# TSG-RAN Meeting #13 *RP-010543*
# Beijing, China, 18 - 21 September 2001

**Title:** **Agreed CRs (Release '99 and Rel-4 category A) to TS 25.323**

**Source:** **TSG-RAN WG2**

**Agenda item:** **8.2.3**

| Doc-1st- | Status- | Spec | CR | Rev | Phase | Subject | Cat | Version | Versio |
|---|---|---|---|---|---|---|---|---|---|
| R2-011893 | agreed | 25.323 | 027 | | R99 | Header compression protocol reinitialisation during SRNS relocation | F | 3.5.0 | 3.6.0 |
| R2-012164 | agreed | 25.323 | 028 | | Rel-4 | Header compression protocol reinitialisation during SRNS relocation | A | 4.1.0 | 4.2.0 |
| R2-012167 | agreed | 25.323 | 029 | 1 | R99 | PDCP SDU Sequence Numbering | F | 3.5.0 | 3.6.0 |
| R2-012194 | agreed | 25.323 | 030 | | Rel-4 | PDCP SDU Sequence Numbering | A | 4.1.0 | 4.2.0 |
| R2-012165 | agreed | 25.323 | 035 | 1 | R99 | Corrections to PDCP | F | 3.5.0 | 3.6.0 |
| R2-012166 | agreed | 25.323 | 036 | | Rel-4 | Corrections to PDCP | A | 4.1.0 | 4.2.0 |

**3GPP TSG-RAN WG2 Meeting #23**
**Helsinki, Finland, 27-31 August 2001**

***Tdoc R2-011893***

*CR-Form-v4*

# CHANGE REQUEST

⌘ **25.323** **CR** **027** ⌘ rev **-** ⌘ Current version: **3.5.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | Header compression protocol reinitialisation during SRNS relocation |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | TEI |
| ***Date:*** | ⌘ | 18th August 01 |
| ***Category:*** | ⌘ | **F** |
| ***Release:*** | ⌘ | R99 |

*Use one of the following categories:*
***F*** *(correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(addition of feature),*
***C*** *(functional modification of feature)*
***D*** *(editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

*Use one of the following releases:*
*2 (GSM Phase 2)*
*R96 (Release 1996)*
*R97 (Release 1997)*
*R98 (Release 1998)*
*R99 (Release 1999)*
*REL-4 (Release 4)*
*REL-5 (Release 5)*

| | | |
|---|---|---|
| ***Reason for change:*** | ⌘ | The description of header compression reinitialisation during SRNS relocation requires a new parameter in the primitives between PDCP and upper layers. |
| ***Summary of change:*** | ⌘ | A new parameter in the CPDCP-CONFIG primitive between PDCP and upper layers has been defined for Header compression reintialisation.<br><br>Isolated impact analysis:<br>The CR contains a correction to a function where the specification was:<br>• ambiguous or not sufficiently explicit.<br>Would not affect implementations behaving like indicated in the CR, would affect implementations supporting the corrected functionality otherwise. |
| ***Consequences if not approved:*** | ⌘ | Description of Header compression reinitialisation during SRNS relocation will not be complete. |

| | | | | |
|---|---|---|---|---|
| ***Clauses affected:*** | ⌘ | 7.1 | | |
| ***Other specs affected:*** | ⌘ | **X** Other core specifications | ⌘ | 25.303<br>25.323 v4.1.0, CR 028 |
| | | ☐ Test specifications | | |
| | | ☐ O&M Specifications | | |
| ***Other comments:*** | ⌘ | | | |

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downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

## 7.1 Primitives between PDCP and upper layers

The primitives between PDCP and upper layers are shown in table 3.

**Table 3: Primitives between PDCP and upper layers**

| Generic Name | Parameter | | | |
|---|---|---|---|---|
| | Req. | Ind. | Resp. | Conf. |
| PDCP-DATA | Data | Data | Not Defined | Not Defined |
| CPDCP-CONFIG | PDCP-Info, RLC-SAP SN_Sync, R/I | Not Defined | Not Defined | Not Defined |
| CPDCP-RELEASE | RLC-SAP | Not Defined | Not Defined | Not Defined |
| CPDCP-SN | PDCP SN | Not Defined | Not Defined | Not Defined |
| CPDCP-RELOC | Receive_SN | Not Defined | Not Defined | Receive_SN, Send_SN |

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

- PDCP-DATA-Req is used by upper user-plane protocol layers to request a transmission of upper layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

- CPDCP-CONFIG Req is used to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) CPDCP-RELEASE-Req.

- CPDCP-RELEASE-Req is used by upper layers to release a PDCP entity.

d) CPDCP-SN-Req.

- CPDCP-SN-Req is used to transfer the PDCP SN to PDCP.

e) CPDCP-RELOC-Req/Conf.

- CPDCP-RELOC-Req initiates the SRNS relocation procedure in PDCP for those radio bearers that are configured to support lossless SRNS relocation. The Receive_SN is only included when the UE receives a new U-RNTI.

- CPDCP-RELOC-Conf is used to transfer the Receive_SN and/or Send_SN to upper layers for lossless SRNS relocation. The Send_SN is only included at the source RNC.

The following parameters are used in the primitives:

1) PDCP-Info:

- Ceontains the parameters for each of the header compression protocols configured to be used by one PDCP entity.

2) RLC-SAP:

- Tthe RLC-SAP (Tr/UM/AM) used by PDCP entity when communicating with RLC sublayer.

3) SN_Sync:

- Indicates that PDCP should start PDCP sequence number synchronization

4) Send_SN:

   - The send PDCP sequence number of the next PDCP PDU to be sent. There is one in the uplink (UL_Send_SN) and one in the downlink (DL_Send_SN). Refer to subclause 5.4.1.

5) Receive_SN:

   - The receive PDCP sequence number of the next PDCP PDU expected to be received. There is one in the uplink (UL_Receive_SN) and one in the downlink (DL_Receive_SN). Refer to subclause 5.4.1.

6) PDCP SN:

   - This includes a PDCP sequence number.

7) R/I:

   - Indicates that PDCP should Re-initialise/Initialise the header compression protocols.

**3GPP TSG-RAN WG2 Meeting #23**
**Helsinki, Finland, 27-31 August 2001**

***Tdoc R2-012164***

*CR-Form-v4*

# CHANGE REQUEST

⌘ **25.323 CR 028** ⌘ rev **-** ⌘ Current version: **4.1.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | Header compression protocol reinitialisation during SRNS relocation |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | TEI |
| ***Date:*** | ⌘ | 27th August 01 |
| ***Category:*** | ⌘ | **A** |
| ***Release:*** | ⌘ | REL-4 |

*Use one of the following categories:*
***F*** *(correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(addition of feature),*
***C*** *(functional modification of feature)*
***D*** *(editorial modification)*
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*Use one of the following releases:*
*2 (GSM Phase 2)*
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*R97 (Release 1997)*
*R98 (Release 1998)*
*R99 (Release 1999)*
*REL-4 (Release 4)*
*REL-5 (Release 5)*

| | | |
|---|---|---|
| ***Reason for change:*** | ⌘ | This CR is the shadow REL-4 CR to CR 027<br><br>The description of header compression reinitialisation during SRNS relocation requires a new parameter in the primitives between PDCP and upper layers. |
| ***Summary of change:*** | ⌘ | A new parameter in the CPDCP-CONFIG primitive between PDCP and upper layers has been defined for Header compression reintialisation. |
| ***Consequences if not approved:*** | ⌘ | Description of Header compression reinitialisation during SRNS relocation will not be complete. |

| | | | | |
|---|---|---|---|---|
| ***Clauses affected:*** | ⌘ | 7.1 | | |
| ***Other specs affected:*** | ⌘ | **X** Other core specifications<br>☐ Test specifications<br>☐ O&M Specifications | ⌘ | 25.303<br>25.323 v3.5.0, CR 027 |
| ***Other comments:*** | ⌘ | | | |

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3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

## 7.1 Primitives between PDCP and upper layers

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**Table 3: Primitives between PDCP and upper layers**

| Generic Name | Parameter | | | |
|---|---|---|---|---|
| | Req. | Ind. | Resp. | Conf. |
| PDCP-DATA | Data | Data | Not Defined | Not Defined |
| CPDCP-CONFIG | PDCP-Info, RLC-SAP SN_Sync, R/I | Not Defined | Not Defined | Not Defined |
| CPDCP-RELEASE | RLC-SAP | Not Defined | Not Defined | Not Defined |
| CPDCP-SN | PDCP SN | Not Defined | Not Defined | Not Defined |
| CPDCP-RELOC | Receive_SN | Not Defined | Not Defined | Receive_SN, Send_SN |

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

- PDCP-DATA-Req is used by upper user-plane protocol layers to request a transmission of upper layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

- CPDCP-CONFIG Req is used to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) CPDCP-RELEASE-Req.

- CPDCP-RELEASE-Req is used by upper layers to release a PDCP entity.

d) CPDCP-SN-Req.

- CPDCP-SN-Req is used to transfer the PDCP SN to PDCP.

e) CPDCP-RELOC-Req/Conf.

- CPDCP-RELOC-Req initiates the SRNS relocation procedure in PDCP for those radio bearers that are configured to support lossless SRNS relocation. The Receive_SN is only included when the UE receives a new U-RNTI.

- CPDCP-RELOC-Conf is used to transfer the Receive_SN and/or Send_SN to upper layers for lossless SRNS relocation. The Send_SN is only included at the source RNC.

The following parameters are used in the primitives:

1) PDCP-Info:

- Ceontains the parameters for each of the header compression protocols configured to be used by one PDCP entity.

2) RLC-SAP:

- Tthe RLC-SAP (Tr/UM/AM) used by PDCP entity when communicating with RLC sublayer.

3) SN_Sync:

- Indicates that PDCP should start PDCP sequence number synchronization

4) Send_SN:

   - The send PDCP sequence number of the next PDCP PDU to be sent. There is one in the uplink (UL_Send_SN) and one in the downlink (DL_Send_SN). Refer to subclause 5.4.1.

5) Receive_SN:

   - The receive PDCP sequence number of the next PDCP PDU expected to be received. There is one in the uplink (UL_Receive_SN) and one in the downlink (DL_Receive_SN). Refer to subclause 5.4.1.

6) PDCP SN:

   - This includes a PDCP sequence number.

7) R/I:

   - Indicates that PDCP should Re-initialise/Initialise the header compression protocols.

**3GPP TSG-RAN WG2 Meeting #23**
**Helsinki, Finland, 27 - 31 Aug. 2001**

***Tdoc R2-012167***

*CR-Form-v4*

# CHANGE REQUEST

⌘ **25.323 CR 029** ⌘ rev **r1** ⌘ Current version: **3.5.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | PDCP SDU Sequence Numbering |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | TEI |
| ***Date:*** | ⌘ | 30 August 2001 |
| ***Category:*** | ⌘ | **F** |
| ***Release:*** | ⌘ | R99 |

*Use one of the following categories:*
***F*** *(correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(addition of feature),*
***C*** *(functional modification of feature)*
***D*** *(editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

*Use one of the following releases:*
*2 (GSM Phase 2)*
*R96 (Release 1996)*
*R97 (Release 1997)*
*R98 (Release 1998)*
*R99 (Release 1999)*
*REL-4 (Release 4)*
*REL-5 (Release 5)*

***Reason for change:*** ⌘ It was decided on RAN WG 2 meeting #22 in Berlin to use PDCP Sequence Numbers to number PDCP SDUs and not PDCP PDUs.

Proposed CR 031 from ASUSTeK and Proposed CR 033 from LG Electronics have been merged with this CR.

Changes on section 5.4 from CR035r1 have been merged with this CR.

***Summary of change:*** ⌘ The PDCP Sequence Numbering is changed according to the decision.

The definition of "invalid next expected Receive SN" is added for the UE side.

Misleading sentences have been removed from to the PDCP Sequence section.

Section 5.4 has been rewritten.

**Isolated Impact Analysis**
Corrected funtionality: Lossless SRNS relocation.

The Sequence Numbering is changed and some clarification are made. This CR affects all implementations supporting lossless SRNS relocation in PDCP.

***Consequences if not approved:*** ⌘ The lossless SRNS relocation does not work properly according to the current description.

***Clauses affected:*** ⌘ 4.2, 5.4, 5.4.1, 7.1, 8.2.3, 8.3.4

***Other specs affected:*** ⌘ **X** Other core specifications ⌘ 25.331, 25.323 v4.1.0, CR 030
☐ Test specifications

| | | |
|---|---|---|
| | ☐ O&M Specifications | |
| ***Other comments:*** | ⌘ | In order for the PDCP SDU numbering to work properly a configuration supporting lossless SRNS relocation and RLC SDU discard must not be used (CR to RRC). |

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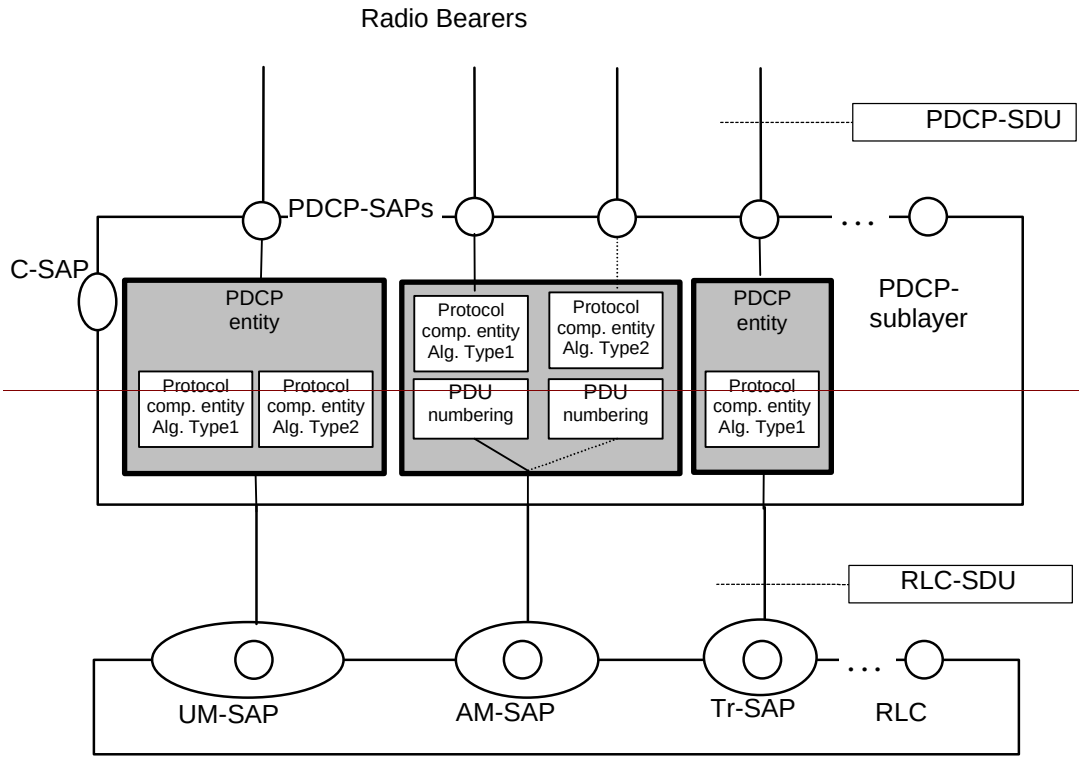
## 4.2 Overview on sublayer architecture

Figure 1 shows the model of the PDCP within the UTRAN protocol architecture. Every PDCP-SAP uses exactly one PDCP entity. Each PDCP entity uses none, one or several header compression protocol types.



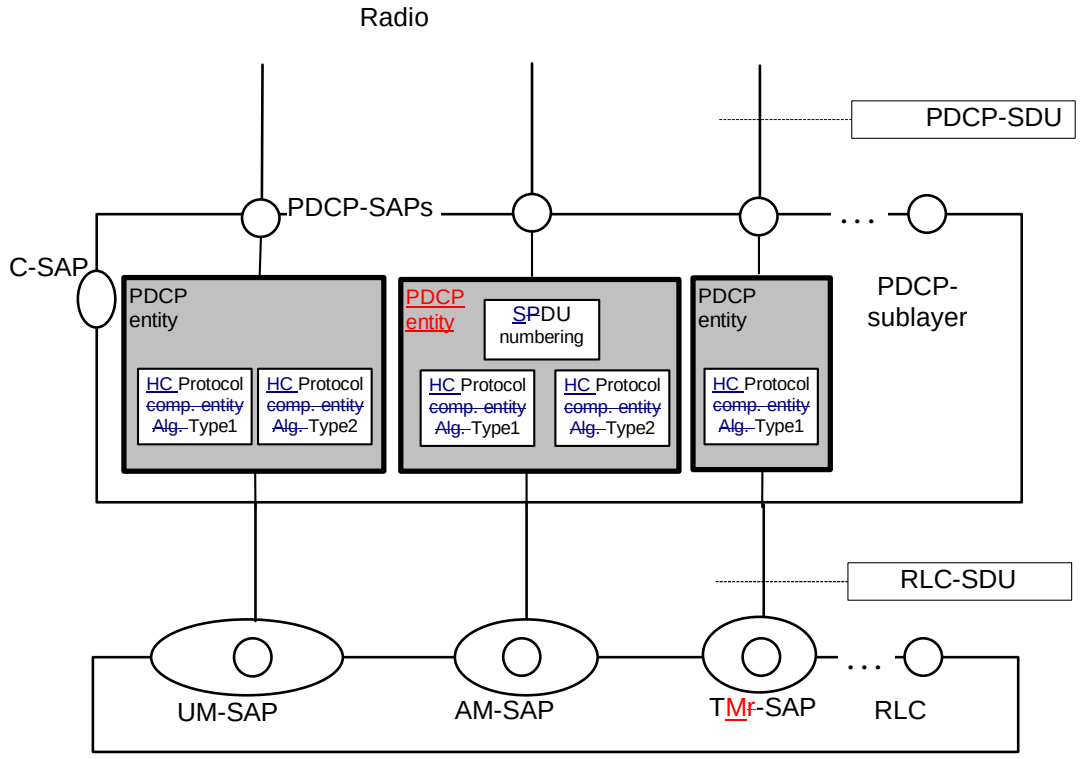



**Figure 1: PDCP structure**

Figure 1 represents only one possible structure for PDCP and this should not restrict implementation. However, subclause 5.1 shall be adhered to.

