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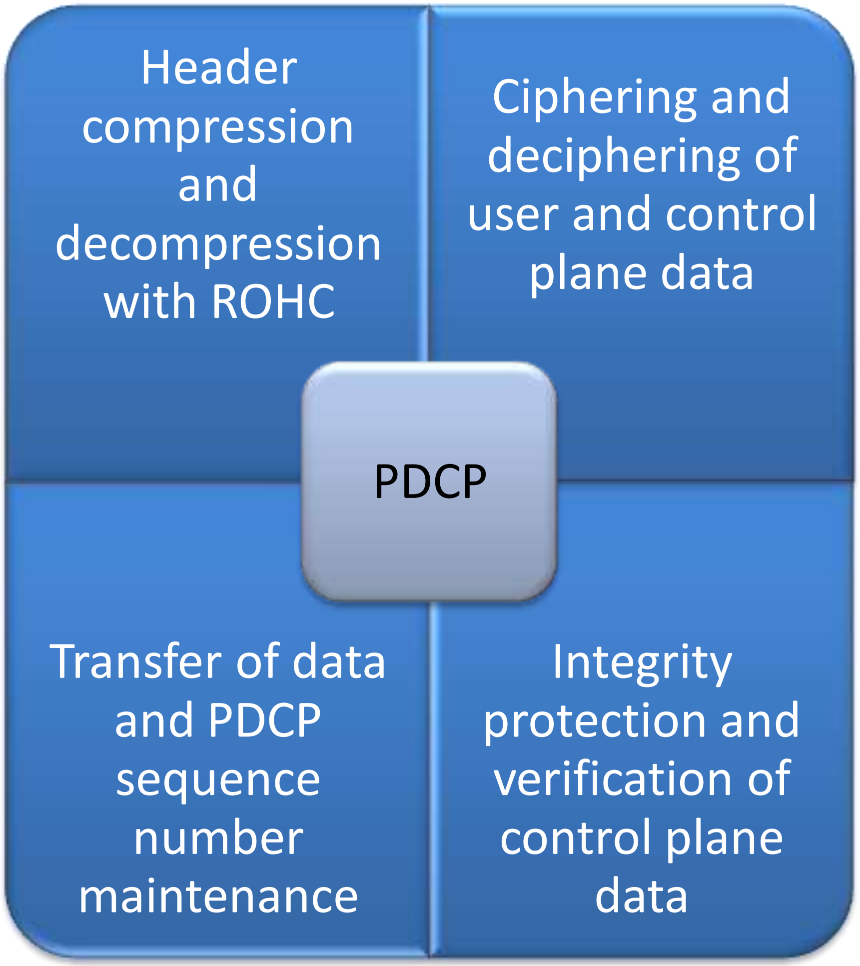
3GPP LTE Packet Data Convergence Protocol (PDCP) Sub Layer

LTE PDCP Sub Layer Functions



- Header compression and decompression of IP data flows using the ROHC protocol;
- Transfer of data (user plane or control plane);
- Maintenance of PDCP SNs;
- In-sequence delivery of upper layer PDUs at re-establishment of lower layers;
- Duplicate elimination of lower layer SDUs at re-establishment of lower layers for radio bearers mapped on RLC AM;
- Ciphering and deciphering of user plane data and control plane data;
- Integrity protection and integrity verification of control plane data
- Timer based discard
- Duplicate discarding

