The following shows the respective DL USER DATA frame.

Bits								Number of Octets
7	6	5	4	3	2	1	0	
PDU Type (=0)				spare				1
X2-U Sequence Number								2
Spare extension								0-4

Figure 5.5.2.1-1: DL USER DATA (PDU Type 0) Format

5.5.2.2 DL DATA DELIVERY STATUS (PDU Type 1)

This frame format is defined to transfer feedback to allow the receiving MeNB to control the downlink user data flow via the SeNB.

<table>
<tr><th colspan="8">Bits</th><th rowspan="2">Number of Octets</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="5">PDU Type (=1)</td><td colspan="2">Spare</td><td>Final Frame Ind.</td><td>Lost Packet Report</td><td>1</td></tr>
<tr><td colspan="8">Highest successfully delivered PDCP Sequence Number</td><td>2</td></tr>
<tr><td colspan="8">Desired buffer size for the E-RAB</td><td>4</td></tr>
<tr><td colspan="8">Minimum desired buffer size for the UE</td><td>4</td></tr>
<tr><td colspan="8">Number of lost X2-U Sequence Number ranges reported</td><td>1</td></tr>
<tr><td colspan="8">Start of lost X2-U Sequence Number range</td><td rowspan="2">4* (Number of reported lost X2-u SN ranges)</td></tr>
<tr><td colspan="8">End of lost X2-U Sequence Number range</td></tr>
<tr><td colspan="8">Spare extension</td><td>0-4</td></tr>
</table>

Figure 5.5.2.2-1: DL DATA DELIVERY STATUS (PDU Type 1) Format

5.5.3 Coding of information elements in frames

5.5.3.1 PDU Type

Description: The PDU Type indicates the structure of the X2 UP frame. The field takes the value of the PDU Type it identifies; i.e. "0" for PDU Type 0. The PDU type is in bit 4 to bit 7 in the first octet of the frame.

Value range: {0=DL USER DATA, 1=DL DATA DELIVERY STATUS, 2-15=reserved for future PDU type extensions}

Field length: 4 bits

5.5.3.2 Spare

Description: The spare field is set to "0" by the sender and should not be interpreted by the receiver. This field is reserved for later versions.

Value range: $(0–2^n-1)$.

Field Length: n bits.

5.5.3.3 X2-U Sequence Number

Description: This parameter indicates the X2-U sequence number as assigned by the respective eNB.

Value range: $\{0..2^{16}-1\}$.

Field length: 2 octets.

5.5.3.4 Lost Packet Report

Description: This parameter indicates the presence of a list of lost X2-U packets in the respective X2 UP frame.

Value range: {0=Lost Frame List not present, 1=Lost Frame List present}.

Field length: 1 bit.

5.5.3.5 Final Frame Indication

Description: This parameter indicates whether the frame is the last DL status report as described in clause 5.4.2.1.

Value range: {0=Frame is not final, 1= Frame is final}.

Field length: 1 bit.

5.5.3.6 Highest successfully delivered PDCP Sequence Number

Description: This parameter indicates feedback about the in-sequence delivery status of PDCP PDUs at the SeNB towards the UE.

Value range: $\{0..2^{15}-1\}$.

Field length: 2 octets.

5.5.3.7 Desired buffer size for the E-RAB

Description: This parameter indicates the desired buffer size for the concerned E-RAB as specified in clause 5.4.2.1.

Value range: $\{0..2^{32}-1\}$.

Field length: 4 octets.

5.5.3.8 Minimum desired buffer size for the UE

Description: This parameter indicates the minimum desired buffer size for all E-RABs established for the UE as specified in clause 5.4.2.1.

Value range: {0..2^{32}-1}.

Field length: 4 octets.

5.5.3.9 Number of lost X2-U Sequence Number ranges reported

Description: This parameter indicates the number of X2-U Sequence Number ranges reported to be lost.

Value range: {1..256}.

Field length: 1 octet.

5.5.3.10 Start of lost X2-U Sequence Number range

Description: This parameter indicates the start of an X2-U sequence number range.

Value range: {0..2^{16}-1}.

Field length: 2 octets.

5.5.3.11 End of lost X2-U Sequence Number range

Description: This parameter indicates the end of an X2-U sequence number range.

Value range: {0..2^{16}-1}.

Field length: 2 octets.

5.5.3.12 Spare extension

Description: The spare extension field shall not be sent. The receiver should be capable of receiving a spare extension. The spare extension should not be interpreted by the receiver, since in later versions of the present document additional new fields might be added in place of the spare extension. The spare extension can be an integer number of octets carrying new fields or additional information; the maximum length of the spare extension field (m) depends on the PDU type.

Value range: 0–2^{m*8}-1.

Field Length: 0–m octets. For the PDU Types defined in the present document m=4.

5.5.4 Timers

Not applicable.

5.6 Handling of unknown, unforeseen and erroneous protocol data

Void.

Annex A (informative): Change history

Change history						
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**New**
2014-08					First draft version of this specification.	0.0.0
2014-08					Version edited during RAN3#85	0.1.0
2014-08					MCC clean-up	0.1.1
2014-10					Version provided to RAN3#85bis with new TS number	0.2.0
2014-10					Version edited during RAN3#85bis	0.3.0
2014-11					Version edited during RAN3#86	0.4.0
2014-12					Submitted for one-step approval	1.0.0
2014-12	RAN#66	RP-141980			Specification approved at RAN#66 and places under change control	12.0.0

History

Document history		
V12.0.0	February 2015	Publication