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## 5.4 SRNS Relocation

In case of SRNS Relocation upper layer indicates to PDCP to perform the re-initialisation of all compression entities of a RB. This entails the following:

- Configured compression parameters remain valid during re-initialisation.
- All compression state information is initialised, e.g. header compression contexts. Therefore, the first 'compressed' packet type after SRNS Relocation is a full header.
- The PDCP sequence numbers are not changed due to the PDCP header compression protocol re-initialisation.

### 5.4.1 Lossless SRNS Relocation

Lossless SRNS Relocation is only applicable when RLC is configured for in-sequence delivery and acknowledged mode. The support of lossless SRNS Relocation is configured by upper layer.

For the support of lossless SRNS Relocation~~reloaction~~ PDCP maintains sequence numbers for PDCP SDUs, as described in subclause 5.3.1.1. These sequence numbers are synchronised between PDCP Sender and Receiver, as described in subclause 5.3.1.2. When a lossless SRNS Relocation is performed sequence numbers are exchanged between UE and UTRAN. They are used to confirm PDCP SDUs successfully received be the Receiver but not yet acknowleged to have been received by the lower layer, as described in subclause 5.3.1.3. After relocation the data transfer begins with the first unconfirmed PDCP SDU.

#### 5.4.1.1 PDCP Sequence Numbering

PDCP sequence numbering shall be applied when lossless SRNS Relocation is to be supported. PDCP Sequence Numbers serve to acknowledge previously sent PDCP SDUs prior to relocation. The value of the PDCP sequence number ranges from 0 to 65535. The PDCP SN window size indicates the maximum number of PDCP ~~PDU~~SDUs~~s~~, not confirmed to have been successfully transmitted to the peer entity by lower layer, that can be numbered at any given time. The PDCP SN window size is configured by upper layers. PDCP sequence numbers are set to "0" when the PDCP entity is set-up for the first time.

In the following the "submission / reception of a PDCP SDU to / from lower layer" is used as a synonym for the submission / reception of a PDCP Data PDU or a PDCP SeqNum PDU to / from lower layer that carries in its Data field a compressed or uncompressed PDCP SDU. In case PDCP sequence numbers are applied, for each radio bearer:

- in the UE
  - the UL_Send PDCP sequence number shall be set to "0" for the first PDCP SDU submitted to lower layer.
  - the UL_Send PDCP sequence number shall be incremented by "1" when a PDCP SDU is submitted to lower layer;
  - the DL_Receive PDCP sequence number is set to "0" for the first received PDCP SDU.
  - the DL_Receive PDCP sequence number is incremented by "1" when a PDCP Data SDU is received from lower layer.
- in the UTRAN
  - the DL_Send PDCP sequence number shall be set to "0" for the first PDCP SDU submitted to lower layer.

- the DL_Send PDCP sequence number shall be incremented by "1" when a PDCP SDU is submitted to lower layer;
- the UL_Receive PDCP sequence number shall be set to "0" for the first received PDCP SDU.
- the UL_Receive PDCP sequence number is incremented by "1" when a PDCP Data SDU is received from lower layer.

PDCP sequence numbers shall not be decremented in a PDCP entity.

#### 5.4.1.2 PDCP Sequence Number synchronization

For radio bearers that are configured to support lossless SRNS Relocation, the PDCP entity shall:

- if upper layer indicates to a PDCP entity that it should synchronise the PDCP SN following a RLC reset or RB reconfiguration;
- if the PDCP entity receives an invalid "next expected UL/DL Receive PDCP Sequence Number" for upper layer after Relocation~~,: the PDCP entity shall:~~
  - Trigger the Synchronization of PDCP SN by submitting one ~~only~~ PDCP SeqNum PDU to lower layer
  - Consider that the synchronisation procedure is complete on confirmation by lower layer of the successful transmission of the PDCP SeqNum PDU;

In the UE, the next expected UL_Receive_SN is considered invalid if its value is less than the PDCP SN of the first sent but unacknowledged PDCP SDU or greater than the first unsent PDCP SDU.

On receiving a PDCP SeqNum PDU, the PDCP entity shall,

- Set the value of the Receive PDCP sequence number (i.e. UL_Receive or DL_Receive) to the value indicated in the PDCP SeqNum PDU.

#### 5.4.1.3 Sequence Number and Data Forwarding

In case of a lossless SRNS Relocation procedure, as described in [1]:

- the UTRAN should send to the UE the next expected UL PDCP Sequence Number and,
- the UE shall send to the UTRAN the next expected DL Receive PDCP Sequence Number.

This information exchange synchronises the Sequence Numbers at the UE and UTRAN PDCP entities.

When requested by the upper layer, for each radio bearer configured to support lossless SRNS Relocation, the PDCP sublayer in the source RNC should forward the following to the target RNC:

- the Receive PDCP Sequence Number of the next PDCP SDUexpected to be received from the UE;
- the Send PDCP sequence number of the first PDCP SDU forwarded to the target SRNC.
- the PDCP-SDUs not confirmed to have been received by the peer PDCP entity;

~~Lossless SRNS relocation is only applicable when RLC is in in-sequence delivery and acknowledged mode PDCP will only support lossless SRNS relocation if it is 'capable' of doing so. This is indicated by upper layers.~~

~~The PDCP layer shall, for those radio bearers that are configured to support lossless SRNS relocation:~~

- ~~support PDCP sequence numbering as specified in subclause 5.4.1.~~

~~The PDCP layer shall carry out the following during lossless SRNS relocation:~~

- ~~provide unconfirmed PDCP SDUs and sequence numbers for forwarding to the target RNC~~

For each radio bearer, the Receive PDCP Sequence Number of the next PDCP SDU expected to be received is transferred from the source to target SRNC. For each radio bearer the source SRNC forwards to the target SRNC the downlink PDCP-SDUs. Source SRNC provides the Send PDCP sequence number of the first PDCP SDU to be forwarded to the target SRNC.

The target SRNC shall send to the UE the next expected UL Receive PDCP Sequence Number. The UE shall send to the target SRNC the DL Receive PDCP Sequence Number of the next expected PDCP SDU. The successfully transmitted PDCP SDUs are thus confirmed. More detailed descriptions of this procedure can be found in [4] and [7].

The reset of all compression entities, for an RB, shall be made during SRNS relocation. Header compression is still possible during relocation. Negotiated compression parameters remain valid during reset, but all state information is initialised, e.g. header compression contexts. Therefore, in header compression case, the first 'compressed' packet is a full header. For later releases of this specification, it may be considered not to reset the PDCP entity, internal protocol information, i.e. states and header compression contexts, but to forward these from the source SRNC to target SRNC. Header compression for a PDCP entity can then continue from the state that it had directly before SRNS relocation.

## 5.4.1 PDCP Sequence Numbering

PDCP sequence numbering is only applicable when lossless SRNS relocation is to be supported. The value of the PDCP sequence number ranges from 0 to 65535. The PDCP SN window size indicates the maximum number of PDCP PSDUs that can be numbered at any given time. The PDCP SN window size is negotiated by upper layers. When the PDCP entity is setup for the first time for the PDCP user the PDCP sequence numbers are initialised to zero.

In the following the "delivery / reception of a PDCP SDU to / from lower layer" is used as a synonym for the delivery / reception of a PDCP Data PDU or a PDCP SeqNum PDU to / from lower layer that carries in its Data field a compressed or uncompressed PDCP SDU. For each radio bearer:

- a value of the UL_Send PDCP sequence number is associated with each sent PDCP PSDU delivered to lower layer in the UE. The UL_Send PDCP sequence number is set to zero for the first sent PDCP PSDU delivered to lower layer. The UL_Send PDCP sequence number is incremented by one when a PDCP PSDU is delivered to lower layerRLC;

- a value of the DL_Send PDCP sequence number is associated with each sent PDCP PSDU delivered to lower layer in UTRAN. The DL_Send PDCP sequence number is set to zero for the first sent PDCP PSDU delivered to lower layer. The DL_Send PDCP sequence number is incremented by one when a PDCP PSDU is delivered to lower layerRLC;

- a value of the UL_Receive PDCP sequence number is associated with each received PDCP PSDU received from lower layer in UTRAN. The UL_Receive PDCP sequence number is set to zero for the first received PDCP PSDU received from lower layer. The UL_Receive PDCP sequence number is incremented by one when a PDCP Data PSDU is received from lower layer.. RLC or is incremented by one for each PDCP Data PDU or PDCP SeqNum PDU that carries in its Data field a compressed or uncompressed PDCP SDU and that is discarded RLC SDUby lower layer, as indicated by the RLC SDU Discard function [5];

- a value of the DL_Receive PDCP sequence number is associated with each received PDCP PSDU received from lower layer in the UE. The DL_Receive PDCP sequence number is set to zero for the first received PDCP PSDU received from lower layer. The DL_Receive PDCP sequence number is incremented by one when a PDCP Data PSDU is received from RLC lower layer. or is incremented by one for each PDCP Data PDU or PDCP SeqNum PDU that carries in its Data field a compressed or uncompressed PDCP SDU and that is discarded by lower layerRLC SDU, as indicated by the RLC SDU Discard function [5].

PDCP sequence numbers are never decremented in the PDCP Tx.

PDCP SeqNum PDUs shall be sent by the peer PDCP entities when synchronization of the PDCP SN is required. It shall only be used for radio bearers that support or are configured / reconfigured to support lossless SRNS relocation. Synchronization of PDCP SN is required after RLC reset, RB reconfiguration or reception of invalid next expected UL/DL Receive PDCP Sequence Number after relocation.

When a PDCP entity receives a PDCP SeqNum PDU, the receive PDCP sequence number (i.e. UL_Receive or DL_Receive) shall be set to the value indicated in the PDCP SeqNum PDU.

PDCP SeqNum PDUs shall not be delivered to RLC after RLC has confirmed the successful transmission of a RLC SDU that contained a numbered PDCP PDU.

## 7.1 Primitives between PDCP and upper layers

The primitives between PDCP and upper layers are shown in table 3.

**Table 3: Primitives between PDCP and upper layers**

| Generic Name | Parameter | | | |
|---|---|---|---|---|
| | Req. | Ind. | Resp. | Conf. |
| PDCP-DATA | Data | Data | Not Defined | Not Defined |
| CPDCP-CONFIG | PDCP-Info, RLC-SAP SN_Sync | Not Defined | Not Defined | Not Defined |
| CPDCP-RELEASE | RLC-SAP | Not Defined | Not Defined | Not Defined |
| CPDCP-SN | PDCP SN | Not Defined | Not Defined | Not Defined |
| CPDCP-RELOC | Receive_SN | Not Defined | Not Defined | Receive_SN, Send_SN |

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

- PDCP-DATA-Req is used by upper user-plane protocol layers to request a transmission of upper layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

- CPDCP-CONFIG Req is used to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) CPDCP-RELEASE-Req.

- CPDCP-RELEASE-Req is used by upper layers to release a PDCP entity.

d) CPDCP-SN-Req.

- CPDCP-SN-Req is used to transfer the PDCP SN to PDCP.

e) CPDCP-RELOC-Req/Conf.

- CPDCP-RELOC-Req initiates the SRNS relocation procedure in PDCP for those radio bearers that are configured to support lossless SRNS relocation. The Receive_SN is only included when the UE receives a new U-RNTI.

- CPDCP-RELOC-Conf is used to transfer the Receive_SN and/or Send_SN to upper layers for lossless SRNS relocation. The Send_SN is only included at the source RNC.

The following parameters are used in the primitives:

1) PDCP-Info:

- contains the parameters for each of the header compression protocols configured to be used by one PDCP entity.

2) RLC-SAP:

- the RLC-SAP (Tr/UM/AM) used by PDCP entity when communicating with RLC sublayer.

3) SN_Sync:

- Indicates that PDCP should start PDCP sequence number synchronization

4) Send_SN:

- The send PDCP sequence number of the next PDCP ~~P~~SDU to be sent. There is one in the uplink (UL_Send_SN) and one in the downlink (DL_Send_SN). Refer to subclause 5.4.1.

5) Receive_SN:

- The receive PDCP sequence number of the next PDCP ~~P~~SDU expected to be received. There is one in the uplink (UL_Receive_SN) and one in the downlink (DL_Receive_SN). Refer to subclause 5.4.1.

6) PDCP SN:

- This includes a PDCP sequence number.

---

## 8.2.3 PDCP SeqNum PDU

The sequence number PDU is used to convey a payload unit containing a PDCP ~~P~~SDU sequence number and PDCP SDU, header compression related control signalling or data that has been obtained from PDCP SDU after header compression.

The format of the PDCP-SeqNum-PDU is shown in table 6.

**Table 6: PDCP-SeqNum-PDU format**

| PDU type | PID |
|---|---|
| Sequence number | |
| | |
| Data | |
| | |

---

## 8.3.4 Sequence number

Length: 16 bits

PDCP ~~P~~SDU sequence number.

**3GPP TSG-RAN WG2 Meeting #23**
**Helsinki, Finland, 27 - 31 Aug. 2001**

***Tdoc R2-012194***

*CR-Form-v4*

# CHANGE REQUEST

⌘ **25.323 CR 030** ⌘ rev **-** ⌘ Current version: **4.1.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | PDCP SDU Sequence Numbering |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | TEI |
| ***Date:*** | ⌘ | 30 August 2001 |
| ***Category:*** | ⌘ | **A** |
| ***Release:*** | ⌘ | REL-4 |

*Use one of the following categories:*
***F*** *(correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(addition of feature),*
***C*** *(functional modification of feature)*
***D*** *(editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

*Use one of the following releases:*
*2 (GSM Phase 2)*
*R96 (Release 1996)*
*R97 (Release 1997)*
*R98 (Release 1998)*
*R99 (Release 1999)*
*REL-4 (Release 4)*
*REL-5 (Release 5)*

***Reason for change:*** ⌘

This is the shadow REL-4 CR to CR029 of R99.

It was decided on RAN WG 2 meeting #22 in Berlin to use PDCP Sequence Numbers to number PDCP SDUs and not PDCP PDUs.

Proposed CR 031 from ASUSTeK and Proposed CR 033 from LG Electronics have been merged with this CR.

Changes on section 5.4 from CR035r1 have been merged with this CR.

***Summary of change:*** ⌘

The PDCP Sequence Numbering is changed according to the decision.

The definition of "invalid next expected Receive SN" is added for the UE side.

Misleading sentences have been removed from to the PDCP Sequence section.

Section 5.4 has been rewritten.

**Isolated Impact Analysis**
Corrected funtionality: Lossless SRNS relocation.

The Sequence Numbering is changed and some clarification are made. This CR affects all implementations supporting lossless SRNS relocation in PDCP.

***Consequences if not approved:*** ⌘

The lossless SRNS relocation does not work properly according to the current description.