PDCP in the LTE Protocol Stack

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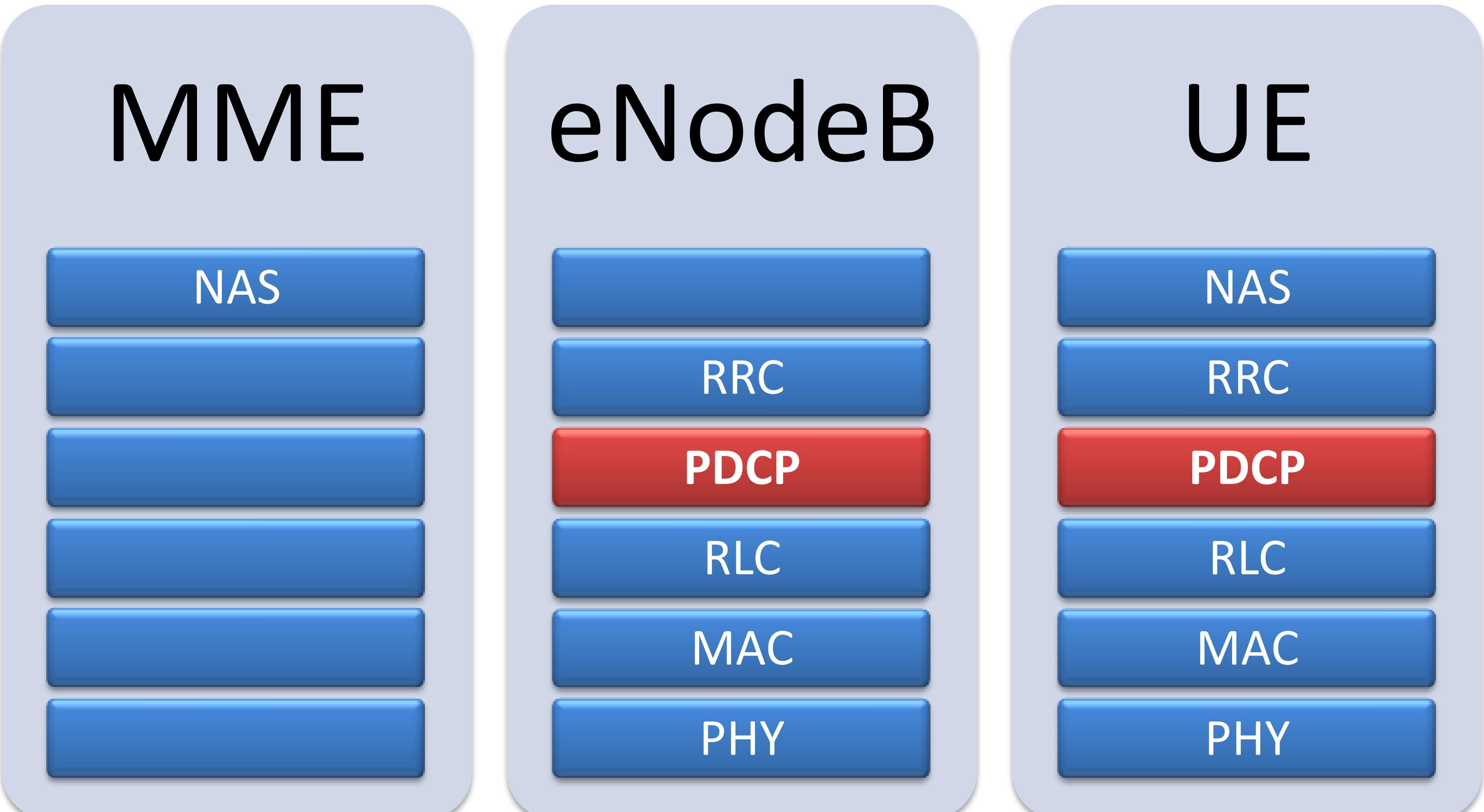

