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Contents

Foreword

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

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1 Scope

The present document provides the description of the Packet Data Convergence Protocol (PDCP).

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".

[3] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol Specification".

[4] 3GPP TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA) Medium Access Control (MAC) protocol specification".

[5] 3GPP TS 36.322: "Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Link Control (RLC) protocol specification".

[6] 3GPP TS 33.401: "3GPP System Architecture Evolution: Security Architecture".

[7] IETF RFC 5795: "The RObust Header Compression (ROHC) Framework".

[8] IETF RFC 6846: "RObust Header Compression (ROHC): A Profile for TCP/IP (ROHC-TCP)".

[9] IETF RFC 3095: "RObust Header Compression (ROHC): Framework and four profiles: RTP, UDP, ESP and uncompressed".

[10] IETF RFC 3843: "RObust Header Compression (ROHC): A Compression Profile for IP".

[11] IETF RFC 4815: "RObust Header Compression (ROHC): Corrections and Clarifications to RFC 3095".

[12] IETF RFC 5225: "RObust Header Compression (ROHC) Version 2: Profiles for RTP, UDP, IP, ESP and UDP Lite".

[13] 3GPP TS 33.303: "Proximity-based Services; Security Aspects".

[14] 3GPP TS 23.303: "Proximity-based Services; Stage 2".

[15] 3GPP TS 36.360: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE-WLAN Aggregation Adaptation Protocol (LWAAP) specification".

[16] IETF RFC 1951: "DEFLATE Compressed Data Format Specification version 1.3".

[17] IETF RFC 3485: "The Session Initiation Protocol (SIP) and Session Description Protocol (SDP) Static Dictionary for Signaling Compression (SigComp)".

[18] IETF RFC 1979: "PPP Deflate Protocol".

3 Definitions 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].

NB-IoT: NB-IoT allows access to network services via E-UTRA with a channel bandwidth limited to 200 kHz.

Split bearer: in dual connectivity, a bearer whose radio protocols are located in both the MeNB and the SeNB to use both MeNB and SeNB resources.

LWA bearer: in LTE-WLAN Aggregation, a bearer whose radio protocols are located in both the eNB and the WLAN to use both eNB and WLAN resources.

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].

AILC	Assistance Information bit for Local Cache
AM	Acknowledged Mode
ARP	Address Resolution Protocol
CID	Context Identifier
DRB	Data Radio Bearer carrying user plane data
EPS	Evolved Packet System
E-UTRA	Evolved UMTS Terrestrial Radio Access
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
eNB	E-UTRAN Node B
FIFO	First In First Out
FMS	First missing PDCP SN
HFN	Hyper Frame Number
HRW	Highest Received PDCP SN on WLAN
IETF	Internet Engineering Task Force
IP	Internet Protocol
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
LWA	LTE-WLAN Aggregation
MAC	Medium Access Control
MAC-I	Message Authentication Code for Integrity
MCG	Master Cell Group
NB-IoT	Narrow Band Internet of Things
NMP	Number of Missing PDCP SDUs
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PEK	ProSe Encryption Key
PGK	ProSe Group Key
ProSe	Proximity-based Services
PTK	ProSe Traffic Key
R	Reserved
RB	Radio Bearer
RFC	Request For Comments
RLC	Radio Link Control
RN	Relay Node
ROHC	RObust Header Compression
RRC	Radio Resource Control
RTP	Real Time Protocol
SAP	Service Access Point

SCG	Secondary Cell Group
SDU	Service Data Unit
SLRB	Sidelink Radio Bearer carrying Sidelink Communication or V2X sidelink communication data
SN	Sequence Number
SRB	Signalling Radio Bearer carrying control plane data
TCP	Transmission Control Protocol
UDC	Uplink Data Compression
UDP	User Datagram Protocol
UE	User Equipment
UM	Unacknowledged Mode
X-MAC	Computed MAC-I

4 General

4.1 Introduction

The present document describes the functionality of the PDCP. Functionality specified for the UE equally applies to the RN for functionality necessary for the RN. There is also functionality which is only applicable to the RN in its communication with the E-UTRAN, in which case the specification denotes the RN instead of the UE. RN-specific behaviour is not applicable to the UE. The functionality specified for the UE applies to communication on Uu interface and PC5 interface [14].