***Clauses affected:*** ⌘ 4.2, 5.4, 5.4.1, 7.1, 8.2.3, 8.3.4

***Other specs*** ⌘ **X** Other core specifications ⌘ 25.331

| | | |
|---|---|---|
| ***affected:*** | Test specifications<br>O&M Specifications | 25.323 v3.5.0, CR 029 |
| ***Other comments:*** ⌘ | In order for the PDCP SDU numbering to work properly a configuration supporting lossless SRNS relocation and RLC SDU discard must not be used (CR to RRC). | |

**How to create CRs using this form:**

Comprehensive information and tips about how to create CRs can be found at: http://www.3gpp.org/3G_Specs/CRs.htm. Below is a brief summary:

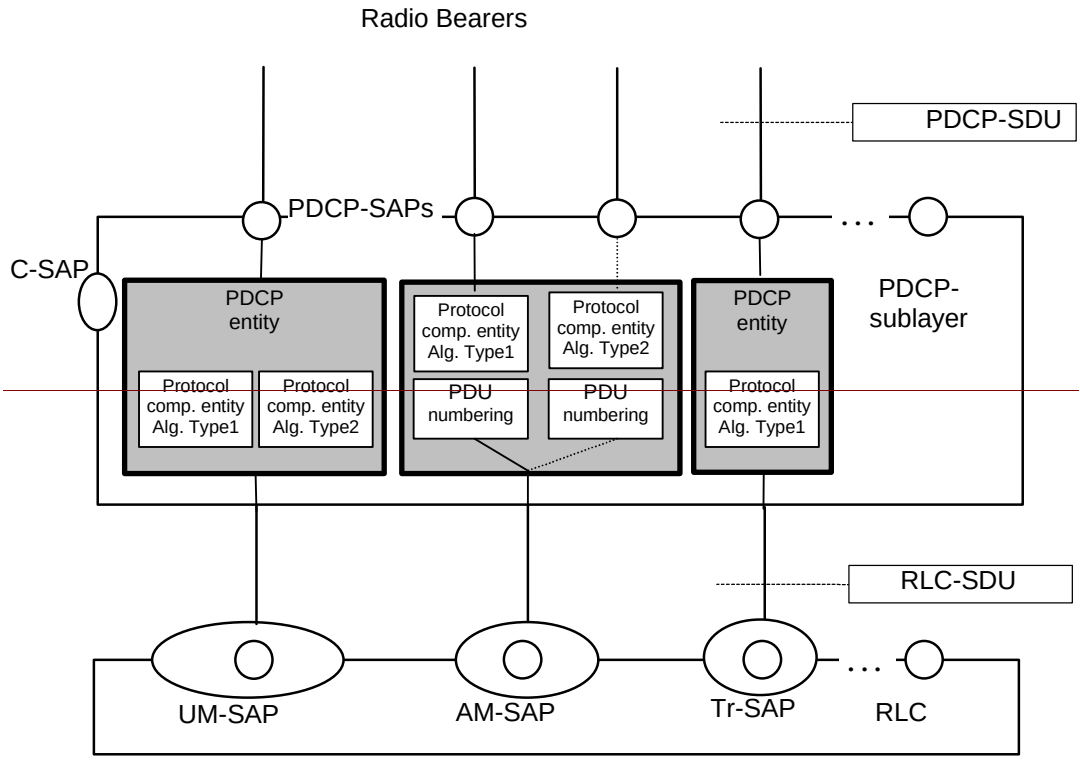
1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

## 4.2 Overview on sublayer architecture

Figure 1 shows the model of the PDCP within the UTRAN protocol architecture. Every PDCP-SAP uses exactly one PDCP entity. Each PDCP entity uses none, one or several header compression protocol types.



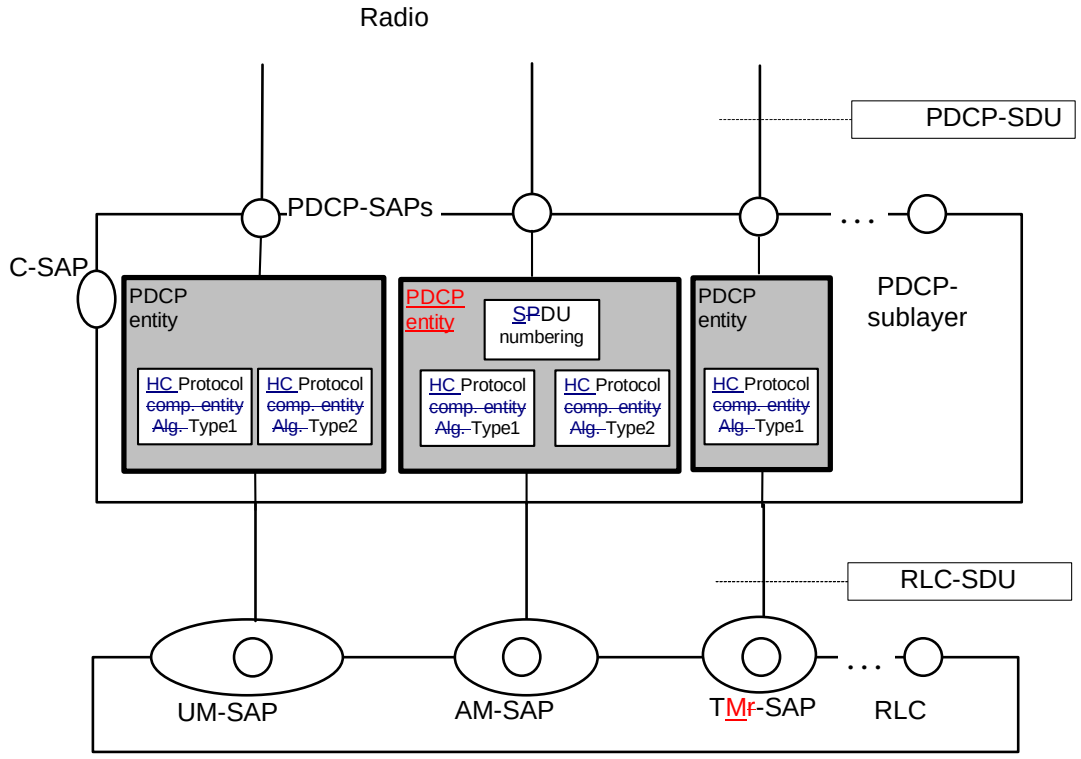



**Figure 1: PDCP structure**

Figure 1 represents only one possible structure for PDCP and this should not restrict implementation. However, subclause 5.1 shall be adhered to.

---

## 5.4 SRNS Relocation

In case of SRNS Relocation upper layer indicates to PDCP to perform the re-initialisation of all compression entities of a RB. This entails the following:

- Configured compression parameters remain valid during re-initialisation.
- All compression state information is initialised, e.g. header compression contexts. Therefore, the first 'compressed' packet type after SRNS Relocation is a full header.
- The PDCP sequence numbers are not changed due to the PDCP header compression protocol re-initialisation.

### 5.4.1 Lossless SRNS Relocation

Lossless SRNS Relocation is only applicable when RLC is configured for in-sequence delivery and acknowledged mode. The support of lossless SRNS Relocation is configured by upper layer.

For the support of lossless SRNS Relocation~~reloaction~~ PDCP maintains sequence numbers for PDCP SDUs, as described in subclause 5.3.1.1. These sequence numbers are synchronised between PDCP Sender and Receiver, as described in subclause 5.3.1.2. When a lossless SRNS Relocation is performed sequence numbers are exchanged between UE and UTRAN. They are used to confirm PDCP SDUs successfully received be the Receiver but not yet acknowleged to have been received by the lower layer, as described in subclause 5.3.1.3. After relocation the data transfer begins with the first unconfirmed PDCP SDU.

#### 5.4.1.1 PDCP Sequence Numbering

PDCP sequence numbering shall be applied when lossless SRNS Relocation is to be supported. PDCP Sequence Numbers serve to acknowledge previously sent PDCP SDUs prior to relocation. The value of the PDCP sequence number ranges from 0 to 65535. The PDCP SN window size indicates the maximum number of PDCP ~~PDU~~SDUs~~s~~, not confirmed to have been successfully transmitted to the peer entity by lower layer, that can be numbered at any given time. The PDCP SN window size is configured by upper layers. PDCP sequence numbers are set to "0" when the PDCP entity is set-up for the first time.

In the following the "submission / reception of a PDCP SDU to / from lower layer" is used as a synonym for the submission / reception of a PDCP Data PDU or a PDCP SeqNum PDU to / from lower layer that carries in its Data field a compressed or uncompressed PDCP SDU. In case PDCP sequence numbers are applied, for each radio bearer:

- in the UE
  - the UL_Send PDCP sequence number shall be set to "0" for the first PDCP SDU submitted to lower layer.
  - the UL_Send PDCP sequence number shall be incremented by "1" when a PDCP SDU is submitted to lower layer;
  - the DL_Receive PDCP sequence number is set to "0" for the first received PDCP SDU.
  - the DL_Receive PDCP sequence number is incremented by "1" when a PDCP Data SDU is received from lower layer.
- in the UTRAN
  - the DL_Send PDCP sequence number shall be set to "0" for the first PDCP SDU submitted to lower layer.

- the DL_Send PDCP sequence number shall be incremented by "1" when a PDCP SDU is submitted to lower layer;
- the UL_Receive PDCP sequence number shall be set to "0" for the first received PDCP SDU.
- the UL_Receive PDCP sequence number is incremented by "1" when a PDCP Data SDU is received from lower layer.

PDCP sequence numbers shall not be decremented in a PDCP entity.

### 5.4.1.2 PDCP Sequence Number synchronization

For radio bearers that are configured to support lossless SRNS Relocation, the PDCP entity shall:

- if upper layer indicates to a PDCP entity that it should synchronise the PDCP SN following a RLC reset or RB reconfiguration;
- if the PDCP entity receives an invalid "next expected UL/DL Receive PDCP Sequence Number" for upper layer after Relocation~~,: the PDCP entity shall:~~
  - Trigger the Synchronization of PDCP SN by submitting one ~~only~~ PDCP SeqNum PDU to lower layer
  - Consider that the synchronisation procedure is complete on confirmation by lower layer of the successful transmission of the PDCP SeqNum PDU;

In the UE, the next expected UL_Receive_SN is considered invalid if its value is less than the PDCP SN of the first sent but unacknowledged PDCP SDU or greater than the first unsent PDCP SDU.

On receiving a PDCP SeqNum PDU, the PDCP entity shall,

- Set the value of the Receive PDCP sequence number (i.e. UL_Receive or DL_Receive) to the value indicated in the PDCP SeqNum PDU.

### 5.4.1.3 Sequence Number and Data Forwarding

In case of a lossless SRNS Relocation procedure, as described in [1]:

- the UTRAN should send to the UE the next expected UL PDCP Sequence Number and,
- the UE shall send to the UTRAN the next expected DL Receive PDCP Sequence Number.

This information exchange synchronises the Sequence Numbers at the UE and UTRAN PDCP entities.

When requested by the upper layer, for each radio bearer configured to support lossless SRNS Relocation, the PDCP sublayer in the source RNC should forward the following to the target RNC:

- the Receive PDCP Sequence Number of the next PDCP SDUexpected to be received from the UE;
- the Send PDCP sequence number of the first PDCP SDU forwarded to the target SRNC.
- the PDCP-SDUs not confirmed to have been received by the peer PDCP entity;

~~Lossless SRNS relocation is only applicable when RLC is in in-sequence delivery and acknowledged mode PDCP will only support lossless SRNS relocation if it is 'capable' of doing so. This is indicated by upper layers.~~

~~The PDCP layer shall, for those radio bearers that are configured to support lossless SRNS relocation:~~

- ~~support PDCP sequence numbering as specified in subclause 5.4.1.~~

~~The PDCP layer shall carry out the following during lossless SRNS relocation:~~

- ~~provide unconfirmed PDCP SDUs and sequence numbers for forwarding to the target RNC~~

For each radio bearer, the Receive PDCP Sequence Number of the next PDCP SDU expected to be received is transferred from the source to target SRNC. For each radio bearer the source SRNC forwards to the target SRNC the downlink PDCP-SDUs. Source SRNC provides the Send PDCP sequence number of the first PDCP SDU to be forwarded to the target SRNC.

The target SRNC shall send to the UE the next expected UL Receive PDCP Sequence Number. The UE shall send to the target SRNC the DL Receive PDCP Sequence Number of the next expected PDCP SDU. The successfully transmitted PDCP SDUs are thus confirmed. More detailed descriptions of this procedure can be found in [4] and [7].

The reset of all compression entities, for an RB, shall be made during SRNS relocation. Header compression is still possible during relocation. Negotiated compression parameters remain valid during reset, but all state information is initialised, e.g. header compression contexts. Therefore, in header compression case, the first 'compressed' packet is a full header. For later releases of this specification, it may be considered not to reset the PDCP entity, internal protocol information, i.e. states and header compression contexts, but to forward these from the source SRNC to target SRNC. Header compression for a PDCP entity can then continue from the state that it had directly before SRNS relocation.

## 5.4.1 PDCP Sequence Numbering

PDCP sequence numbering is only applicable when lossless SRNS relocation is to be supported. The value of the PDCP sequence number ranges from 0 to 65535. The PDCP SN window size indicates the maximum number of PDCP PSDUs that can be numbered at any given time. The PDCP SN window size is negotiated by upper layers. When the PDCP entity is setup for the first time for the PDCP user the PDCP sequence numbers are initialised to zero.

In the following the "delivery / reception of a PDCP SDU to / from lower layer" is used as a synonym for the delivery / reception of a PDCP Data PDU or a PDCP SeqNum PDU to / from lower layer that carries in its Data field a compressed or uncompressed PDCP SDU. For each radio bearer:

- a value of the UL_Send PDCP sequence number is associated with each sent PDCP PSDU delivered to lower layer in the UE. The UL_Send PDCP sequence number is set to zero for the first sent PDCP PSDU delivered to lower layer. The UL_Send PDCP sequence number is incremented by one when a PDCP PSDU is delivered to lower layerRLC;

- a value of the DL_Send PDCP sequence number is associated with each sent PDCP PSDU delivered to lower layer in UTRAN. The DL_Send PDCP sequence number is set to zero for the first sent PDCP PSDU delivered to lower layer. The DL_Send PDCP sequence number is incremented by one when a PDCP PSDU is delivered to lower layerRLC;

- a value of the UL_Receive PDCP sequence number is associated with each received PDCP PSDU received from lower layer in UTRAN. The UL_Receive PDCP sequence number is set to zero for the first received PDCP PSDU received from lower layer. The UL_Receive PDCP sequence number is incremented by one when a PDCP Data PSDU is received from lower layer., RLC or is incremented by one for each PDCP Data PDU or PDCP SeqNum PDU that carries in its Data field a compressed or uncompressed PDCP SDU and that is discarded RLC SDUby lower layer, as indicated by the RLC SDU Discard function [5];

- a value of the DL_Receive PDCP sequence number is associated with each received PDCP PSDU received from lower layer in the UE. The DL_Receive PDCP sequence number is set to zero for the first received PDCP PSDU received from lower layer. The DL_Receive PDCP sequence number is incremented by one when a PDCP Data PSDU is received from RLC lower layer. or is incremented by one for each PDCP Data PDU or PDCP SeqNum PDU that carries in its Data field a compressed or uncompressed PDCP SDU and that is discarded by lower layerRLC SDU, as indicated by the RLC SDU Discard function [5].

PDCP sequence numbers are never decremented in the PDCP Tx.

PDCP SeqNum PDUs shall be sent by the peer PDCP entities when synchronization of the PDCP SN is required. It shall only be used for radio bearers that support or are configured / reconfigured to support lossless SRNS relocation. Synchronization of PDCP SN is required after RLC reset, RB reconfiguration or reception of invalid next expected UL/DL Receive PDCP Sequence Number after relocation.

When a PDCP entity receives a PDCP SeqNum PDU, the receive PDCP sequence number (i.e. UL_Receive or DL_Receive) shall be set to the value indicated in the PDCP SeqNum PDU.

PDCP SeqNum PDUs shall not be delivered to RLC after RLC has confirmed the successful transmission of a RLC SDU that contained a numbered PDCP PDU.

## 7.1 Primitives between PDCP and upper layers

The primitives between PDCP and upper layers are shown in table 5.

**Table 5: Primitives between PDCP and upper layers**

| Generic Name | Parameter | | | |
|---|---|---|---|---|
| | Req. | Ind. | Resp. | Conf. |
| PDCP-DATA | Data | Data | Not Defined | Not Defined |
| CPDCP-CONFIG | PDCP-Info, RLC-SAP SN_Sync | Not Defined | Not Defined | Not Defined |
| CPDCP-RELEASE | RLC-SAP | Not Defined | Not Defined | Not Defined |
| CPDCP-SN | PDCP SN | Not Defined | Not Defined | Not Defined |
| CPDCP-RELOC | Receive_SN | Not Defined | Not Defined | Receive_SN, Send_SN |

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

- PDCP-DATA-Req is used by upper user-plane protocol layers to request a transmission of upper layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

- CPDCP-CONFIG Req is used to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) CPDCP-RELEASE-Req.

- CPDCP-RELEASE-Req is used by upper layers to release a PDCP entity.

d) CPDCP-SN-Req.

- CPDCP-SN-Req is used to transfer the PDCP SN to PDCP.

e) CPDCP-RELOC-Req/Conf.

- CPDCP-RELOC-Req initiates the SRNS relocation procedure in PDCP for those radio bearers that are configured to support lossless SRNS relocation. The Receive_SN is only included when the UE receives a new U-RNTI.

- CPDCP-RELOC-Conf is used to transfer the Receive_SN and/or Send_SN to upper layers for lossless SRNS relocation. The Send_SN is only included at the source RNC.

The following parameters are used in the primitives:

1) PDCP-Info:

- contains the parameters for each of the header compression protocols configured to be used by one PDCP entity.

2) RLC-SAP:

- the RLC-SAP (Tr/UM/AM) used by PDCP entity when communicating with RLC sublayer.

3) SN_Sync:

- Indicates that PDCP should start PDCP sequence number synchronization

4) Send_SN:

- The send PDCP sequence number of the next PDCP ~~P~~SDU to be sent. There is one in the uplink (UL_Send_SN) and one in the downlink (DL_Send_SN). Refer to subclause 5.4.1.

5) Receive_SN:

- The receive PDCP sequence number of the next PDCP ~~P~~SDU expected to be received. There is one in the uplink (UL_Receive_SN) and one in the downlink (DL_Receive_SN). Refer to subclause 5.4.1.