LTE PDCP – Layer View

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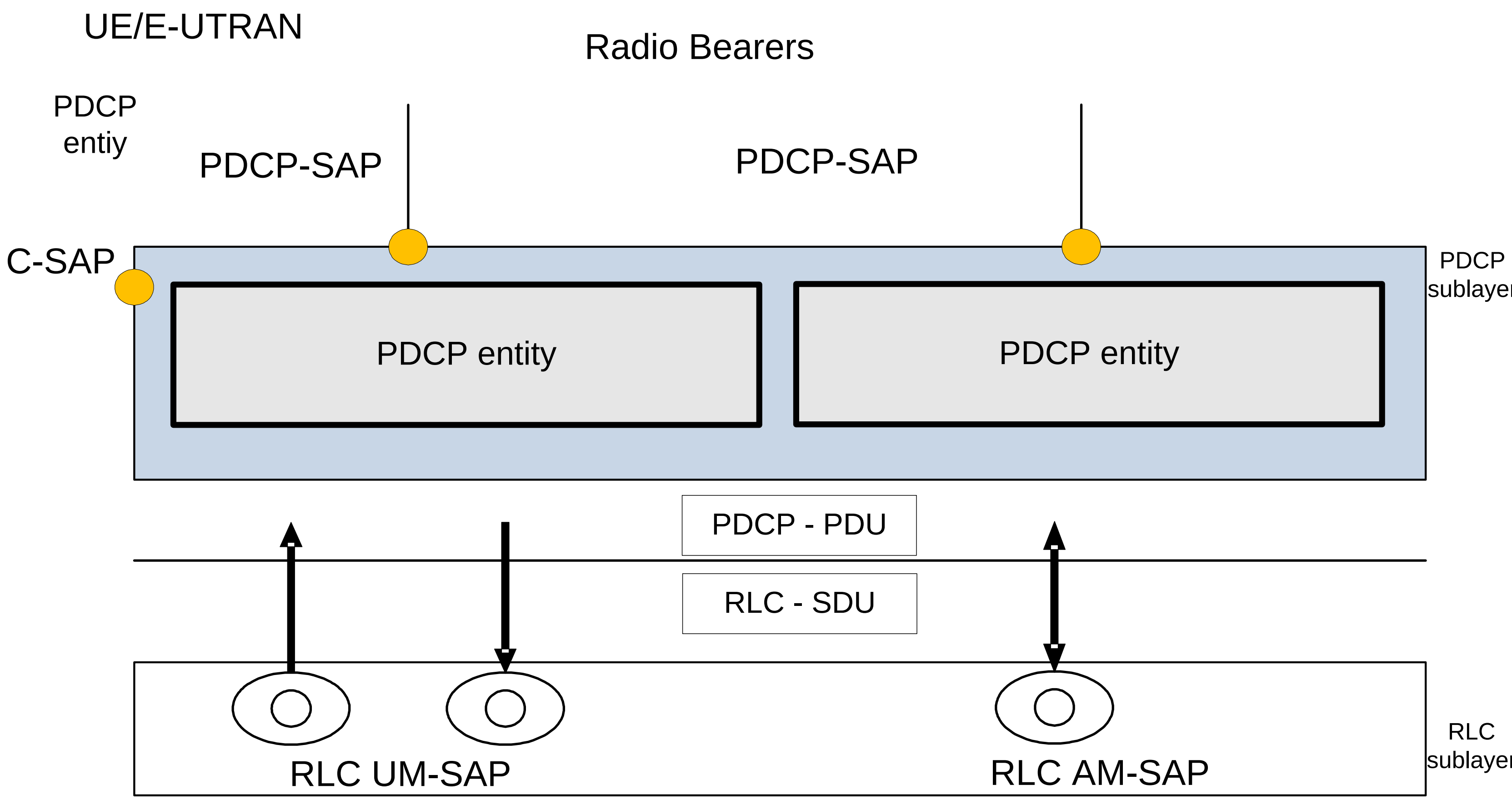
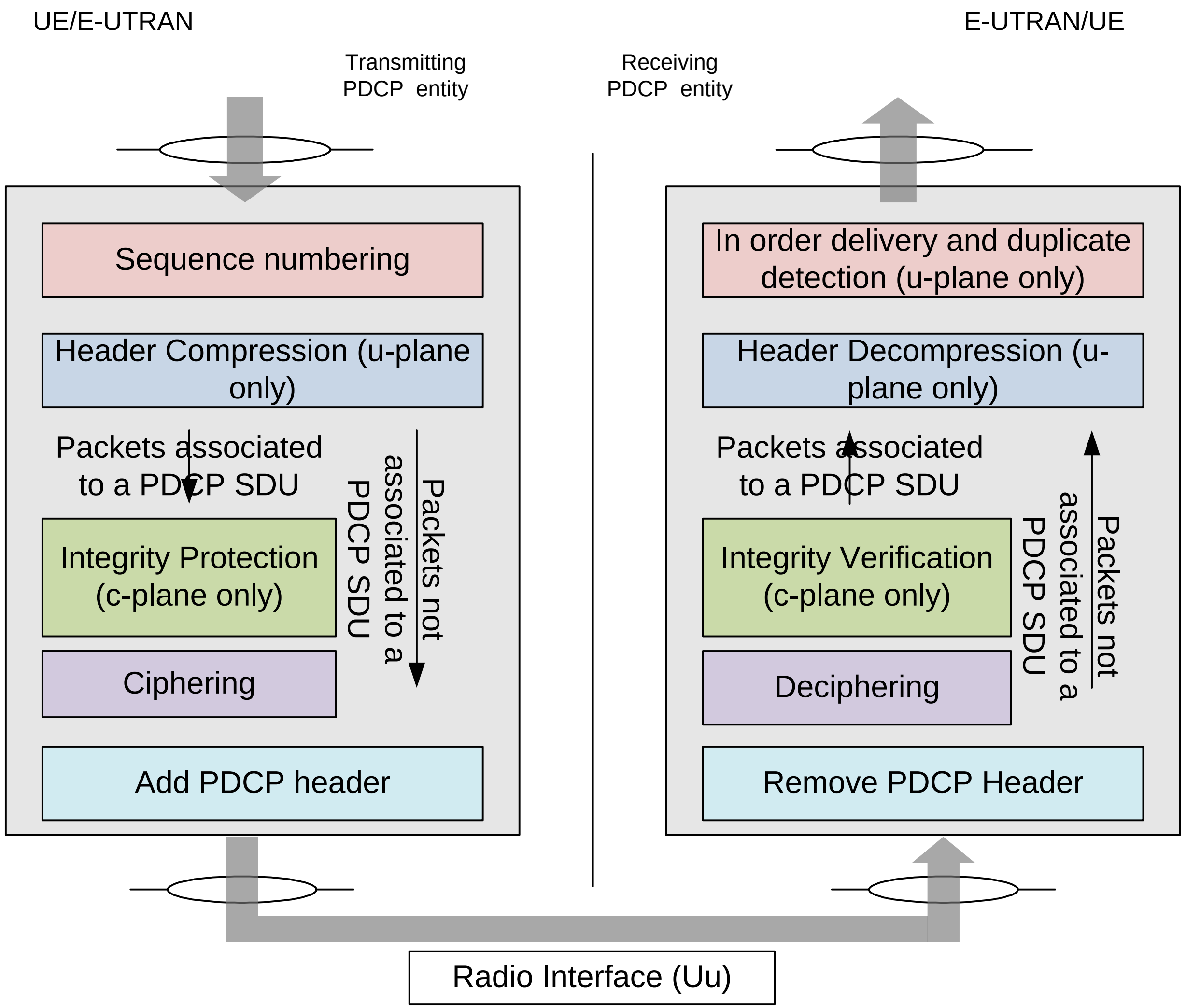