4.2 PDCP architecture

4.2.1 PDCP structure

Figure 4.2.1.1 represents one possible structure for the PDCP sublayer; it should not restrict implementation. The figure is based on the radio interface protocol architecture defined in TS 36.300 [2].

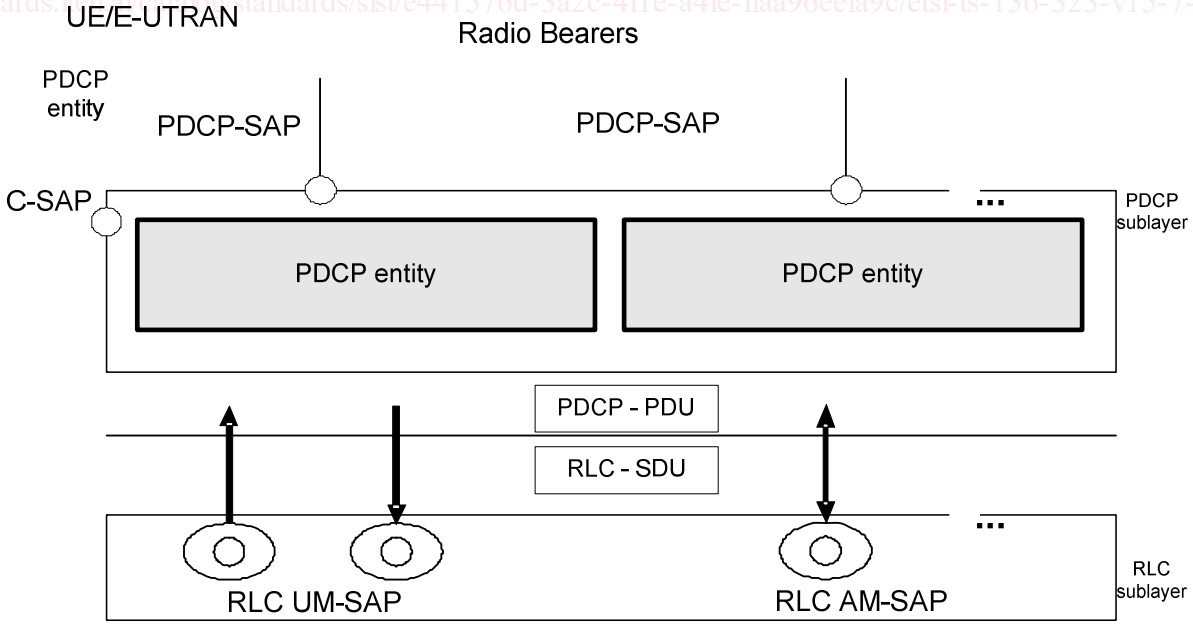

Figure 4.2.1.1 - PDCP layer, structure view

Each RB (i.e. DRB, SLRB and SRB, except for SRB0 and SRB1bis) is associated with one PDCP entity. Each PDCP entity is associated with one, two, or four (e.g uni-directional/bi-directional or split/non-split) RLC entities depending on the RB characteristic (i.e. uni-directional or bi-directional) or RLC mode:

- For split bearers or for RBs configured with PDCP duplication, each PDCP entity is associated with two (bi-directional) AM RLC entities, two (for same direction) UM RLC entities or four (uni-directional) UM RLC entities.
- For LWA bearers, each PDCP entity is associated with one (bi-directional) AM RLC entity or two (uni-directional) UM RLC entities and the LWAAP entity.
- Otherwise, each PDCP entity is associated with one UM RLC entity, two UM RLC entities (one for each direction), or one AM RLC entity (bi-directional).

PDCP entities are located in the PDCP sublayer. The PDCP sublayer is configured by upper layers, see TS 36.331 [3].

4.2.2 PDCP entities

The PDCP entities are located in the PDCP sublayer. Several PDCP entities may be defined for a UE. Each PDCP entity carrying user plane data may be configured to use either uplink data compression (UDC) or to use header compression.

Each PDCP entity is carrying the data of one radio bearer. In this version of the specification, the robust header compression protocol (ROHC) and UDC, are supported. Every PDCP entity uses at most one ROHC or one UDC compressor instance and at most one ROHC or UDC decompressor instance. ROHC and UDC are not supported simultaneously for the same radio bearer.

A PDCP entity is associated either to the control plane or the user plane depending on which radio bearer it is carrying data for.

