Protocol Stack

5G Test Bed

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- RLC
- MAC

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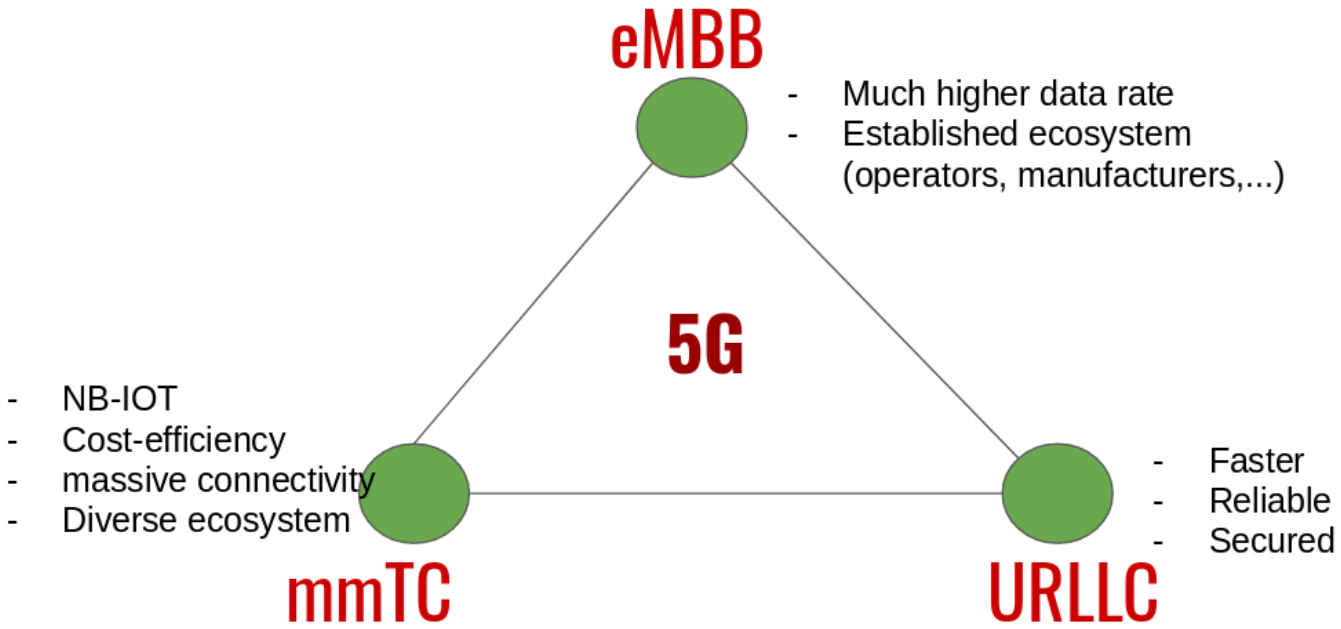
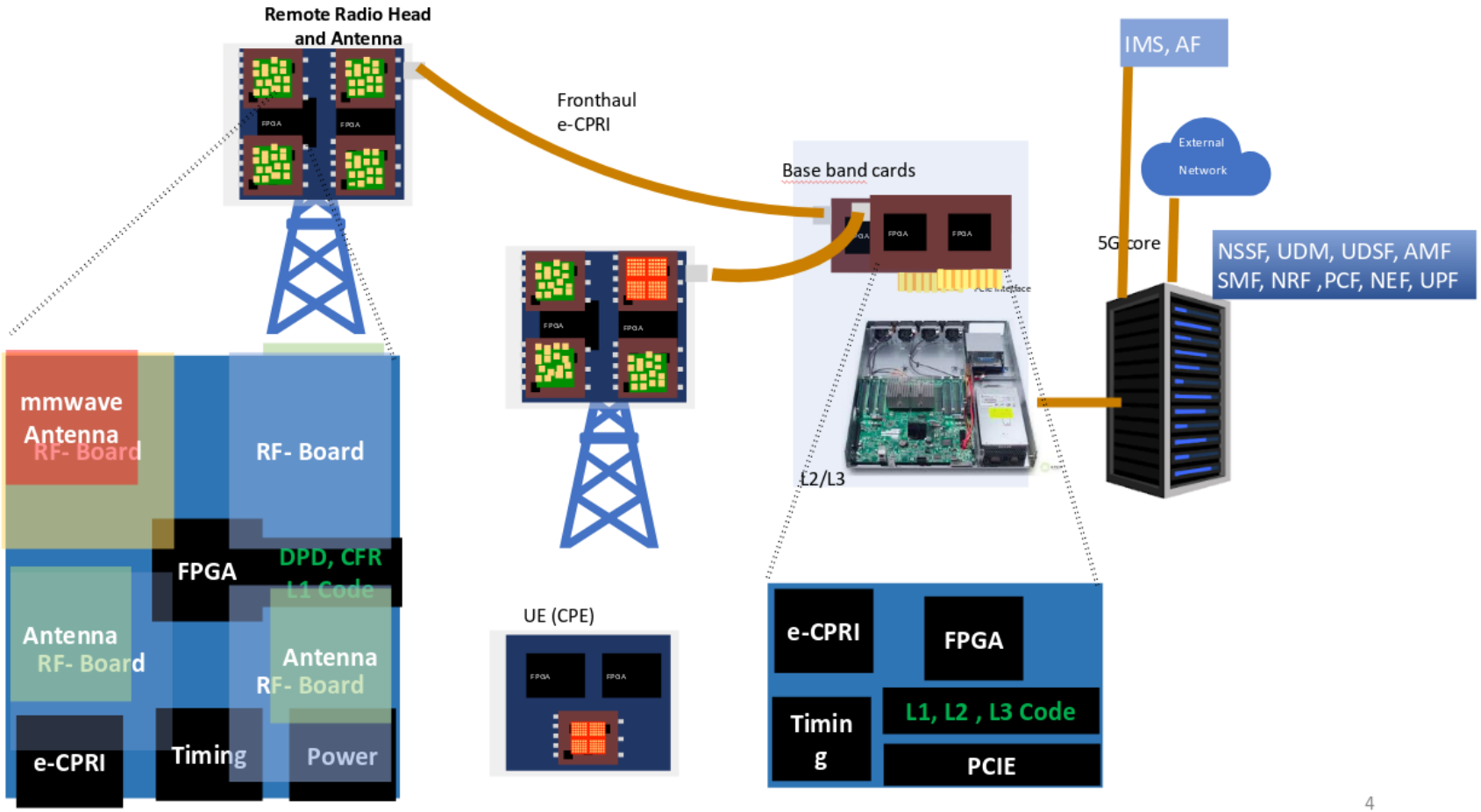
Overview