PDCP Layer Functions



3GPP LTE Packet Data Convergence Protocol (PDCP) Sub Layer

ROBUST HEADER COMPRESSION

RoHC Modes

Unidirectional Mode (U-Mode)

- Packets are only sent in one direction: from compressor to decompressor.
- This mode therefore makes ROHC usable over links where a return path from decompressor to compressor is unavailable or undesirable.

Bidirectional Optimistic Mode (O-Mode)

- Similar to the Unidirectional mode, except that a feedback channel is used to send error recovery requests and (optionally) acknowledgments of significant context updates from the decompressor to compressor.
- The O-mode aims to maximize compression efficiency and sparse usage of the feedback channel.

Bidirectional Reliable Mode (R-Mode)

- More intensive usage of the feedback channel and a stricter logic at both the compressor and the decompressor that prevents loss of context synchronization between compressor and decompressor.

RoHC Compressor States

Initialization and Refresh State

- Compressor has just been created or reset
- Full packet headers are sent

First Order State

- Detected and stored static fields (such as IP address and port number)
- Sending dynamic field differences
- Compressing all static fields and most dynamic fields

Second Order State

- Suppressing all dynamic fields such as RTP sequence numbers, and send only a logical sequence number and partial checksum
- Other end regenerates the headers and verifies the headers.
- Compressing all static and dynamic fields

RoHC Compressor States in Unidirectional Mode (U-Mode)

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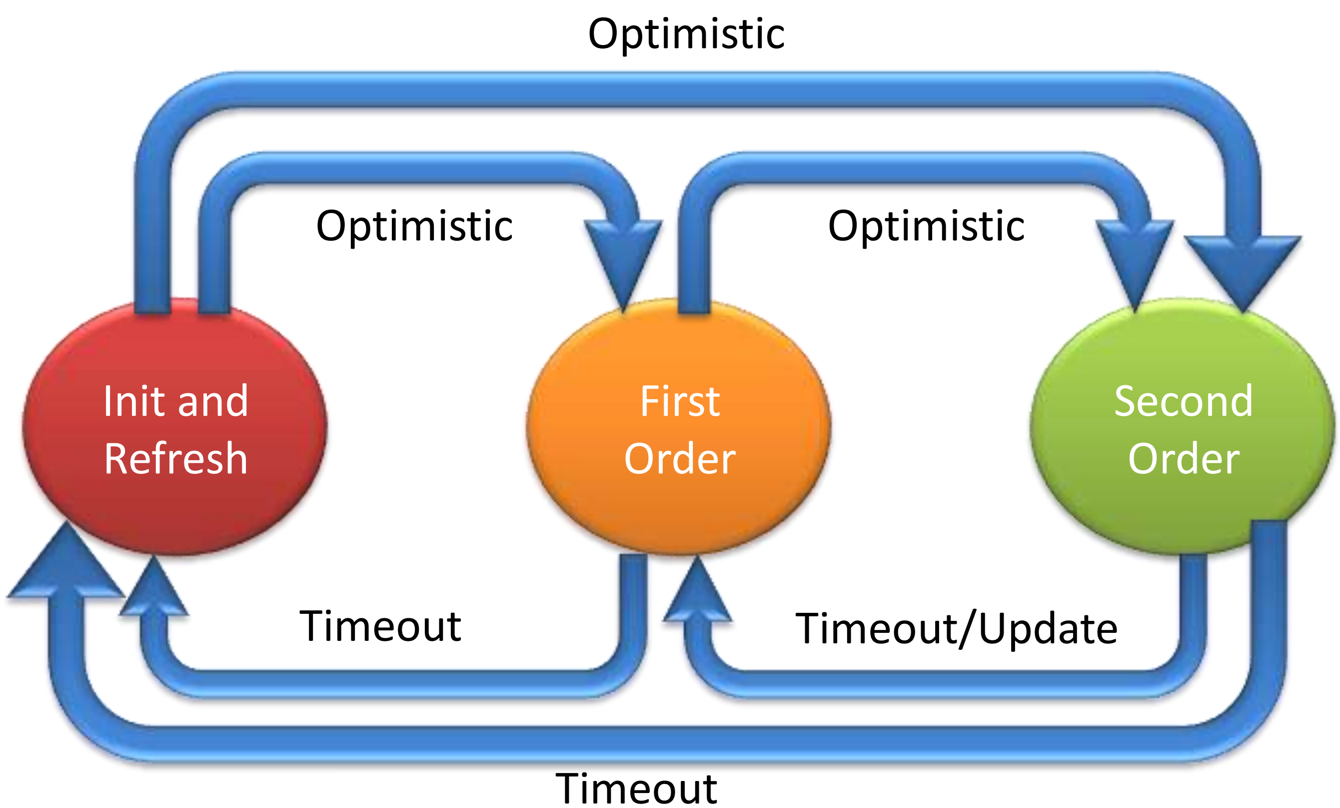