Figure 4.2.2.1 represents the functional view of the PDCP entity for the PDCP sublayer; it should not restrict implementation. The figure is based on the radio interface protocol architecture defined in TS 36.300 [2].

For RNs, integrity protection and verification are also performed for the u-plane.

For split and LWA bearers, routing is performed in the transmitting PDCP entity, and reordering is performed in the receiving PDCP entity.

For PDCP duplication, submission of duplicates is performed in the transmitting PDCP entity, and duplicate discard is performed in the receiving PDCP entity.

For split bearers, except when PDCP duplication is configured and activated, when requested by lower layers to submit PDCP PDUs, the transmitting PDCP entity shall:

- if *ul-DataSplitThreshold* is configured and the data available for transmission is larger than or equal to *ul-DataSplitThreshold*:
  - submit the PDCP PDUs to either the associated RLC entity configured for SCG or the associated RLC entity configured for MCG, whichever the PDUs were requested by;
- else:
  - if *ul-DataSplitDRB-ViaSCG* is set to *TRUE* by upper layers, see TS 36.331 [3]:
    - if the PDUs were requested by the associated lower layers configured for SCG:
      - submit the PDCP PDUs to the associated RLC entity configured for SCG;
  - else:
    - if the PDUs were requested by the associated lower layers configured for MCG:
      - submit the PDCP PDUs to the associated RLC entity configured for MCG.

For LWA bearers, when submitting PDCP PDUs to lower layers, the transmitting PDCP entity shall:

- if *ul-LWA-DataSplitThreshold* is configured and the data available for transmission is larger than or equal to *ul-LWA-DataSplitThreshold*:
  - submit the PDCP PDUs to either the associated RLC entity upon request from lower layers or the associated LWAAP entity;
- else:
  - if *ul-LWA-DRB-ViaWLAN* is set to *TRUE* by upper layers,see TS 36.331 [3]:
    - submit the PDCP PDUs to the associated LWAAP entity;
  - else:
    - submit the PDCP PDUs to the associated RLC entity upon request from lower layers.

NOTE: The selection of PDCP PDUs submitted to the associated LWAAP entity is left up to the UE implementation.

For bearers configured with PDCP duplication, when requested by lower layers to submit the PDCP PDUs, the transmitting PDCP entity shall:

- if PDCP duplication is activated:
  - if the PDCP PDU is a PDCP Data PDU:
    - duplicate the PDCP Data PDU and submit the PDCP Data PDU to the associated RLC entities;
  - else:
    - submit the PDCP Control PDU to the primary RLC entity;
- else:
  - submit the PDCP PDU to the associated RLC entity.