6) PDCP SN:

- This includes a PDCP sequence number.

---

## 8.2.3 PDCP SeqNum PDU

The sequence number PDU is used to convey a payload unit containing a PDCP ~~P~~SDU sequence number and PDCP SDU, header compression related control signalling or data that has been obtained from PDCP SDU after header compression.

The format of the PDCP-SeqNum-PDU is shown in table 8.

**Table 8: PDCP-SeqNum-PDU format**

| PDU type | PID |
|---|---|
| Sequence number | |
| | |
| Data | |
| | |

---

## 8.3.4 Sequence number

Length: 16 bits

PDCP ~~P~~SDU sequence number.

**3GPP TSG-RAN WG2 Meeting#21**
**Helsinki, Finland, 27-31 August 2001**

***R2-012165***

*CR-Form-v3*

# CHANGE REQUEST

⌘ **25.323** **CR** **035** ⌘ rev **r1** ⌘ Current version: **3.5.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

| | | | | | |
|---|---|---|---|---|---|
| ***Title:*** | ⌘ | Corrections to PDCP | | | |
| ***Source:*** | ⌘ | TSG-RAN WG2 | | | |
| ***Work item code:*** | ⌘ | TEI | ***Date:*** | ⌘ | August 27, 2001 |
| ***Category:*** | ⌘ | **F** | ***Release:*** | ⌘ | R99 |

*Use one of the following categories:*
***F*** *(correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(Addition of feature),*
***C*** *(Functional modification of feature)*
***D*** *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

*Use one of the following releases:*
*2* *(GSM Phase 2)*
*R96* *(Release 1996)*
*R97* *(Release 1997)*
*R98* *(Release 1998)*
*R99* *(Release 1999)*
*REL-4* *(Release 4)*
*REL-5* *(Release 5)*

***Reason for change:*** ⌘

1. Clause 1:The scope contains text that is more relevant to the functionality of PDCP and is therefore more appropriately covered in the later clauses.

2. Clause 2: Missing references.

3. Clause 3: Missing Definitions subclause.

4. Clause 4: Ambiguous statements about transparency function of PDCP. Details of PDCP model more appropriately covered in later subclauses. Duplication of text. Ambiguity about number of header compression entities within PDCP entity.

5. Clause 5: Duplicate text about model of PDCP.

6. Subclause 5.1.1: Ambiguity about applicability of PID.

7. Subclause 5.1.1: Ambiguity about use of PID value "0".

8. Subclause 5.1.1: Ambiguous text on re-mapping of PID values on reconfiguration.

9. Subclause 5.1.1: Inclusion of error cases more appropriately included in TS 25.331 or separate subclause.

10. Subclause 5.1.2: Functionality of RFC 2507 and inclusion of clauses of RFC 2507.

11. Subclause 5.1.2.1: Ambiguity on number of PID values possible in R99.

12. Subclause 5.2: Incomplete description of Data Transfer function.

13. Subclause 5.3: Unclear description of SRNS Relocation and Lossless SRNS Relocation and functions of source RNC, target RNC and UE. Incorrect description of sequence number synchronisation in case of combined "Hard Handover" and "SRNS Relocation".

14. Subclause 6.1: Incomplete description of services provided.

15. Subclause 6.2: Incorrect description of services expected from RLC.

16. Subclause 8.2.1: Ambiguous use of PDCP No-header PDU.

17. Subclause 8.3.3: Incomplete description of the Data field. Missing possibility to include header compression control internal feedback information.

18. Clause 9: Missing error cases.

19. Subclause 7.1 : Text regarding PDCP-Reloc-Req is not correct since a new U-RNTI is a 'necessary condition but not sufficient' for a SRNS relocation.

20. Subclause 5.1.1: The text is not clear on the procedure of the lossless relocation.

21: Miscellaneous editorial corrections.

***Summary of change:*** ⌘ 1. Text relating to functionality of PDCP is deleted.

No isolated impact. Modification is editorial.

2. References added.

No isolated impact. Modification is editorial.

3. Definitions subclause added.

No isolated impact. Modification is editorial.

4. Text related to model of PDCP sublayer moved to Subclause 4.1. It is clarified that in R99 there is only one header compression entity per PDCP entity.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

5. Duplicate text removed.

No isolated impact. Modification is editorial.

6. It is clarified that the use of PID to meet certain requirements depends on the configuration of the PDCP entity.

7. The use of PID = 0 is clarified.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

8. Text is clarified to imply that PID values are not assigned but mapped internally.

No isolated impact. Modification is editorial.

9. Error cases have been deleted and are either covered in clause 9 of this specification or moved to RRC as appropriate. No isolated impact. Modification is editorial.

10. It is clarified that the enabling of the functionality of RFC 2507 is not covered in this specification. Clause references to RFC 2507 are deleted.

No isolated impact. Modification is editorial.

11. It is clarified that the number of PID values in R99 is limited to 5.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

12. A more complete description with the inclusion of PDCP SN in case of lossless SRNS

relocation configured RBs is provided.

No isolated impact. Modification is editorial.

13. Description of SRNS Relocation and Lossless SRNS Relocation are broken up into separate subclauses to clarify the PDCP role in both cases. It is further corrected that in case of the combined "Hard Handover and SRNS Relocation" the source RNC provides to the UE the next expected UL receive SN.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

14. A more complete description of PDCP services to upperlayers is provided including the maintenance of unconfirmed PDCP SDUs and PDCP SNs.

No isolated impact. Modification is editorial.

15. Segmentation and reassembly function requirement is deleted.

No isolated impact. Modification is editorial.

16. It is clarified that the "PDCP No-header PDU" shall not be used in case lossless relocation is configured for the associated RBs.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

17. It is clarified that the Data field can also carry header compression control feedback information.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

18. Error cases have been included. It is clarified that in case a PDCP SeqNum PDU is received in the absence of "lossless Relocation" configuration the PDCP entity shall ignore the SN information but shall process the Data field. It is clarified that in case the PDCP entity receives a PDCP PDU with an invalid PID value it shall ignore the PDCP PDU.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

19. Deleted trigger of U-RNTI being received for this primitve.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

20. Added text clarifying the procedure of the lossless relocation.

Updates have been made according to comments from the group. They are highlighted in yellow.

Changes on section 5.4 have been merged with CR 029.

| | | |
|---|---|---|
| ***Consequences if not approved:*** | ⌘ | Where clarifications have been provided if the CR is not approved, interoperability errors may result if the peer PDCP entities are not implemented according to this CR due to ambiguous specification text in earlier versions. |

| | | | | | |
|---|---|---|---|---|---|
| ***Clauses affected:*** | ⌘ | 1, 2, 3, 3.1, 3.2 (new), 4.1, 4.2, 5, 5.1, 5.1.1, 5.1.2, 5.1.2.1, 5.3, 5.3.1, 5.3.2, 6.1, 6.2, 7.1, 8.1, 8.2, 8.2.1, 8.2.2, 8.2.3, 8.3.1, 8.3.2, 8.3.3, 9.1 (new), 9.2 (new) | | | |
| ***Other specs affected:*** | ⌘ | X | Other core specifications | ⌘ | 3GPP TS 25.331<br>25.323 v4.1.0, CR 036 |
| | | | Test specifications | | |
| | | | O&M Specifications | | |
| ***Other comments:*** | ⌘ | | | | |

*Technical Specification*

# 3GPP TS 25.323 V3.5.0 (2001-06)

# 3rd Generation Partnership Project;
# Technical Specification Group Radio Access Network;
# Packet Data Convergence Protocol (PDCP) Specification
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# Contents

# 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

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- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
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- 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 provides the description of the Packet Data Convergence Protocol (PDCP).

~~PDCP provides its services to the NAS at the UE or the relay at the Radio Network Controller (RNC).~~

~~PDCP uses the services provided by the Radio Link Control (RLC) sublayer.~~

~~The main functions of PDCP are:~~

- ~~compression of redundant Network PDU control information (header compression);~~
- ~~transfer of packet data protocol user data using services provided by RLC protocol~~.

# 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 TRS ~~3GPP TS 25.401: "UTRAN Overall Description".~~23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[2] 3GPP TRS ~~21.905: "3G Vocabulary".~~25.331: "Radio Resource Control".

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

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

[5] 3GPP TS 25.322: "RLC Protocol Specification".

[6] IETF RFC 2507: "IP Header Compression".

[7] 3GPP TSR ~~23.060~~21.905: "Vocabulary for 3GPP Specifications".~~"General Packet Radio Service (GPRS); Service description; Stage 2".~~


# 3 Definitions and Abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in [7] apply.

## 3.2 Abbreviations

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

AS Access Stratum

| | |
|---|---|
| C-SAP | Control Service Access Point |
| HC | Header Compression |
| IETF | Internet Engineering Task Force |
| IP | Internet Protocol |
| L2 | Layer 2 (data link layer) |
| L3 | Layer 3 (network layer) |
| NAS | Non Access Stratum |
| PDCP | Packet Data Convergence Protocol |
| PDU | Protocol Data Unit |
| PID | Packet Identifier |
| PPP | Point-to-Point Protocol |
| RB | Radio Bearer |
| RFC | Request For Comments |
| RLC | Radio Link Control |
| RNC | Radio Network Controller |
| RTP | Real Time Protocol |
| SDU | Service Data Unit |
| TCP | Transmission Control Protocol |
| UDP | User Datagram Protocol |
| UE | User Equipment |
| UMTS | Universal Mobile Telecommunications System |
| UTRA | UMTS Terrestrial Radio Access |
| UTRAN | UMTS Terrestrial Radio Access Network |

# 4 General

## 4.1 Objective

The present document describes the functionality of the ~~UTRAN~~ PDCP. ~~The overall UTRAN logical architecture is defined in [3].~~

~~Network layer protocols are intended to be capable of operating over services derived from a wide variety of subnetworks and data links. UMTS supports several network layer protocols providing protocol transparency for the users of the service. At that point of view supported protocols are IPv4 and IPv6. Introduction of new network layer protocols to be transferred over UTRAN shall be possible without any changes to UTRAN protocols. Therefore, all functions related to transfer of packets from higher layers (PDCP SDUs) shall be carried out in a transparent way by the UTRAN network entities. This is one of the requirements for UTRAN PDCP.~~

~~Another requirement for the PDCP is to provide functions that help to improve channel efficiency. This requirement is fulfilled by the possibility to implement different kinds of optimisation methods. The currently known optimisation methods are standardised IETF header compression protocols.~~

~~Every RB is connected to one PDCP entity and one PDCP entity is connected to one RLC entity. The PDCP entities are located in the PDCP sublayer.~~

~~Every PDCP entity uses zero, one or several header compression protocol types with certain parameters. Several PDCP entities may use the same protocol type. The protocol types and their parameters are negotiated by higher layers and indicated to PDCP through the PDCP Control Service Access Point (PDCP-C-SAP).~~

~~Since the adaptation of different network layer protocols to PDCP is implementation dependent, it is not defined in the present document.~~

## 4.2 Overview on sublayer architecture

Figure 1 shows the model of the PDCP within the ~~UTRAN~~ radio interface protocol architecture. The radio interface protocol architecture is defined in [3]. The PDCP sublayer is defined for the PS domain only.~~Every PDCP-SAP uses exactly one PDCP entity. Each PDCP entity uses none, one or several header compression protocol types.~~

Every PS domain RAB is associated with one RB, which in turn is associated with one PDCP entity. The PDCP entities are located in the PDCP sublayer.

Every PDCP entity uses zero, one or several different header compression protocol types. Several PDCP entities may be defined for a UE with each usinge the same or different protocol type. In this version of the specification, only one header compression protocol type, RFC 2507 [6], is supported.

The PDCP sublayer is configured by upper layer [2] through the PDCP-C-SAP.

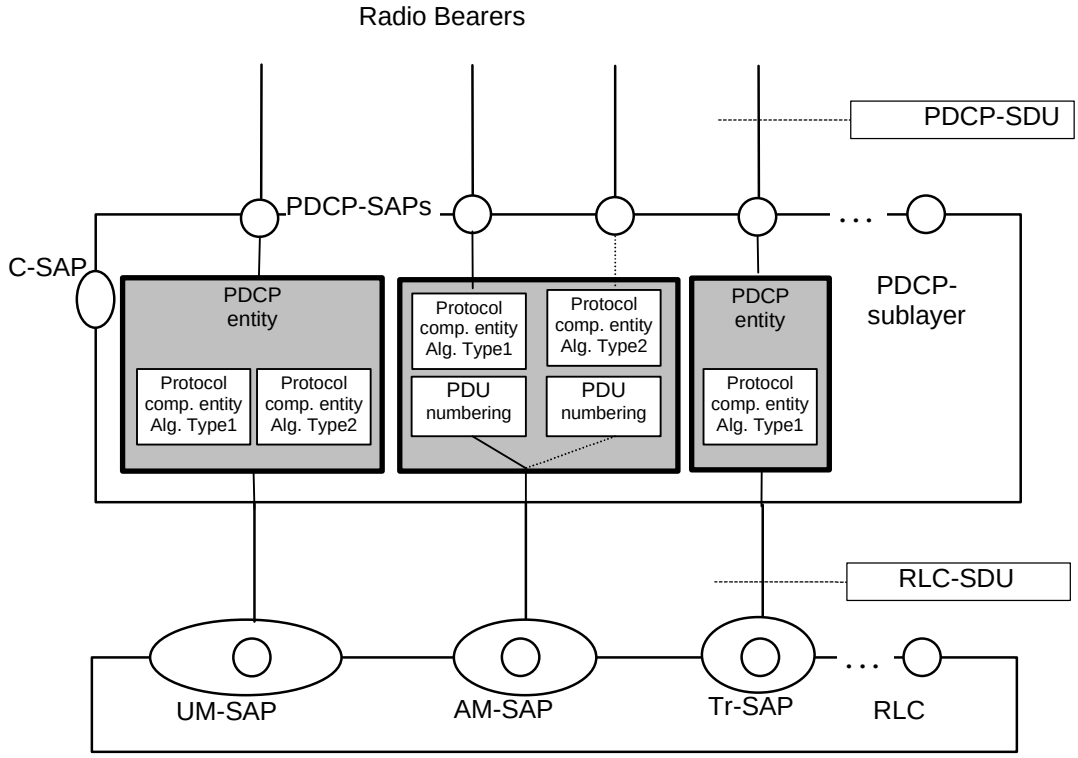


**Figure 1: PDCP structure**

Figure 1 represents only one possible structure for the PDCP sublayer and this should not restrict implementation. However, subclause 5.1 shall be adhered to.

# 5 Functions

PDCP provides its services to the NAS at the UE or the relay at the Radio Network Controller (RNC).

The Packet Data Convergence Protocol shall perform the following functions:

- header compression and decompression of IP data streams (e.g., TCP/IP and RTP/UDP/IP headers for IPv4 and IPv6) at the transmitting and receiving entity, respectively. The header compression method is specific to the particular network layer, transport layer or upper layer protocol combinations e.g. TCP/IP and RTP/UDP/IP

- transfer of user data. This function is used for conveyance of data between users of PDCP services. Transmission of user data means that PDCP receives PDCP SDUs from the NAS higherupper layers and forwards it them to the RLC lower layers and vice versa

- maintenance of PDCP SDUs and PDCP sequence numbers for radio bearers that are configured to support lossless SRNS relocationRelocation.

PDCP uses the services provided by the Radio Link Control (RLC) sublayer.

## 5.1 Header Compression

The header compression ~~method~~ protocol is specific to the particular network layer, transport layer or upper layer protocol combinations e.g. TCP/IP and RTP/UDP/IP~~for each network layer protocol type~~. The network layer protocol type, e.g. IP or PPP, is indicated during PDP context activation as defined in [1~~7~~]. The header compression protocols and their parameters are configured by ~~higher~~ upper layers for each PDCP entity ~~and indicated to PDCP through the PDCP-C-SAP~~. Compressor and decompressor initiated signalling between peer PDCP entities, during operation, is accomplished through in-band signalling.~~carried out in the user plane.~~

~~The PDCP layer shall be able to support several header compression protocols and it shall always be possible to extend the list of supported protocols in the future.~~

~~The PDCP layer can have one or several PDCP entities. Each PDCP entity may use zero, one, or several header compression protocols. It shall be possible to establish several header compression protocols of different types related to one PDCP entity. Different PDCP entities may include header compression protocols of the same type.~~

~~Figure 1 shows an example how PDCP may be configured.~~

### 5.1.1 ~~Assignment~~ Mapping of PID values

Depending on the configuration by upper layers (i.e. PDCP PDU type to be used and header compressor protocol), the PDCP sublayer shall be able to

- identify the correct header compression protocol ~~to apply at the r~~Receiver ~~and~~

- distinguish different types of header compression packets within a header compression protocol. ~~to handle them with a correct header compression protocol and furthermore to indicate the type of the packet within a certain protocol.~~

Th~~is~~e ~~is~~ above requirements are realised by utilising the PID field in the PDCP PDU. ~~structure~~.