RoHC Compressor States in Bidirectional Optimistic Mode (O-Mode)

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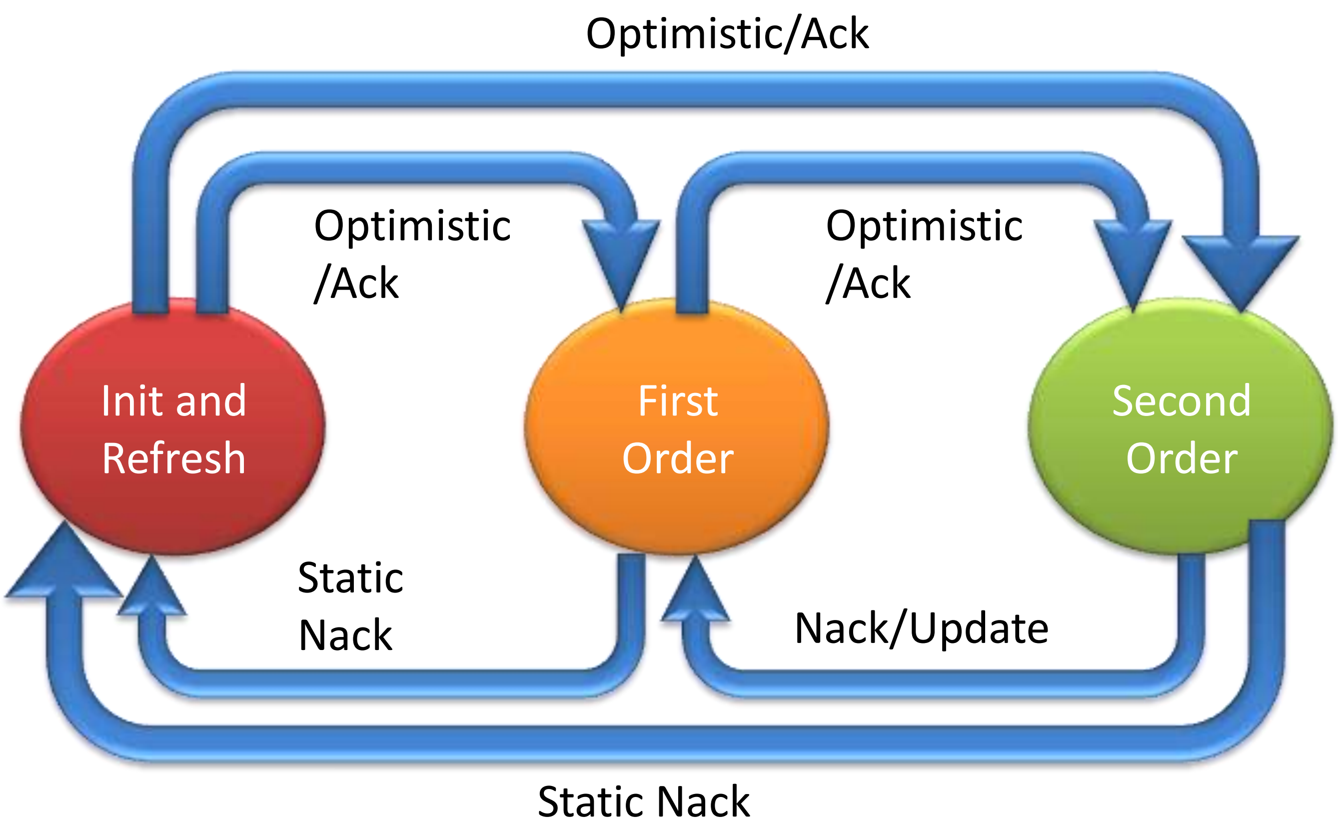
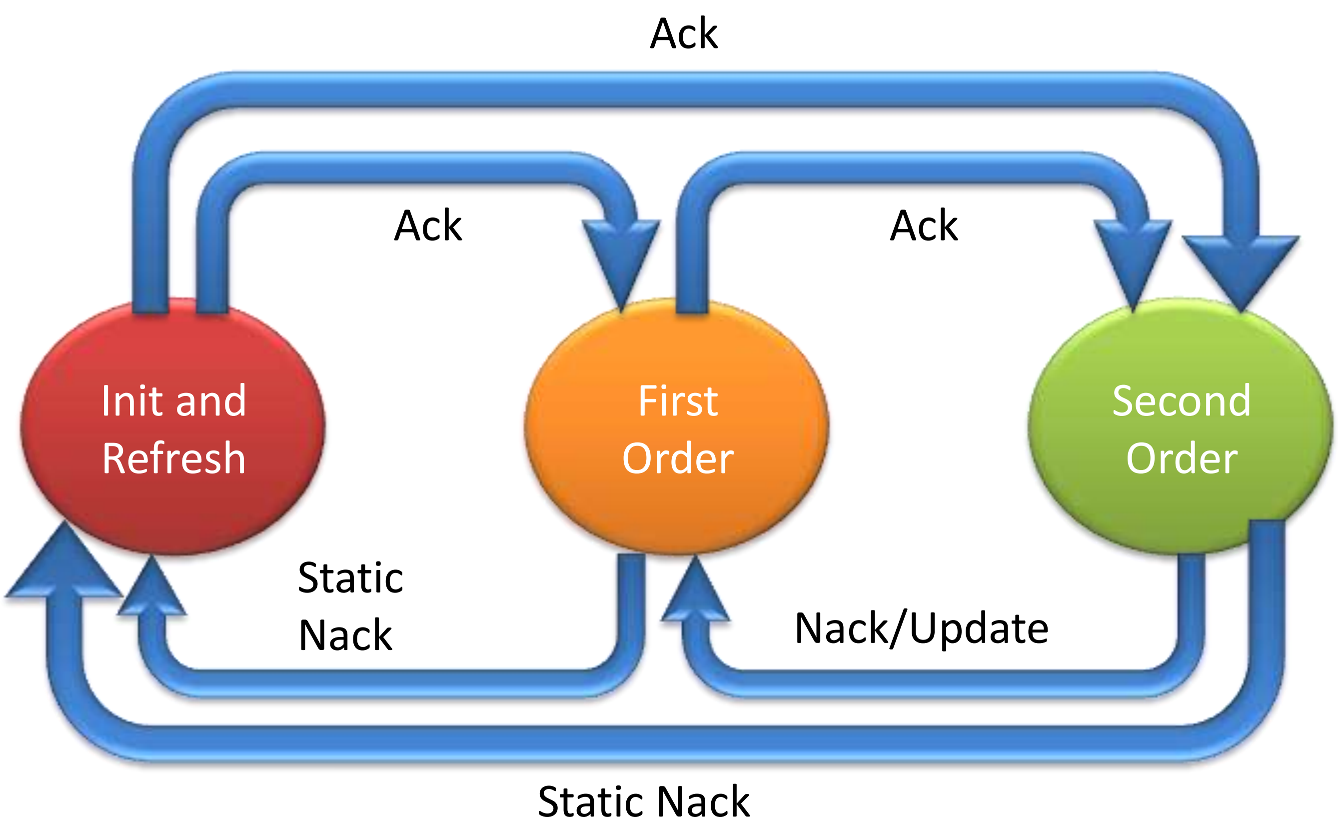


RoHC Compressor States in Bidirectional Reliable Mode (R-Mode)