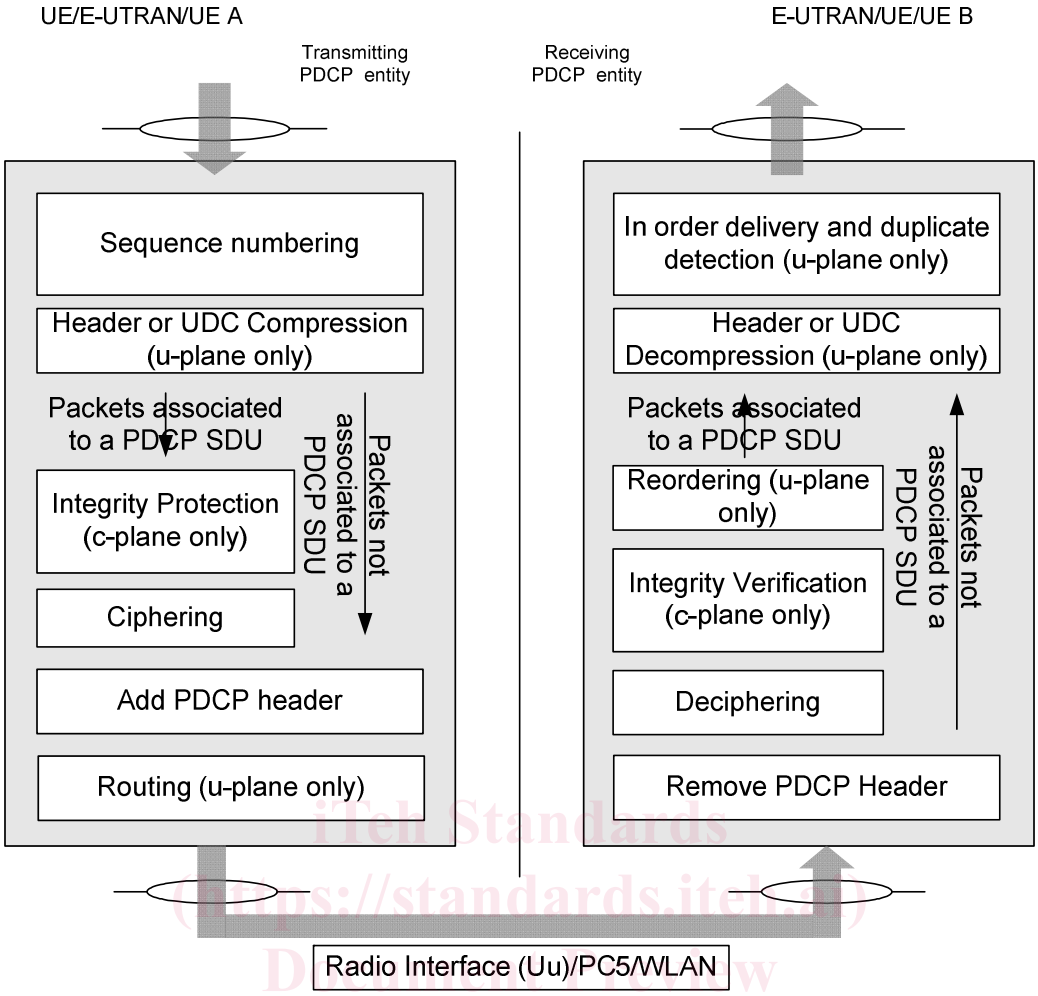

Figure 4.2.2.1 - PDCP layer, functional view

4.3 Services

4.3.1 Services provided to upper layers

PDCP provides its services to the RRC and user plane upper layers at the UE or to the relay at the evolved Node B (eNB). The following services are provided by PDCP to upper layers:

- transfer of user plane data;
- transfer of control plane data;
- header compression;
- uplink data compression;
- ciphering;
- integrity protection.

The maximum supported size of a PDCP SDU is 8188 octets, except in NB-IoT for which the maximum supported size of a PDCP SDU is 1600 octets. The maximum supported size of a PDCP Control PDU is 8188 octets except in NB-IoT for which the maximum supported size of PDCP Control PDU is 1600 octets.

4.3.2 Services expected from lower layers

A PDCP entity expects the following services from lower layers per RLC entity (for a detailed description see TS 36.322 [5]):

- acknowledged data transfer service, including indication of successful delivery of PDCP PDUs;
- unacknowledged data transfer service;
- in-sequence delivery, except at re-establishment of lower layers;
- duplicate discarding, except at re-establishment of lower layers.

A PDCP entity expects the following services from the LWAAP entity (for a detailed description see TS 36.360 [15]):

- user plane data transfer service;

4.4 Functions

The Packet Data Convergence Protocol supports the following functions:

- header compression and decompression of IP data flows using the ROHC protocol;
- compression and decompression of uplink PDCP SDU;
- transfer of data (user plane or control plane);
- maintenance of PDCP SNs;
- in-sequence delivery of upper layer PDUs at re-establishment of lower layers;
- duplicate elimination of lower layer SDUs at re-establishment of lower layers for radio bearers mapped on RLC AM;
- ciphering and deciphering of user plane data and control plane data;
- integrity protection and integrity verification of control plane data;
- integrity protection and integrity verification of sidelink one-to-one communication data;
- for RNs, integrity protection and integrity verification of user plane data;
- timer based discard;
- duplicate transmission and duplicate discarding;
- for split and LWA bearers, routing and reordering.

PDCP uses the services provided by the RLC sublayer and the LWAAP sublayer.

PDCP is used for SRBs, DRBs, and SLRBs mapped on DCCH, DTCH, and STCH type of logical channels. PDCP is not used for any other type of logical channels. PDCP is not used for SRB1bis.

4.5 Data available for transmission

For the purpose of MAC buffer status reporting, the UE shall consider PDCP Control PDUs, as well as the following as data available for transmission in the PDCP layer:

For SDUs for which no PDU has been submitted to lower layers:

- the SDU itself, if the SDU has not yet been processed by PDCP, or
- the PDU if the SDU has been processed by PDCP.