~~The following table illustrates an example of the PID value allocation table when three arbitrary header compression methods (RFC 2507[6], Methods A and B) are configured for one PDCP entity. The table is reconfigured every time the PDCP entity is reconfigured with a change in the supported header compression protocols.~~

**~~Table 1: Example of the PID value allocation table~~**

| ~~PID Value~~ | ~~Optimisation method~~ | ~~Packet type~~ |
|---|---|---|
| ~~0~~ | ~~No header compression~~ | ~~-~~ |
| ~~1~~ | ~~RFC 2507~~ | ~~Full header~~ |
| ~~2~~ | ~~RFC 2507~~ | ~~Compressed TCP~~ |
| ~~3~~ | ~~RFC 2507~~ | ~~Compressed TCP nondelta~~ |
| ~~4~~ | ~~RFC 2507~~ | ~~Compressed non TCP~~ |
| ~~5~~ | ~~RFC 2507~~ | ~~Context state~~ |
| ~~6~~ | ~~Method A~~ | ~~Uncompressed TCP/IP~~ |
| ~~7~~ | ~~Method A~~ | ~~Compressed TCP/IP~~ |
| ~~8~~ | ~~Method B~~ | ~~Uncompressed IP/UDP/RTP~~ |
| ~~9~~ | ~~Method B~~ | ~~Compressed IP/UDP/RTP~~ |
| ~~...~~ | ~~Unassigned value~~ | ~~-~~ |

The ~~assignment~~ mapping of the PID values shall follow the general rules listed below:

- PID values shall be mapped to the different packet types independently at each PDCP entity;

- PID value "0" ~~is~~ shall indicate ~~reserved permanently for~~ "no compression". PID value "0" shall be used in a PDCP PDU containing in its Data field a PDCP SDU that is unchanged by the Sender and that shall not be decompressed by the Receiver;

- ~~PID values are assigned in ascending order, starting from 1;~~

- ~~PID values are assigned independently to each PDCP entity;~~

- PID values are mapped in ascending order, starting from 1, for every configured header compression protocol, in the order of configuration by upperhigher layer. The first available PID value is assigned to the first packet type of the header compression protocol as defined in the specification for this header compression protocol. PID values are assignedmapped for all the specified packet types defined for the header compression protocol and in the order defined in subclause 5.1.2.1 for the respective header compression protocol.

- PID values are reassigned re-evaluatedre-mapped for the PDCP entity after any renegotiation reconfiguration of the header compression protocols for that entity;

- the list of negotiated (or re-negotiated) header compression entities shall be examined, starting from the first one in the list. The number of PID values to be assigned is specified in the subclause for this protocol;

- if there are not enough unused PID values to be assigned to a header compression protocol, the negotiated header compression entities using this protocol shall be ignored without error notification;

- PID values that are used and are not defined invalidate the PDCP PDU;

- In this version of the protocol - as there is at maximum one header compression protocol configured for each PDCP entity - no PID values greater than 5 can be assigned to any packet type or header compression protocol.

- for a certain protocol in a PDCP entity the assignment of PID values starts from (n+1) where n is the number of PID values already assigned to other protocols. The assignment is done in the order the protocols are configured by higher layers. In the example given in table 1 RFC 2507 was the first, Method A was the second and Method B was the third protocol configured by higher layers. The PID follows this order.

The following table illustrates an example of the PID value allocation tablemapping to the packet types when three header compression methods are configured for one PDCP entity: (RFC 2507[6] with the five packet types listed in subclause 5.1.2, and Methods A and Method B with two different packet types each) are configured for one PDCP entity. Methods A and Method B are imaginary header compression protocols introduced for the purposepropose of illustration.

**Table 1: Example of the PID value allocationmapping table**

| PID Value | Optimisation method | Packet type |
|---|---|---|
| 0 | No header compression | - |
| 1 | RFC 2507 | Full header |
| 2 | RFC 2507 | Compressed TCP |
| 3 | RFC 2507 | Compressed TCP non-delta |
| 4 | RFC 2507 | Compressed non-TCP |
| 5 | RFC 2507 | Context state |
| 6 | Method A | Packet Type 1 of Method A |
| 7 | Method A | Packet Tapype 2 of Method A |
| 8 | Method B | Packet Taype 1 of Method B |
| 9 | Method B | Packet Taype 2 of Method B |
| ... | Unassigned value | - |

The used header compression protocols and the packet type are unambiguously known by the basis of the PID value and shall apply to peer PDCP entities. While transferring data, the PID values are conveyed in theas one field of the PDCP PDU header belonging to the PDCP PDU. Any successfully negotiated protocol may be used for header compression of a PDCP SDU.

## 5.1.2 IP Header Compression (RFC 2507)

Detailed The detailed operation of the RFC 2507 header compression protocol is specified described in clause 3 of the IETF specification RFC 2507 [6]. Furthermore theThe mechanisms related to error recovery and packet reordering are also described in clauses 10 and 11 of the RFC 2507. These mechanisms shall be included in the functionality of the header compression supported by PDCP. The enabling implementation of the RFC 2507 header compression functionality is not covered in this specification and is left to the implementation.

#### 5.1.2.1 ~~Assignment~~ Mapping of PID values for RFC 2507

~~The following~~ PID values shall be ~~assigned~~ mapped to the RFC 2507 header compression packet types in the order presented in ~~the table~~Table 2 below ~~–~~where "n" is the number of PID values already ~~assigned~~ mapped to other protocol packet types~~s~~. In this version of the specification, since only one instance and one type of header compression protocol (RFC 2507) per PDCP entity is supported, PID values greater than 5 shall not be mapped (i.e. value of "n" shall always equal 0).

**Table 2: Mapping of PID values ~~assigned to~~for RFC 2507 header compression protocol**

| PID value | Optimisation method | Packet type |
|---|---|---|
| n+1 | RFC 2507 | Full header |
| n+2 | RFC 2507 | Compressed TCP |
| n+3 | RFC 2507 | Compressed TCP non-delta |
| n+4 | RFC 2507 | Compressed non-TCP |
| n+5 | RFC 2507 | Context state |

## 5.2 Void

## 5.3 Data Transfer

If header compression is configured the PDCP entity in the ~~s~~Sender shall

- perform header compression upon reception of a PDCP SDU from ~~higher~~upper layers,
- if the radio bearer is configured for lossless SRNS Relocation, ~~support~~maintain PDCP sequence numbering as specified in subclause 5.3.1.1.~~–~~
- submit the PDCP PDU to lower layer in the sequence received from the upper layer.

When the PDCP entity at the ~~r~~Receiver receives the PDCP PDU from lower layers, it shall,

- perform header decompression (if header compression is configured) of the PDCP PDU to obtain the PDCP SDU and
- ~~deliver~~~~submit~~deliver the PDCP SDU to the ~~PDCP user~~upper layer in the order received from the lower layer.
- ~~–~~if the received PDCP PDU is of type PDCP SeqNum PDU, follow the procedure in subclause ~~5.5.2~~5.3.1.2

### 5.3.1 Data transfer over acknowledged mode RLC

~~If header compression is negotiated the PDCP entity shall perform header compression upon reception of a PDCP-DATA.Req. The PDCP-PDU is then delivered in RLC-AM-DATA.Req to RLC.~~

~~During operation, when the peer PDCP entity receives the PDCP-PDU in a RLC-AM-DATA.Ind primitive, the PDCP entity shall perform the header decompression (if negotiated) of PDCP-PDU to obtain the PDCP SDU and deliver the PDCP SDU to the PDCP user with the PDCP-DATA.Ind. The following figure illustrates data transfer over acknowledged mode RLC.~~Figure 2 shows the PDCP data transfer over acknowledged mode RLC.

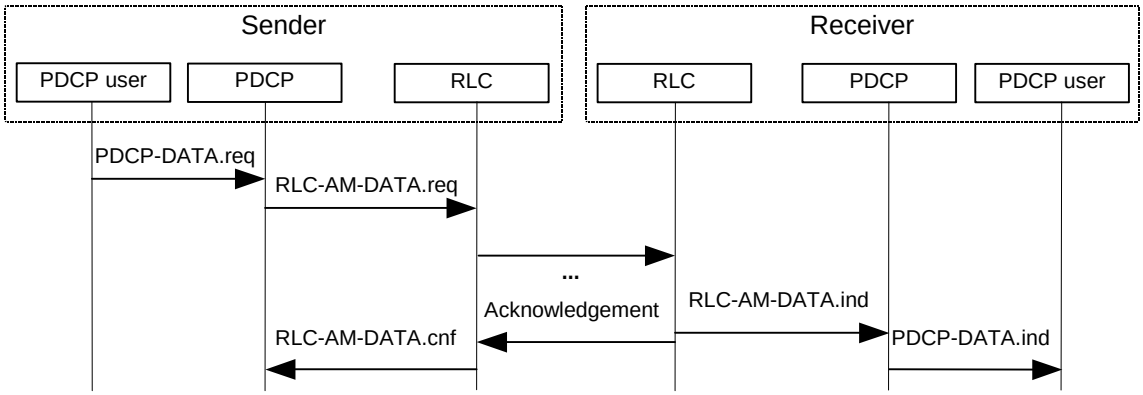


**Figure 2: PDCP data transfer over acknowledged mode RLC**

## 5.3.2 Data transfer over unacknowledged and transparent mode RLC

~~If header compression is negotiated the PDCP entity shall perform header compression upon reception of a PDCP-DATA.Req. The PDCP-PDU is then delivered in RLC-UM-DATA.Req or RLC-Tr-DATA.Req to RLC.~~

~~When the peer PDCP entity receives the PDCP-PDU in the RLC-UM-DATA.Ind or RLC-Tr-DATA.Ind primitive, the PDCP entity shall perform the header decompression (if negotiated) of PDCP-PDU to obtain the PDCP SDU and deliver the PDCP SDU to the PDCP user with the PDCP-DATA.Ind. The following figure illustrates data transfer over unacknowledged and transparent mode RLC.~~Figure 3 shows the PDCP data transfer over unacknowledged or transparent mode RLC.

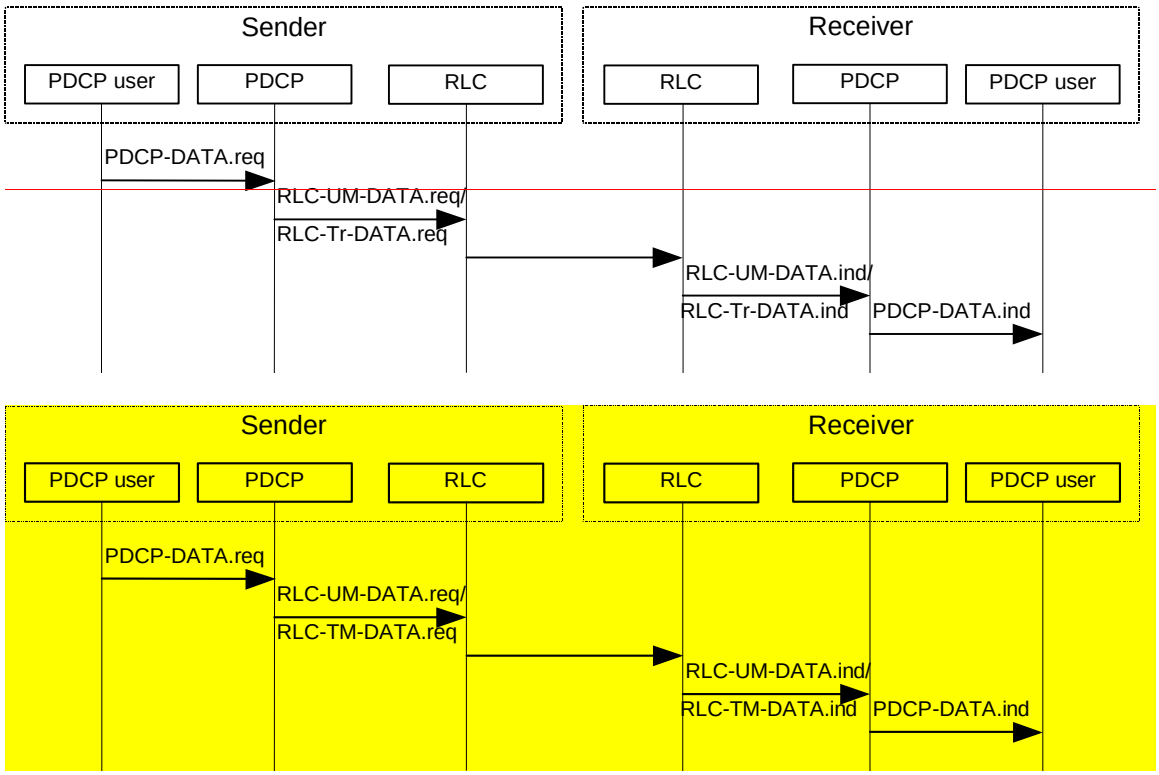


**Figure 3: PDCP data transfer over unacknowledged or transparent mode RLC**

# 6 Services

## 6.1 Services provided to upper layers

The following services are provided by PDCP to upper layers:

- ~~PDCP SDU delivery;~~.Transfer of user data
- maintenance of PDCP PDU sequence numbers;
- ~~maintenance of PDCP SDUs not confirmed to have been received by the peer PDCP entity.~~

## 6.2 Services expected from RLC layer

For a detailed description of the following functions see [5].

- Transparent data transfer Service.
- Unacknowledged data transfer Service.
- Acknowledged data transfer Service.
- ~~Data transfer in acknowledged mode.~~
- ~~Data transfer in unacknowledged mode.~~
- ~~Data transfer in transparent mode.~~

~~- Segmentation and reassembly.~~

- ~~In-Sequence delivery.~~

# 7 Elements for layer-to-layer communication

The interaction between the PDCP layer and other layers are described in terms of primitives where the primitives represent the logical exchange of information and control between the PDCP layer and other layers. The primitives shall not specify or constrain implementations.

## 7.1 Primitives between PDCP and upper layers

The primitives between PDCP and upper layers are shown in ~~table~~ Table 3.

**Table 3: Primitives between PDCP and upper layers**

| Generic Name | Parameter | | | |
|---|---|---|---|---|
| | Req. | Ind. | Resp. | Conf. |
| PDCP-DATA | Data | Data | Not Defined | Not Defined |
| CPDCP-CONFIG | PDCP-Info, RLC-SAP SN_Sync | Not Defined | Not Defined | Not Defined |
| CPDCP-RELEASE | RLC-SAP | Not Defined | Not Defined | Not Defined |
| CPDCP-SN | PDCP SN | Not Defined | Not Defined | Not Defined |
| CPDCP-RELOC | Receive_SN | Not Defined | Not Defined | Receive_SN, Send_SN |

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

- PDCP-DATA-Req is used by upper user-plane protocol layers to request a transmission of upper layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

- CPDCP-CONFIG Req is used to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) CPDCP-RELEASE-Req.

- CPDCP-RELEASE-Req is used by upper layers to release a PDCP entity.

d) CPDCP-SN-Req.

- This primitive is used at the UTRAN. CPDCP-SN-Req is used to transfer the PDCP SN to PDCP.

e) CPDCP-RELOC-Req/Conf.

- CPDCP-RELOC-Req initiates the SRNS ~~relocation~~Relocation procedure in PDCP for those radio bearers that are configured to support lossless SRNS ~~relocation~~Relocation. The Receive_SN is only included at the UE side.~~The Receive_SN is only included when the UE receives a new U-RNTI.~~

- CPDCP-RELOC-Conf is used to transfer the Receive_SN and/or Send_SN to upper layers for lossless SRNS ~~relocation~~Relocation. The Send_SN is only included at the source RNC.

The following parameters are used in the primitives:

1) PDCP-Info:

- C~~c~~ontains the parameters for each of the header compression protocols configured to be used by one PDCP entity.

2) RLC-SAP:

- T~~t~~he RLC-SAP (T~~r~~TM/UM/AM) used by PDCP entity when communicating with RLC sublayer.

3) SN_Sync:

- Indicates that PDCP should start PDCP sequence number synchronization

4) Send_SN:

- The send PDCP sequence number of the next PDCP PDU to be sent. There is one in the uplink (UL_Send_SN) and one in the downlink (DL_Send_SN). Refer to subclause 5.4.1.

5) Receive_SN:

- The receive PDCP sequence number of the next PDCP PDU expected to be received. There is one in the uplink (UL_Receive_SN) and one in the downlink (DL_Receive_SN). Refer to subclause 5.4.1.

6) PDCP SN:

- This includes a PDCP sequence number.

# 8 Elements for peer-to-peer communication

## 8.1 Protocol data units

Different ~~protocol data unit~~PDU formats are defined ~~in~~ for the PDCP protocol, one not introducing any overhead to the (compressed) PDCP SDU, others introducing such overhead. ~~Whether overhead is introduced by the PDCP protocol is configured for the PDCP entity by higher layers.~~

## 8.2 Formats

A PDCP PDU ~~is~~shall be a multiple of 8 bits~~byte-aligned~~, if the RLC entity is ~~run on~~ configured for unacknowledged or acknowledged mode. Otherwise, if the RLC entity is ~~in~~ configured for transparent mode, it is bit-aligned. In ~~the drawings in subclause 8.2~~Tables 4, 5 and 6, bit strings are represented ~~by tables in which~~as follows: 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.

SDUs are bit strings, with any non-null length. If not compressed within PDCP an SDU is included from first bit onward.