RoHC Decompressor States

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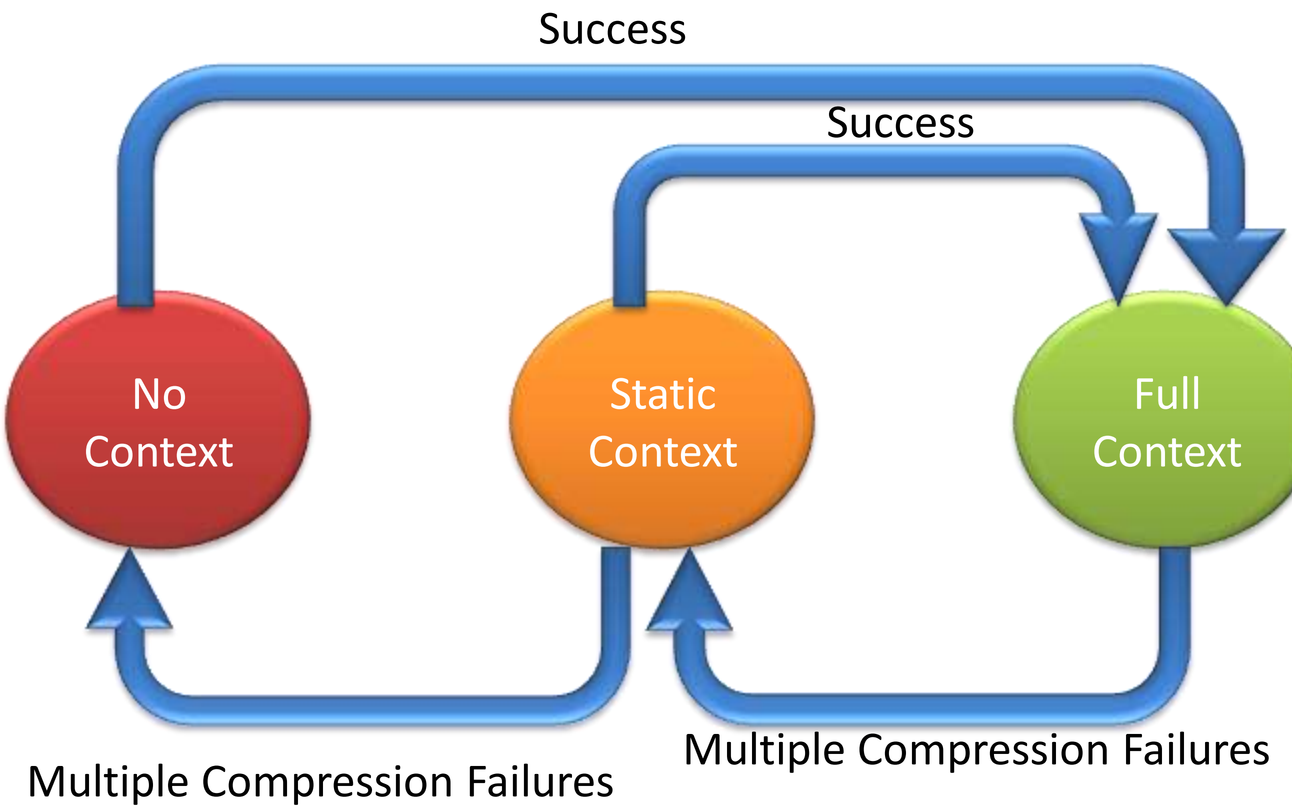

3GPP LTE Radio Link Control (RLC) Sub Layer

PDCP PDU FORMATS

Control Plane PDCP PDUs

PDU for SRB

R	R	R	PDCP SN	Oct 1
Data				Oct 2
...				
MAC-I				Oct N-3
MAC-I (cont.)				Oct N-2
MAC-I (cont.)				Oct N-1
MAC-I (cont.)				Oct N

PDU for Interspersed ROHC Feedback (RLC AM and UM Mapped DRBs)

D/C	PDU Type	R	R	R	R	Oct 1
Interspersed ROHC feedback packet						Oct 2
...						

PDU for PDCP Status Report (RLC AM Mapped DRBs)

D/C	PDU Type	FMS	Oct 1
FMS (cont.)			Oct 2
Bitmap_1 (optional)			Oct 3
...			
Bitmap_N (optional)			Oct 2+N

SRB: Signaling Radio Bearer
DRB: Data Radio Bearer

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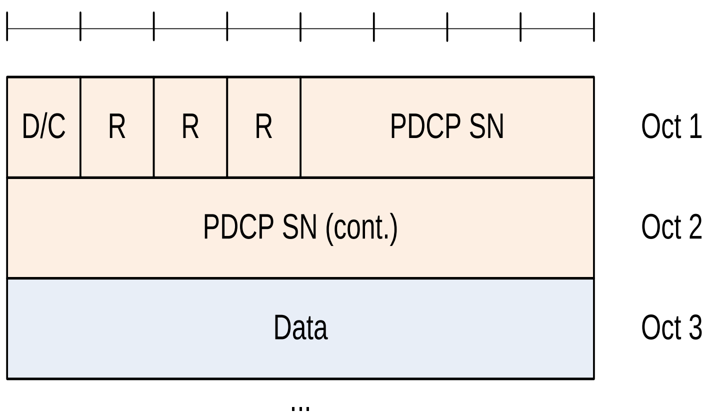
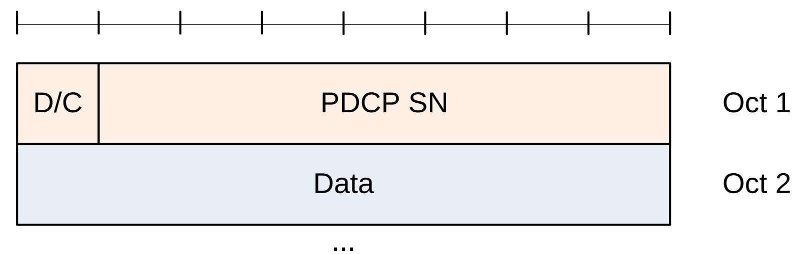
User Plane PDCP PDUs

Data PDU with Long PDCP SN (12 bit) (RLC AM and UM Mapped DRBs)



Data PDU with Short SN (7 bit) (RLC UM Mapped DRBs)



PDCP PDU Fields 1

PDCP SN (Serial Number)

- 5 bit for SRBs
- 7 or 12 bit for DRBs

Data

- Uncompressed PDCP SDU (user or control plane data)
- Compressed PDU SDU (user plane data only)

MAC-I

- Contains message authentication code
- Contains 0 in control plane messages

COUNT

- 32 bit number made from Hyper Frame Number (HFN) and PDCP SN
- HFN bits = 32 – PDCP SN bits

R (1 bit)

- Reserved. Should be set to 0.

PDCP PDU Fields 2

D/C (1 bit)

- 0 = Control PDU; 1 = Data PDU

PDU Type (3 bit)

- 0 = PDCP Status; 1 = Interspersed ROHC Feedback Packet; Rest Reserved

FMS (12 bit)

- PDCP SN of the first missing PDCP SDU

Bitmap

- The MSB of the first octet of the type "Bitmap" indicates whether or not the PDCP SDU with the SN (FMS + 1) modulo 4096 has been received and, optionally decompressed correctly.
- The LSB of the first octet of the type "Bitmap" indicates whether or not the PDCP SDU with the SN (FMS + 8) modulo 4096 has been received and, optionally decompressed correctly.

Interspersed ROHC Feedback Packet

- Contains ROHC Feedback packet

PDCP Variables

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Next_PDCP_TX_SN

- The variable Next_PDCP_TX_SN indicates the PDCP SN of the next PDCP SDU for a given PDCP entity.
- At establishment of the PDCP entity, the UE shall set Next_PDCP_TX_SN to 0.

TX_HFN

- The variable TX_HFN indicates the HFN value for the generation of the COUNT value used for PDCP PDUs for a given PDCP entity.
- At establishment of the PDCP entity, the UE shall set TX_HFN to 0.
- The receiving side of each PDCP entity shall maintain the following state variables:

Next_PDCP_RX_SN

- The variable Next_PDCP_RX_SN indicates the next expected PDCP SN by the receiver for a given PDCP entity.
- At establishment of the PDCP entity, the UE shall set Next_PDCP_RX_SN to 0.

RX_HFN

- The variable RX_HFN indicates the HFN value for the generation of the COUNT value used for the received PDCP PDUs for a given PDCP entity.
- At establishment of the PDCP entity, the UE shall set RX_HFN to 0.

Last_Submitted_PDCP_RX_SN

- For PDCP entities for DRBs mapped on RLC AM the variable Last_Submitted_PDCP_RX_SN indicates the SN of the last PDCP SDU delivered to the upper layers.
- At establishment of the PDCP entity, the UE shall set Last_Submitted_PDCP_RX_SN to 4095.

Explore More

Specification	Title
3GPP TS 36.323	Evolved Universal Terrestrial Radio Access (E-UTRA); **Packet Data Convergence Protocol (PDCP) specification**
3GPP TS 36.300	Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); **Overall description**; Stage 2
3GPP TS 36.321	Evolved Universal Terrestrial Radio Access (E-UTRA); **Medium Access Control (MAC) protocol specification**
3GPP TS 36.322	Evolved Universal Terrestrial Radio Access (E-UTRA) **Radio Link Control (RLC) protocol specification**
3GPP TS 36.211	Evolved Universal Terrestrial Radio Access (E-UTRA); **Physical channels and modulation**

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Links	Description
EventStudio System Designer 4.0	Sequence diagram based systems engineering tool.
VisualEther Protocol Analyzer 1.0	Wireshark based visual protocol analysis and system design reverse engineering tool.
Telecom Call Flows	GSM, SIP, H.323, ISUP, LTE and IMS call flows.
TCP/IP Sequence Diagrams	TCP/IP explained with sequence diagrams.
Real-time and Embedded System Articles	Real-time and embedded systems, call flows and object oriented design articles.