### 8.2.1 PDCP- No-Header PDU

The PDCP- No-Header PDU does not introduce any overhead to the PDCP SDU. The use of the PDCP No-header PDU is configured by the upper layer. ~~The choice of applying PDCP No-Header PDU shall be possible only for the case where support of lossless SRNS Relocation is not configured.~~

The format of the PDCP-No-Header- PDU is shown in ~~t~~Table 4.

**Table 4: PDCP-No-Header PDU**

| Data |
|---|

### 8.2.2 PDCP Data PDU

The PDCP ~~d~~Data PDU is used to convey

- ~~a payload unit~~ data containing an uncompressed PDCP SDU or,
- header compression related control signalling or,
- ~~data~~ data that has been obtained from PDCP SDU after header compression.

The format of the PDCP -Data -PDU is shown in ~~table~~ Table 5.

**Table 5: PDCP -Data -PDU format**

| PDU type | PID |
|---|---|
| Data | |

### 8.2.3 PDCP SeqNum PDU

The PDCP SeqNum~~sequence number~~ PDU is used to convey a PDCP ~~P~~SDU sequence number and,

- ~~a payload unit~~data containing ~~a PDCP PDU sequence number and~~ an uncompressed PDCP SDU or,
- header compression related control signalling or,
- data that has been obtained from PDCP SDU after header compression.

The format of the PDCP -SeqNum -PDU is shown in ~~table~~ Table 6.

**Table 6: PDCP -SeqNum -PDU format**

| PDU type | PID |
|---|---|
| Sequence number | |
| | |
| Data | |
| | |

## 8.3 Parameters

If not otherwise mentioned in the definition of each field then the bits in the parameters shall be interpreted as follows: the left most bit string is the first and most significant and the right most bit is the last and least significant bit.

Unless otherwise mentioned, integers are encoded in standard binary encoding for unsigned integers. In all cases the bits appear ordered from MSB to LSB when read in the PDU.

### 8.3.1 PDU Type

Length: 3 bits.

The PDU type field indicates the PDCP ~~d~~Data PDU type.

| Bit | PDU Type |
|---|---|
| **000** | ~~PID field used for header compression information (PDCP -PDU format described in table 5)~~PDCP Data PDU (Table 5) |
| **001** | ~~PID field used for header compression information and the PDCP PDU sequence number included (PDCP -PDU format described in table 6)~~PDCP SeqNum PDU (Table 6) |
| **010-111** | Reserved (PDUs with this encoding are invalid for this version of the protocol) |

### 8.3.2 PID

Length: 5 bits.

The PID field indicates the used header compression and packet type.

| Bit | Description |
|---|---|
| **00000** | No header compression |
| **00001-11111** | Dynamically negotiated header compression identifier, as described in subclause 5.1.1 |

The PID field value ~~defines~~ indicates the used header compression protocol type and packet type. ~~One~~ A specific header compression protocol may ~~reserve~~ utilize a certain ~~amount~~ range of consecutive values from the PID field value space for different packet types. The Receiving PDCP entity ~~makes~~ performs the ~~reverse~~ necessary operation (e.g. header decompression) according to the PID field value. ~~There is not fixed relation between PID field value and used optimisation / packet type, but PID field values are defined dynamically at the PDCP parameter negotiation.~~

### 8.3.3 Data

The Data field may include either one of the following:

- Uncompressed PDCP SDU;
- Header compressed PDCP SDU ~~with header compressed~~;
- Header compression protocol feedback information.

~~PDCP SDUs that have been header compressed are mapped to this field if header compression is negotiated~~configured~~. Otherwise, PDCP SDUs are mapped to this field.~~

### 8.3.4 Sequence number

Length: 16 bits

PDCP PDU sequence number.

# 9 Handling of unknown, unforeseen and erroneous protocol data

## 9.1 Invalid PDU type

If a PDCP entity receives a PDCP PDU with a PDU Type set to Reserved (see subclause 8.3.1), it shall:

- discard the PDCP PDU.

If a PDCP entity is not configured for lossless SRNS Relocation and receives a PDCP SeqNum PDU, it shall:

- discard the PDCP SeqNum PDU.~~ignore the Sequence number field of the PDCP SeqNum PDU~~

## 9.2 Invalid PID value

If a PDCP entity receives a PDCP PDU with a PID value that is not mapped with a valid packet type (see subclause 5.1.1), it shall:

- discard the PDCP PDU.~~In case of error situations the following action is foreseen:~~

~~1) PDCP entity should discard invalid PDU.~~

# Annex A (informative): Change history

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **TSG #** | **TSG Doc.** | **CR** | **Rev** | **Subject/Comment** | **Old** | **New** |
| 12/1999 | RP-06 | RP-99645 | - | | Approved at TSG-RAN #6 and placed under Change Control | - | 3.0.0 |
| 03/2000 | RP-07 | RP-000041 | 004 | | Bit order of PDCP PDUs | 3.0.0 | 3.1.0 |
| | RP-07 | RP-000041 | 005 | | Changes to PDCP | 3.0.0 | 3.1.0 |
| 06/2000 | RP-08 | RP-000221 | 006 | 4 | Changes in PDCP PDU format due to PDCP sequence numbering | 3.1.0 | 3.2.0 |
| 09/2000 | RP-09 | RP-000359 | 009 | 3 | Clarification of PDCP Sequence Numbering | 3.1.0 | 3.2.0 |
| | RP-09 | RP-000359 | 011 | | Clarification on how to handle invalid PDUs | 3.2.0 | 3.3.0 |
| | RP-09 | RP-000359 | 012 | 2 | Primitives required for SRNS relocation | 3.2.0 | 3.3.0 |
| | RP-09 | RP-000359 | 015 | | Handling of invalid PDCP PDU sequence number | 3.2.0 | 3.3.0 |
| 03/2001 | RP-11 | RP-010027 | 018 | 1 | Editorial Corrections | 3.3.0 | 3.4.0 |
| | RP-11 | RP-010027 | 019 | 1 | Updates necessary for Rel-4 specification | 3.3.0 | 3.4.0 |
| 06/2001 | RP-12 | RP-010310 | 020 | 1 | Clarification on PDCP Sequence numbering | 3.4.0 | 3.5.0 |

**3GPP TSG-RAN WG2 Meeting#21**
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***R2-012166***

*CR-Form-v3*

# CHANGE REQUEST

⌘ **25.323** **CR** **036** ⌘ rev **-** ⌘ Current version: **4.1.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | Corrections to PDCP |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | TEI |
| ***Date:*** | ⌘ | August 27, 2001 |
| ***Category:*** | ⌘ | **A** |
| ***Release:*** | ⌘ | REL-4 |

*Use one of the following categories:*
***F*** *(correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(Addition of feature),*
***C*** *(Functional modification of feature)*
***D*** *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

*Use one of the following releases:*
*2* *(GSM Phase 2)*
*R96* *(Release 1996)*
*R97* *(Release 1997)*
*R98* *(Release 1998)*
*R99* *(Release 1999)*
*REL-4* *(Release 4)*
*REL-5* *(Release 5)*

***Reason for change:*** ⌘

1. Clause 1:The scope contains text that is more relevant to the functionality of PDCP and is therefore more appropriately covered in the later clauses.

2. Clause 2: Missing references.

3. Clause 3: Missing Definitions subclause.

4. Clause 4: Ambiguous statements about transparency function of PDCP. Details of PDCP model more appropriately covered in later subclauses. Duplication of text. Ambiguity about number of header compression entities within PDCP entity.

5. Clause 5: Duplicate text about model of PDCP.

6. Subclause 5.1.1: Ambiguity about applicability of PID.

7. Subclause 5.1.1: Ambiguity about use of PID value "0".

8. Subclause 5.1.1: Ambiguous text on re-mapping of PID values on reconfiguration.

9. Subclause 5.1.1: Inclusion of error cases more appropriately included in TS 25.331 or separate subclause.

10. Subclause 5.1.2: Functionality of RFC 2507 and inclusion of clauses of RFC 2507.

11. Subclause 5.2: Incomplete description of Data Transfer function.

12. Subclause 5.3: Unclear description of SRNS Relocation and Lossless SRNS Relocation and functions of source RNC, target RNC and UE. Incorrect description of sequence number synchronisation in case of combined "Hard Handover" and "SRNS Relocation".

13. Subclause 6.1: Incomplete description of services provided.

14. Subclause 6.2: Incorrect description of services expected from RLC.

15. Subclause 8.2.1: Ambiguous use of PDCP No-header PDU.

16. Subclause 8.3.3: Incomplete description of the Data field. Missing possibility to include header compression control internal feedback information.

17. Clause 9: Missing error cases.

18: Miscellaneous editorial corrections.

***Summary of change:*** ⌘ 1. Text relating to functionality of PDCP is deleted.

No isolated impact. Modification is editorial.

2. References added.

No isolated impact. Modification is editorial.

3. Definitions subclause added.

No isolated impact. Modification is editorial.

4. Text related to model of PDCP sublayer moved to Subclause 4.1. It is clarified that in REL-4 there are only two header compression protocol types.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

5. Duplicate text removed.

No isolated impact. Modification is editorial.

6. It is clarified that the use of PID to meet certain requirements depends on the configuration of the PDCP entity.

7. The use of PID = 0 is clarified.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

8. Text is clarified to imply that PID values are not assigned but mapped internally.

No isolated impact. Modification is editorial.

9. Error cases have been deleted and are either covered in clause 9 of this specification or moved to RRC as appropriate. No isolated impact. Modification is editorial.

10. It is clarified that the enabling of the functionality of RFC 2507 is not covered in this specification. Clause references to RFC 2507 are deleted.

No isolated impact. Modification is editorial.

11. A more complete description with the inclusion of PDCP SN in case of lossless SRNS relocation configured RBs is provided.

No isolated impact. Modification is editorial.

12. Description of SRNS Relocation and Lossless SRNS Relocation are broken up into separate subclauses to clarify the PDCP role in both cases. It is further corrected that in case of the combined "Hard Handover and SRNS Relocation" the source RNC provides to the UE the next expected UL receive SN.

Isolated Impact Analysis: No impact to systems implementing as per this clarification.

13. A more complete description of PDCP services to upperlayers is provided including

| | | |
|---|---|---|
| | | the maintenance of unconfirmed PDCP SDUs and PDCP SNs.<br><br>No isolated impact. Modification is editorial.<br><br>14. Segmentation and reassembly function requirement is deleted.<br><br>No isolated impact. Modification is editorial.<br><br>15. It is clarified that the "PDCP No-header PDU" shall not be used in case lossless relocation is configured for the associated RBs.<br><br>Isolated Impact Analysis: No impact to systems implementing as per this clarification.<br><br>16. It is clarified that the Data field can also carry header compression control feedback information.<br><br>Isolated Impact Analysis: No impact to systems implementing as per this clarification.<br><br>17. Error cases have been included. It is clarified that in case a PDCP SeqNum PDU is received in the absence of "lossless Relocation" configuration the PDCP entity shall ignore the SN information but shall process the Data field. It is clarified that in case the PDCP entity receives a PDCP PDU with an invalid PID value it shall ignore the PDCP PDU.<br><br>Isolated Impact Analysis: No impact to systems implementing as per this clarification. |
| ***Consequences if not approved:*** | ⌘ | Where clarifications have been provided if the CR is not approved, interoperability errors may result if the peer PDCP entities are not implemented according to this CR due to ambiguous specification text in earlier versions. |

| | | | | | |
|---|---|---|---|---|---|
| ***Clauses affected:*** | ⌘ | 1, 2, 3, 3.1, 3.2 (new), 4.1, 4.2, 5, 5.1, 5.1.1, 5.1.2, 5.1.2.1, 5.1.2.2, 5.1.3, 5.1.3.1, 5.1.3.2, 5.1.3.3, 5.1.3.4, 5.3, 5.3.1, 5.3.2, 6.1, 6.2, 7.1, 8.1, 8.2, 8.2.1, 8.2.2, 8.2.3, 8.3.1, 8.3.2, 8.3.3, 9.1 (new), 9.2 (new) | | | |
| ***Other specs affected:*** | ⌘ | X | Other core specifications | ⌘ | 3GPP TS 25.331<br>25.323 v3.5.0, CR 035r1 |
| | | | Test specifications | | |
| | | | O&M Specifications | | |
| ***Other comments:*** | ⌘ | | | | |

*Technical Specification*

# 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Packet Data Convergence Protocol (PDCP) Specification (Release 4)

# 3GPP TS 25.323 V4.1.0 (2001-06)

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# Contents

# 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.

# 1 Scope

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

~~PDCP provides its services to the NAS at the UE or the relay at the Radio Network Controller (RNC).~~

~~PDCP uses the services provided by the Radio Link Control (RLC) sublayer.~~

~~The main functions of PDCP are:~~

- ~~compression of redundant Network PDU control information (header compression);~~
- ~~transfer of packet data protocol user data using services provided by RLC protocol.~~

# 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~~S 25.401: "UTRAN Overall Description"~~23.060: "General Packet Radio Service (GPRS); Service description; Stage 2"..

[2] 3GPP TS 25.331: "Radio Resource Control"~~,R 21.905: "3G Vocabulary".~~

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

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

[5] 3GPP TS 25.322: "RLC Protocol Specification".

[6] IETF RFC 2507: "IP Header Compression".

[7] 3GPP TR 21.905: "3G Vocabulary"~~.3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".~~

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

[9] IETF RFC 3096: "Requirements for robust IP/UDP/RTP header compression".


# 3 Definitions and Abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in [7] apply.

## 3.2 Abbreviations

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

| | |
|---|---|
| AS | Access Stratum |
| CID | Context Identifier |
| C-SAP | Control Service Access Point |
| HC | Header Compression |
| IETF | Internet Engineering Task Force |
| IP | Internet Protocol |
| L2 | Layer 2 (data link layer) |
| L3 | Layer 3 (network layer) |
| NAS | Non Access Stratum |
| PDCP | Packet Data Convergence Protocol |
| PDU | Protocol Data Unit |
| PID | Packet Identifier |
| PPP | Point-to-Point Protocol |
| RB | Radio Bearer |
| RFC | Request For Comments |
| RLC | Radio Link Control |
| RNC | Radio Network Controller |
| ROHC | RObust Header Compression |
| RTP | Real Time Protocol |
| SDU | Service Data Unit |
| TCP | Transmission Control Protocol |
| UDP | User Datagram Protocol |
| UE | User Equipment |
| UMTS | Universal Mobile Telecommunications System |
| UTRA | UMTS Terrestrial Radio Access |
| UTRAN | UMTS Terrestrial Radio Access Network |

# 4 General

## 4.1 Objective

The present document describes the functionality of the ~~UTRAN~~ PDCP. ~~The overall UTRAN logical architecture is defined in [3].~~

~~Network layer protocols are intended to be capable of operating over services derived from a wide variety of subnetworks and data links. UMTS supports several network layer protocols providing protocol transparency for the users of the service. At that point of view supported protocols are IPv4 and IPv6. Introduction of new network layer protocols to be transferred over UTRAN shall be possible without any changes to UTRAN protocols. Therefore, all functions related to transfer of packets from higher layers (PDCP SDUs) shall be carried out in a transparent way by the UTRAN network entities. This is one of the requirements for UTRAN PDCP.~~

~~Another requirement for the PDCP is to provide functions that help to improve channel efficiency. This requirement is fulfilled by the possibility to implement different kinds of optimisation methods. The currently known methods are standardised IETF header compression protocols.~~

~~Every RB is connected to one PDCP entity and one PDCP entity is connected to one RLC entity. The PDCP entities are located in the PDCP sublayer.~~

~~Every PDCP entity uses zero, one or several header compression protocol types with certain parameters. Several PDCP entities may use the same protocol type. The protocol types and their parameters are negotiated by higher layers and indicated to PDCP through the PDCP Control Service Access Point (PDCP-C-SAP).~~

~~Since the adaptation of different network layer protocols to PDCP is implementation dependent, it is not defined in the present document.~~

## 4.2 Overview on sublayer architecture

Figure 1 shows the model of the PDCP within the ~~UTRAN~~ radio interface protocol architecture. The radio interface protocol architecture is defined in [3]. The PDCP sublayer is defined for the PS domain only.~~Every PDCP-SAP uses exactly one PDCP entity. Each PDCP entity uses none, one or several header compression protocol types.~~

Every PS domain RAB is associated with one RB, which in turn is associated with one PDCP entity. Each PDCP entity is associated with one RLC entity. The PDCP entities are located in the PDCP sublayer.

Every PDCP entity uses zero, one or several different header compression protocol types. Several PDCP entities may be defined for a UE with each using the same or different protocol type. In this version of the specification, only two header compression protocol types, RFC 2507 [6] and RFC 3095[8], are supported.

The PDCP sublayer is configured by upper layer [2] through the PDCP-C-SAP.

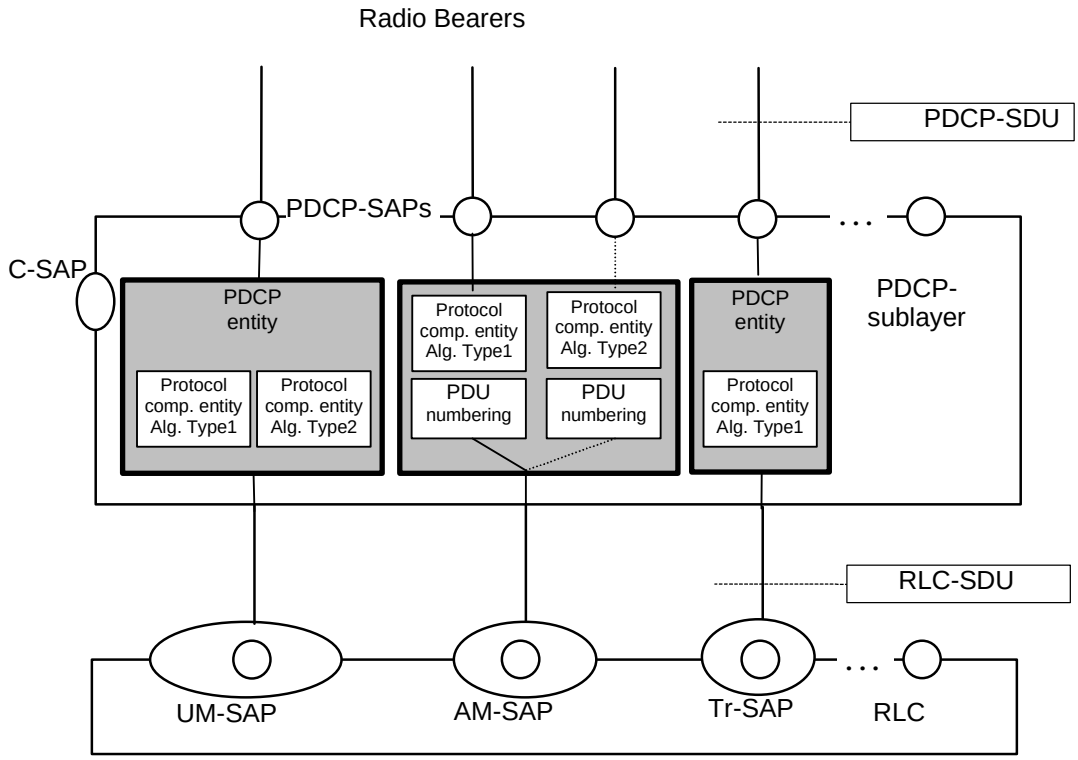


**Figure 1: PDCP structure**

Figure 1 represents ~~only~~ one possible structure for the PDCP sublayer and ~~this~~ should not restrict implementation. ~~However, subclause 5.1 shall be adhered to.~~

# 5 Functions

PDCP provides its services to the NAS at the UE or the relay at the Radio Network Controller (RNC).

The Packet Data Convergence Protocol shall perform the following functions:

- header compression and decompression of IP data streams (e.g., TCP/IP and RTP/UDP/IP headers for IPv4 and IPv6) at the transmitting and receiving entity, respectively. ~~The header compression method is specific to the particular network layer, transport layer or upper layer protocol combinations e.g. TCP/IP and RTP/UDP/IP~~
- transfer of user data. This function is used for conveyance of data between users of PDCP services. ~~Transmission of user data means that PDCP receives PDCP SDU from the NAS and forwards it to the RLC layer and vice versa~~

- maintenance of ~~PDCP SDUs and~~ PDCP sequence numbers for radio bearers that are configured to support lossless SRNS ~~relocation~~Relocation

PDCP uses the services provided by the Radio Link Control (RLC) sublayer.

# 5.1 Header Compression

The header compression ~~method~~ protocol is specific to the particular network layer, transport layer or upper layer protocol combinations e.g. TCP/IP and RTP/UDP/IP~~for each network layer protocol type~~. The network layer protocol type, e.g. IP or PPP, is indicated during PDP context activation as defined in [~~7~~1]. The header compression protocols and their parameters are configured by ~~higher~~ upper layers for each PDCP entity ~~and indicated to PDCP through the PDCP-C-SAP~~. Compressor and decompressor initiated signalling between peer PDCP entities, during operation, is ~~carried out~~ accomplished through in-band signalling~~in the user plane~~.

~~The PDCP layer shall be able to support several header compression protocols and it shall always be possible to extend the list of supported protocols in the future.~~

~~The PDCP layer can have one or several PDCP entities. Each PDCP entity may use zero, one, or several header compression protocols. It shall be possible to establish several header compression protocols of different types related to one PDCP entity. Different PDCP entities may include header compression protocols of the same type.~~

~~Figure 1 shows an example how PDCP may be configured.~~

## 5.1.1 ~~Assignment~~ Mapping of PID values

~~PDCP shall be able to distinguish different types of header compression packets to handle them with a correct header compression protocol and furthermore to indicate the type of the packet within a certain protocol. This is realised by utilising the PID field in the PDU structure.~~

Depending on the configuration by upper layers (i.e. PDCP PDU type to be used and header compressor protocol), the PDCP sublayer shall be able to:

- identify different types of header compression protocols ~~to apply at the Receiver~~
- identify different header compression protocol packet types within a header compression protocol and
- identify different contexts for a header compression protocol

The above requirements ~~above~~ are realised by utilising the PID field in the PDCP PDU ~~format~~.

~~The following table illustrates an example of the PID value allocation table when five arbitrary header compression methods (RFC 2507[6], Methods A and B, Method C and RFC 3095 [8]) are configured for one PDCP entity. The table is reconfigured every time the PDCP entity is reconfigured with a change in the supported header compression protocols.~~

**Table 1: Example of the PID value allocation table**

| PID Value | Optimisation method | Packet type |
|---|---|---|
| 0 | No header compression | - |
| 1 | RFC 2507 | Full header |
| 2 | RFC 2507 | Compressed TCP |
| 3 | RFC 2507 | Compressed TCP nondelta |
| 4 | RFC 2507 | Compressed non TCP |
| 5 | RFC 2507 | Context state |
| 6 | Method A | Uncompressed TCP/IP |
| 7 | Method A | Compressed TCP/IP |
| 8 | Method B | Uncompressed IP/UDP/RTP |
| 9 | Method B | Compressed IP/UDP/RTP |
| 10 | RFC 3095 | CID 0 |
| 11 | RFC 3095 | CID 1 |
| 12 | RFC 3095 | CID 2 |
| 13 | Method C | Full header |
| 14 | Method C | Compressed header |
| 15...31 | Unassigned value | - |

The assignment mapping of the PID values shall follow the general rules listed below:

- PID values shall be mapped to the different packet types independently at each PDCP entity;
- PID value "0" is reserved permanently forshall indicate "no compression". PID value "0" shall be used in a PDCP PDU containing in its Data field a PDCP SDU that is unchanged by the Sender and that shall not be decompressed by the Receiver.;
- PID values are assigned in ascending order, starting from 1;
- PID values are assigned independently to each PDCP entity;
- PID values are mapped in ascending order, starting from 1, for every configured header compression protocol, in the order of configuration by upperhigher layer. The first available PID value is assigned to the first packet type of the header compression protocol as defined in the specification for this header compression protocol. PID values are assignedmapped for all the specified packet types defined for the header compression protocol and in the order defined in subclause 5.1.2.1 for the respective header compression protocol.
- PID values are reassigned re-evaluatedre-mapped for the PDCP entity after any renegotiation reconfiguration of the header compression protocols for that entity;
- the list of negotiated (or re-negotiated) header compression entities shall be examined, starting from the first one in the list. The number of PID values to be assigned is specified in the subclause for this protocol;
- if there are not enough unused PID values to be assigned to a header compression protocol, the negotiated header compression entities using this protocol shall be ignored without error notification;
- PID values that are used and are not defined invalidate the PDCP PDU;
- for a certain protocol in a PDCP entity the assignment of PID values starts from (n+1) where n is the number of PID values already assigned to other protocols. The assignment is done in the order the protocols are configured by higher layers. In the example given in table 1, RFC 2507 was the first, Method A the second, Method B the third. RFC 3095 the fourth and Method C the fifth protocol configured by higher layers. The PID assignment shall follow this order.

The used header compression protocol, the header compression packet type and header compression protocol contexts are unambiguously known by the basis of the PID value and shall apply to peer PDCP entities. While transferring data, the PID values are conveyed in the field of the PDCP header belonging to the PDCP PDU. Any successfully configured header compression protocol may be used for header compression of a PDCP SDU.

The following table illustrates an example of the PID value mapping to the packet types when five arbitrary header compression methods are configured for one PDCP entity: (RFC 2507[6], Methods A and B, RFC 3095 [8] and Method C and RFC 3095 [8]) are configured for one PDCP entity.. Method A, Method B and Method C are imaginary header compression protocols introduced for the purposepropose of illustration.

**Table 1: Example of the PID value ~~allocation~~mapping table**

| PID Value | Optimisation method | Packet type |
|---|---|---|
| 0 | No header compression | - |
| 1 | RFC 2507 | Full header |
| 2 | RFC 2507 | Compressed TCP |
| 3 | RFC 2507 | Compressed TCP nondelta |
| 4 | RFC 2507 | Compressed non TCP |
| 5 | RFC 2507 | Context state |
| 6 | Method A | ~~Uncompressed TCP/IP~~Packet Type 1 of Method A |
| 7 | Method A | Packet Type 2 of Method A~~Compressed TCP/IP~~ |
| 8 | Method B | Packet Type 1 of Method B~~Uncompressed IP/UDP/RTP~~ |
| 9 | Method B | Packet Type 2 of Method B~~Compressed IP/UDP/RTP~~ |
| 10 | RFC 3095 | CID 0 |
| 11 | RFC 3095 | CID 1 |
| 12 | RFC 3095 | CID 2 |
| 13 | Method C | Packet Type 1 of Method C~~Full header~~ |
| 14 | Method C | Packet Type 2 of Method C~~Compressed header~~ |
| 15...31 | Unassigned value | - |

## 5.1.2 IP Header Compression (RFC 2507)

The detailed operation of the RFC 2507 header compression protocol ~~"IP Header Compression" protocol~~ is ~~described~~ specified in ~~clause 3 of the~~ IETF ~~specification~~ RFC 2507 [6]. ~~Furthermore the~~ The mechanisms related to error recovery and packet reordering are also described in ~~clauses 10 and 11 of the~~ RFC 2507. These mechanisms shall be included in the functionality of the header compression supported by PDCP. The ~~enabling~~implementation of the RFC 2507 header compression functionality is not covered in this specification and is left to the implementation.

### 5.1.2.1 Context identifiers

Context identifiers for RFC 2507 shall only be included in the RFC 2507 packet typesformat, as defined in [6].

### 5.1.2.2 ~~Assignment~~ Mapping of PID values for RFC 2507

~~The following~~ PID values shall be ~~assigned~~ mapped to the RFC 2507 header compression packet types in the order presented in ~~the table~~Table 2 below where "n" is the number of PID values already ~~assigned~~ mapped to other protocols packet types.

**Table 2: Mapping of PID values ~~assigned to~~for RFC 2507 header compression protocol**

| PID value | Optimisation method | Packet type |
|---|---|---|
| n+1 | RFC 2507 | Full header |
| n+2 | RFC 2507 | Compressed TCP |
| n+3 | RFC 2507 | Compressed TCP non-delta |
| n+4 | RFC 2507 | Compressed non-TCP |
| n+5 | RFC 2507 | Context state |

## 5.1.3 Robust Header Compression (RFC 3095)

The detailed operation of the~~,~~ "RObust Header Compression (ROHC)~~: Framework and four profiles: RTP, UDP, ESP, and uncompressed~~",~~ protocol is ~~described~~ specified in ~~the~~ IETF ~~specification~~ RFC 3095 [8].

### 5.1.3.1 Context identifiers

The context of the RFC 3095 protocol is defined in [8]. RFC 3095 can ~~only~~ be configured to support one or several contexts. Each context is identified by a value known as the context identifier (CID). If CIDs are to be used, then the CID shall be either:

- included in the PDCP header; or
- included in the RFC 3095 packet format [8].

The choice of which of the above two methods to use is configured by upper layers. The ~~assignment~~ mapping of the PID values is specified in subclauses 5.1.3.2 and 5.1.3.3, respectively for the above two methods.

### 5.1.3.2 ~~Assignment~~ Mapping of PID values for RFC 3095 with CIDs in PDCP PDU Header

The following PID values shall be ~~assigned~~ mapped to the RFC 3095 header compression protocol in the order presented in the table where n is the number of PID values already ~~assigned~~ mapped to other protocols packet types. As shown in the Table 3 below, the ~~allocation~~ mapping of PID values for the RFC 3095 map to the CID values used by RFC 3095. The maximum CID value ($CID_X$) is configured by upper layers. If this method is configured by upper layers, ~~The RFC 3095~~PDCP ~~protocol~~ shall not introduce CIDs in the ROHC packet format.

**Table 3: Mapping of PID values ~~assigned to~~for RFC 3095 header compression protocol**

| PID value | Optimisation method | Packet type |
|---|---|---|
| n+1 | RFC 3095 | CID1 |
| n+2 | RFC 3095 | CID2 |
| … | RFC 3095 | … |
| … | RFC 3095 | … |
| n+x | RFC 3095 | $CID_X$ |

### 5.1.3.3 ~~Assignment~~ Mapping of PID values for RFC 3095 with CIDs within ROHC packet format

The following PID value shall be ~~assigned~~ mapped to the ~~ROHC~~ RFC 3095 header compression protocol as presented in the table where n is the number of PID values already assigned to other protocols packet types.

**Table 4: Mapping of PID values ~~assigned to~~for RFC ~~2507~~ 3905 header compression protocol**

| PID value | Optimisation method | Packet type |
|---|---|---|
| n+1 | RFC 3095 | RFC 3095 packet format |

If this method is configured by upper layers, ~~The RFC 3095 protocol can be configured to handle CIDs within the ROHC packet format. In such a case~~, PDCP shall not be configured to accommodate ROHC CIDs in the PDCP P~~I~~DU header~~, as described in subclause 5.1.3.1.~~.

### 5.1.3.4 RFC 3095 Segmentation

The RFC 3095 protocol supports segmentation. The segmentation:

- ~~-~~ can vary on a packet ~~-~~ by ~~-~~ packet basis and ~~it~~
- does not ~~cause~~ add any overhead to packets that are not segmented.

~~The segmentation~~The Segmentation option of~~in~~ RFC 3095 shall:

- not be used when ~~RFC 3095 uses the~~ RLC is configured in non-transparent mode ~~of RLC~~ [5], in which case the MRRU (maximum reconstructed reception unit) shall be set equal to 0~~.~~; ~~RFC 3095 segmentation shall~~
- only be used when RLC is configured in ~~RFC 3095 uses the~~ transparent mode ~~of RLC~~ and the PACKET_SIZES_ALLOWED is used to configure ROHC packet sizes~~.~~; ~~Furthermore, segmentation shall~~

- be applied if the produced packet does not fit ~~to~~ the largest packet as indicated by PACKET_SIZES_ALLOWED.

#### 5.1.3.5 Protocol Parameters

RFC 3095 has two types of parameters [8]:

- configuration parameters: these are mandatory and must be configured between compressor and decompressor peers.
- implementation parameters: these are optional and, when used, stipulate how RFC 3095 operates.

These parameters are categorized in four different groups, as defined below:

- M: Mandatory and configured by upper layers.
- MO: Parameters that must be supported and when used can only be configured or triggered by upper layers.
- O: Optional RFC 3095 parameters that are not configured by upper layers. They may be used locally (i.e. UTRAN and/or in UE) for RFC 3095.
- N/A: These are not used in RFC 3095.

The usage and definition of the parameters shall be as specified below.

- MAX_CID (M): This is the maximum CID value that can be used. One CID value shall always be reserved for uncompressed flows.
- LARGE_CIDS: This is not configured by upper layers but inferred from the configured value of MAX_CID according to the following rule:

  If MAX_CID > 15 then LARGE_CIDS = TRUE else LARGE_CIDS = FALSE.
- PROFILES (M): Profiles are used to define which profiles are allowed to be used by the UE in uplink. All profiles defined in [8] shall be supported by the UE.
- FEEDBACK_FOR (N/A):
- MRRU (M): Segmentation is not used by default.
- NO_OF_PACKET_SIZES_ALLOWED (O)
- PACKET_SIZES_ALLOWED (MO): This parameter, if configured, governs which packet sizes in bytes may be used by RFC 3095. Thus, packet sizes not in the set of values for this parameter shall not be used.
- PAYLOAD_SIZES (O)
- NO_OF_PACKET_SIZES_USED (O)
- PACKET_SIZES_USED (O)
- CONTEXT_REINITIALIZATION (MO)
- MODE (O)
- CLOCK_RESOLUTION (O)
- REVERSE_DECOMPRESSION_DEPTH (M): Default value is that reverse decompression is not used.

## 5.2 Void

## 5.3 Data Transfer

If header compression is configured the PDCP entity in the sender shall

- perform header compression upon reception of a PDCP SDU from upper layers,
- if the radio bearer is configured for lossless SRNS Relocation, ~~support~~ maintain PDCP sequence numbering as specified in subclause 5.3.1.1.
- submit the PDCP PDU to lower layer in the sequence received from the upper layer.

When the PDCP entity at the R~~r~~eceiver receives the PDCP PDU from lower layers, it shall,

- perform header decompression (if header compression is configured) of the PDCP PDU to obtain the PDCP SDU and
- ~~submit~~deliver the PDCP SDU to the upper layer in the order received from the lower layer.
- if the received PDCP PDU is of type SeqNum PDU, follow the procedure in subclause 5.3.1.2~~5.5.2~~

### 5.3.1 Data transfer over acknowledged mode RLC

Figure 2 shows the PDCP data transfer over acknowledged mode RLC.~~If header compression is negotiated the PDCP entity shall perform header compression upon reception of a PDCP-DATA.Req. The PDCP-PDU is then delivered in RLC-AM-DATA.Req to RLC.~~

~~During operation, when the peer PDCP entity receives the PDCP-PDU in a RLC-AM-DATA.Ind primitive, the PDCP entity shall perform the header decompression (if negotiated) of PDCP-PDU to obtain the PDCP SDU and deliver the PDCP SDU to the PDCP user with the PDCP-DATA.Ind. The following figure illustrates data transfer over acknowledged mode RLC.~~

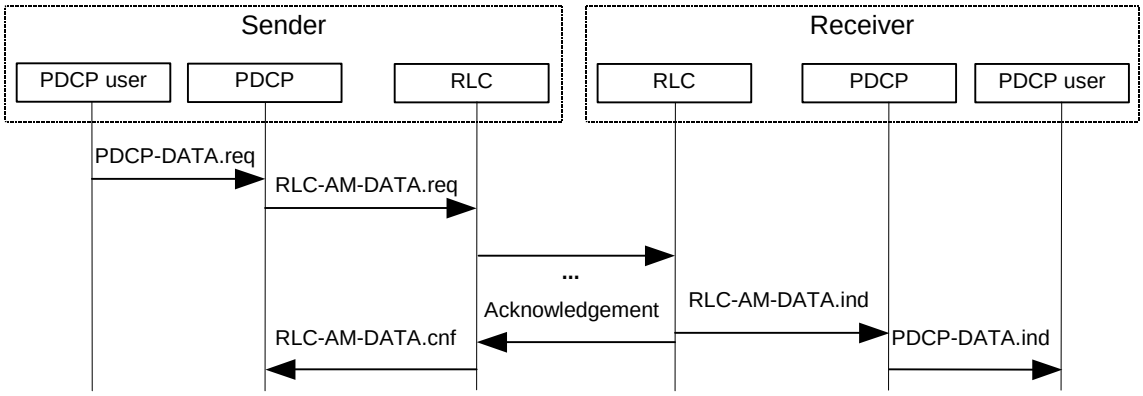


**Figure 2: PDCP data transfer over acknowledged mode RLC**

### 5.3.2 Data transfer over unacknowledged and transparent mode RLC

Figure 3 shows the PDCP data transfer over unacknowledged or transparent mode RLC.~~If header compression is negotiated the PDCP entity shall perform header compression upon reception of a PDCP-DATA.Req. The PDCP-PDU is then delivered in RLC-UM-DATA.Req or RLC-Tr-DATA.Req to RLC.~~

~~When the peer PDCP entity receives the PDCP-PDU in the RLC-UM-DATA.Ind or RLC-Tr-DATA.Ind primitive, the PDCP entity shall perform the header decompression (if negotiated) of PDCP-PDU to obtain the PDCP SDU and deliver the PDCP SDU to the PDCP user with the PDCP-DATA.Ind. The following figure illustrates data transfer over unacknowledged and transparent mode RLC.~~

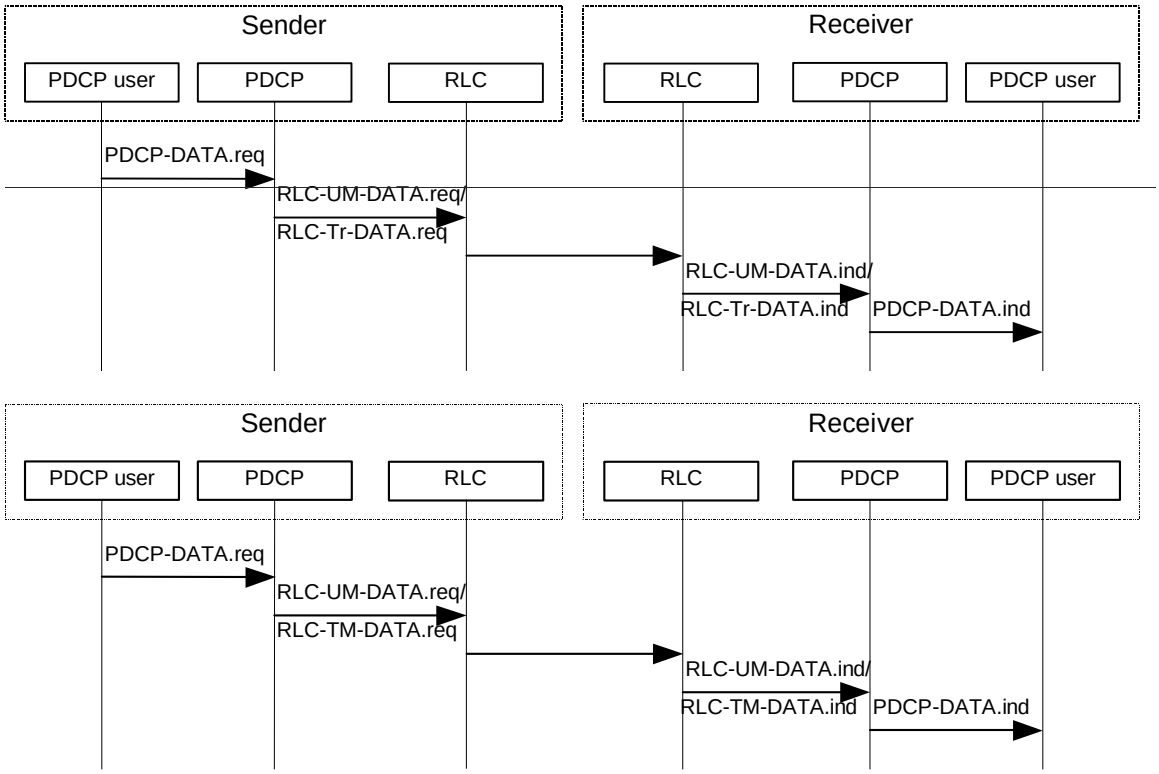


**Figure 3: PDCP data transfer over unacknowledged or transparent mode RLC**

# 6 Services

## 6.1 Services provided to upper layers

The following services are provided by PDCP to upper layers:

- Transfer of user data~~PDCP SDU delivery~~;
- maintenance of PDCP PDU sequence numbers;
- ~~maintenance of PDCP SDUs not confirmed to be received by the peer PDCP entity.~~.

## 6.2 Services expected from RLC layer

For a detailed description of the following functions see [5].

- Transparent data transfer Service.
- Unacknowledged data transfer Service.
- Acknowledged data transfer Service.
- ~~Data transfer in acknowledged mode.~~
- ~~Data transfer in unacknowledged mode.~~
- ~~Data transfer in transparent mode.~~
- ~~Segmentation and reassembly.~~
- ~~In-Sequence delivery.~~

# 7 Elements for layer-to-layer communication

The interaction between the PDCP layer and other layers are described in terms of primitives where the primitives represent the logical exchange of information and control between the PDCP layer and other layers. The primitives shall not specify or constrain implementations.

## 7.1 Primitives between PDCP and upper layers

The primitives between PDCP and upper layers are shown in ~~table~~Table 5.

**Table 5: Primitives between PDCP and upper layers**

| Generic Name | Parameter | | | |
|---|---|---|---|---|
| | Req. | Ind. | Resp. | Conf. |
| PDCP-DATA | Data | Data | Not Defined | Not Defined |
| CPDCP-CONFIG | PDCP-Info, RLC-SAP SN_Sync | Not Defined | Not Defined | Not Defined |
| CPDCP-RELEASE | RLC-SAP | Not Defined | Not Defined | Not Defined |
| CPDCP-SN | PDCP SN | Not Defined | Not Defined | Not Defined |
| CPDCP-RELOC | Receive_SN | Not Defined | Not Defined | Receive_SN, Send_SN |

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

- PDCP-DATA-Req is used by upper user-plane protocol layers to request a transmission of upper layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

- CPDCP-CONFIG Req is used to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) CPDCP-RELEASE-Req.

- CPDCP-RELEASE-Req is used by upper layers to release a PDCP entity.

d) CPDCP-SN-Req.

- This primitive is used at the UTRAN. CPDCP-SN-Req is used to transfer the PDCP SN to PDCP.

e) CPDCP-RELOC-Req/Conf.

- CPDCP-RELOC-Req initiates the SRNS ~~relocation~~Relocation procedure in PDCP for those radio bearers that are configured to support lossless SRNS ~~relocation~~Relocation. The Receive_SN is only included at the UE side~~when the UE receives a new U-RNTI~~.

- CPDCP-RELOC-Conf is used to transfer the Receive_SN and/or Send_SN to upper layers for lossless SRNS ~~relocation~~Relocation. The Send_SN is only included at the source RNC.

The following parameters are used in the primitives:

1) PDCP-Info:

- C~~c~~ontains the parameters for each of the header compression protocols configured to be used by one PDCP entity.

2) RLC-SAP:

- ~~the~~ The RLC-SAP (~~Tr~~TM/UM/AM) used by PDCP entity when communicating with RLC sublayer.

3) SN_Sync:

- Indicates that PDCP should start PDCP sequence number synchronization

4) Send_SN:

- The send PDCP sequence number of the next PDCP PDU to be sent. There is one in the uplink (UL_Send_SN) and one in the downlink (DL_Send_SN). Refer to subclause 5.4.1.

5) Receive_SN:

- The receive PDCP sequence number of the next PDCP PDU expected to be received. There is one in the uplink (UL_Receive_SN) and one in the downlink (DL_Receive_SN). Refer to subclause 5.4.1.

6) PDCP SN:

- This includes a PDCP sequence number.

# 8 Elements for peer-to-peer communication

## 8.1 Protocol data units

Different ~~protocol data unit~~PDU formats are defined ~~in~~ for the PDCP protocol, one not introducing any overhead to the (compressed) PDCP SDU, others introducing such overhead. ~~Whether overhead is introduced by the PDCP protocol is configured for the PDCP entity by higher layers.~~

## 8.2 Formats

A PDCP PDU shall be a multiple of 8 bits~~is byte-aligned~~, if the RLC entity is configured for ~~run on~~ unacknowledged or acknowledged mode. Otherwise, if the RLC entity is configured for~~in~~ transparent mode, it is bit-aligned. In Tables 6, 7 and 8~~the drawings in subclause 8.2~~, bit strings are represented ~~by tables in which~~as follows: 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.

SDUs are bit strings, with any non-null length. If not compressed within PDCP an SDU is included from first bit onward.

### 8.2.1 PDCP-No-Header PDU

The PDCP-No-Header PDU does not introduce any overhead to the PDCP SDU. The use of the No-header PDU is configured by the upper layer. ~~The choice of applying PDCP No-Header PDU shall be possible only for the case where lossless SRNS Relocation is not configured.~~

The format of the PDCP-No-Header-PDU is shown in ~~table~~ Table 6.

**Table 6: PDCP-No-Header PDU**

| Data |
|---|

### 8.2.2 PDCP Data PDU

The ~~data~~ PDCP Data PDU is used to convey

- data~~a payload unit~~ containing an uncompressed PDCP SDU or,
- header compression related control signalling or
- data that has been obtained from PDCP SDU after header compression.

The format of the PDCP -Data -PDU is shown in table Table 7.

**Table 7: PDCP -Data -PDU format**

| PDU type | PID |
|---|---|
| Data | |

## 8.2.3 PDCP SeqNum PDU

The PDCP SeqNumsequence number PDU is used to convey a PDCP PSDU sequence number and,

- dataa payload unit containing a PDCP PDU sequence number and an uncompressed PDCP SDU or,
- header compression related control signalling or
- data that has been obtained from PDCP SDU after header compression.

The format of the PDCP -SeqNum -PDU is shown in table Table 8.

**Table 8: PDCP -SeqNum -PDU format**

| PDU type | PID |
|---|---|
| Sequence number | |
| | |
| Data | |
| | |

# 8.3 Parameters

If not otherwise mentioned in the definition of each field then the bits in the parameters shall be interpreted as follows: the left most bit string is the first and most significant and the right most bit is the last and least significant bit.

Unless otherwise mentioned, integers are encoded in standard binary encoding for unsigned integers. In all cases the bits appear ordered from MSB to LSB when read in the PDU.

## 8.3.1 PDU Type

Length: 3 bits.

The PDU type field indicates the PDCP-d Data -PDU type.

| Bit | PDU Type |
|---|---|
| **000** | PDCP Data PDU (Table 7)PID field used for header compression information (PDCP-PDU format described in table 5) |
| **001** | PDCP SeqNum PDU (Table 8)PID field used for header compression information and the PDCP PDU sequence number included (PDCP-PDU format described in table 6) |
| **010-111** | Reserved (PDUs with this encoding are invalid for this version of the protocol) |

## 8.3.2 PID

Length: 5 bits.

The PID field indicates the used header compression packet type or a context identifier.

| Bit | Description |
|---|---|
| **00000** | No header compression |
| **00001-11111** | Dynamically negotiated header compression identifier, as described in subclause 5.1.1 |

The PID field value ~~defines~~ indicates the used header compression protocol type and packet type or CID. A specific header~~One~~ compression protocol may ~~reserve~~ utilize a certain ~~amount~~ range of consecutive ~~of~~ values from the PID field value space for different packet types. The ~~receiving~~ Receiving PDCP entity ~~makes~~ performs the ~~reverse~~ necessary operation (~~i.e.~~e.g. header decompression) according to the PID field value. There is no fixed relationship between the PID field value and the used optimisation / packet type~~, ; but~~ PID field values are ~~defined dynamically~~mapped ~~at the PDCP parameter negotiation~~on PDCP set-up and re-configuration.

The PID field can also be used to represent context identifier values, as ~~illustrated~~ specified in subclause 5.1.1.

### 8.3.3 Data

If:

- header compression is configured, and
  - PDU type = PDCP Data PDU, or PDU type = PDCP SeqNum PDU,
    - PDCP SDUs with headers compressed or,
    - Header compression protocol feedback information shall be mapped to the "Data" field.

Else

- If header compression is not configured, and
- RB is configured for "lossless Relocation" and
- PDU type = PDCP No-header PDU

- uncompressed PDCP SDUs shall be mapped to the "Data" field.~~PDCP SDUs that have been header compressed are mapped to this field if header compression is negotiated. Otherwise, PDCP SDUs are mapped to this field.~~

### 8.3.4 Sequence number

Length: 16 bits

PDCP PDU sequence number.

# 9 Handling of unknown, unforeseen and erroneous protocol data

## 9.1 Invalid PDU type

If a PDCP entity receives a PDCP PDU with a PDU Type set to Reserved (see subclause 8.3.1), it shall:

- discard the PDCP PDU.

If a PDCP entity is not configured for lossless SRNS Relocation and receives a PDCP SeqNum PDU, it shall:

- ignore the Sequence number field of the PDCP SeqNum PDU

## 9.2 Invalid PID value

If a PDCP entity receives a PDCP PDU with a PID value that is not mapped with a valid packet type (see subclause 5.1.1), it shall:

- discard the PDCP PDU.~~In case of error situations the following action is foreseen:~~

~~1) PDCP entity should discard invalid PDU~~.

# Annex A (informative): Change history

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **TSG #** | **TSG Doc.** | **CR** | **Rev** | **Subject/Comment** | **Old** | **New** |
| 12/1999 | RP-06 | RP-99645 | - | | Approved at TSG-RAN #6 and placed under Change Control | - | 3.0.0 |
| 03/2000 | RP-07 | RP-000041 | 004 | | Bit order of PDCP PDUs | 3.0.0 | 3.1.0 |
| | RP-07 | RP-000041 | 005 | | Changes to PDCP | 3.0.0 | 3.1.0 |
| 06/2000 | RP-08 | RP-000221 | 006 | 4 | Changes in PDCP PDU format due to PDCP sequence numbering | 3.1.0 | 3.2.0 |
| 09/2000 | RP-09 | RP-000359 | 009 | 3 | Clarification of PDCP Sequence Numbering | 3.1.0 | 3.2.0 |
| | RP-09 | RP-000359 | 011 | | Clarification on how to handle invalid PDUs | 3.2.0 | 3.3.0 |
| | RP-09 | RP-000359 | 012 | 2 | Primitives required for SRNS relocation | 3.2.0 | 3.3.0 |
| | RP-09 | RP-000359 | 015 | | Handling of invalid PDCP PDU sequence number | 3.2.0 | 3.3.0 |
| 03/2001 | RP-11 | RP-010027 | 018 | 1 | Editorial Corrections | 3.3.0 | 3.4.0 |
| | RP-11 | RP-010027 | 019 | 1 | Updates necessary for Rel-4 specification | 3.3.0 | 3.4.0 |
| | RP-11 | RP-010039 | 017 | 2 | Robust Header Compression | 3.4.0 | 4.0.0 |
| 06/2001 | RP-12 | RP-010310 | 021 | | Clarification on PDCP Sequence numbering | 4.0.0 | 4.1.0 |