5G Overiew

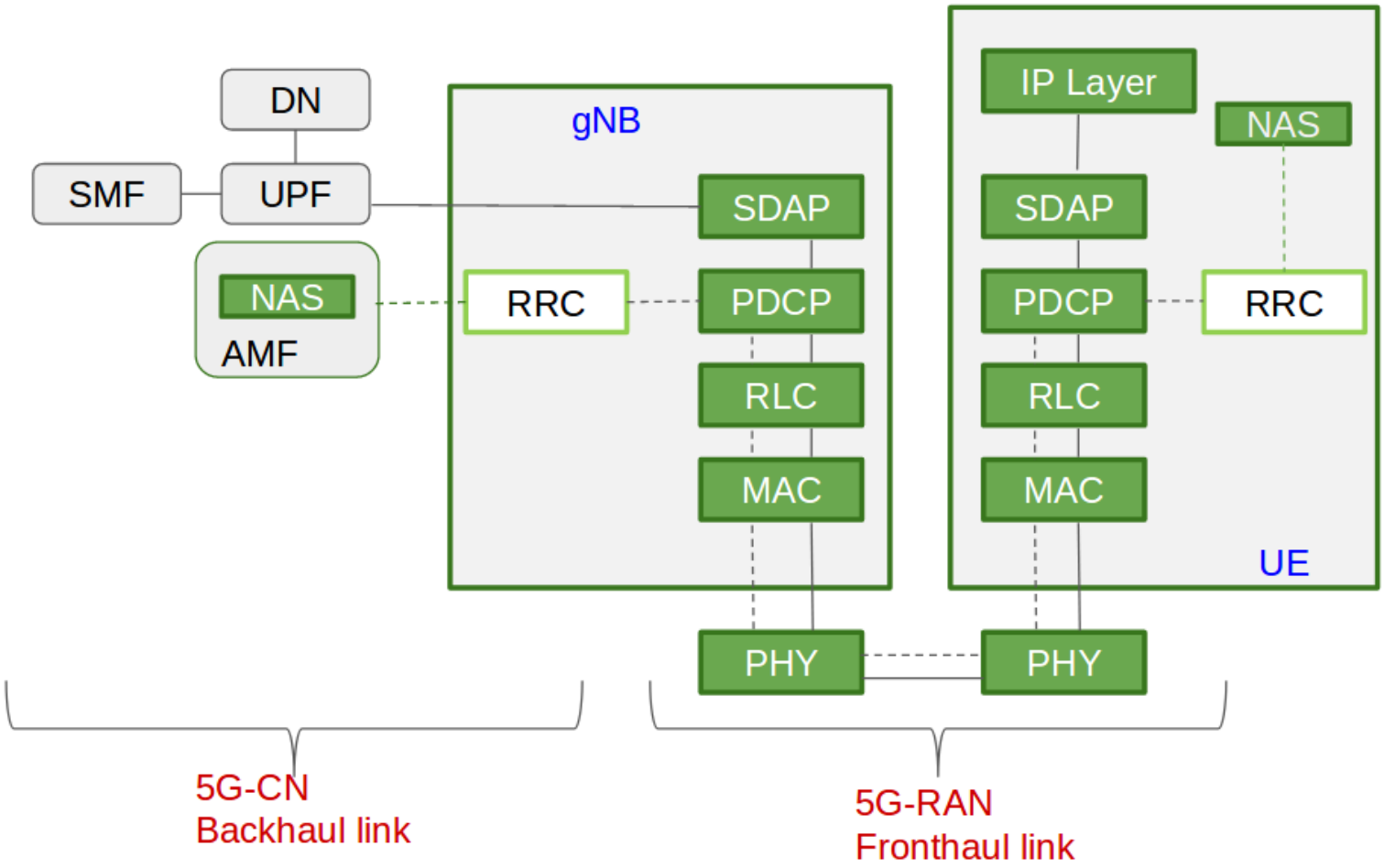

eMBB
- Much higher data rate
- Established ecosystem (operators, manufacturers,...)
5G
- NB-IOT
- Cost-efficiency
- massive connectivity
- Diverse ecosystem
mmTC
- Faster
- Reliable
- Secured
URLLC

5G TestBed Architecture



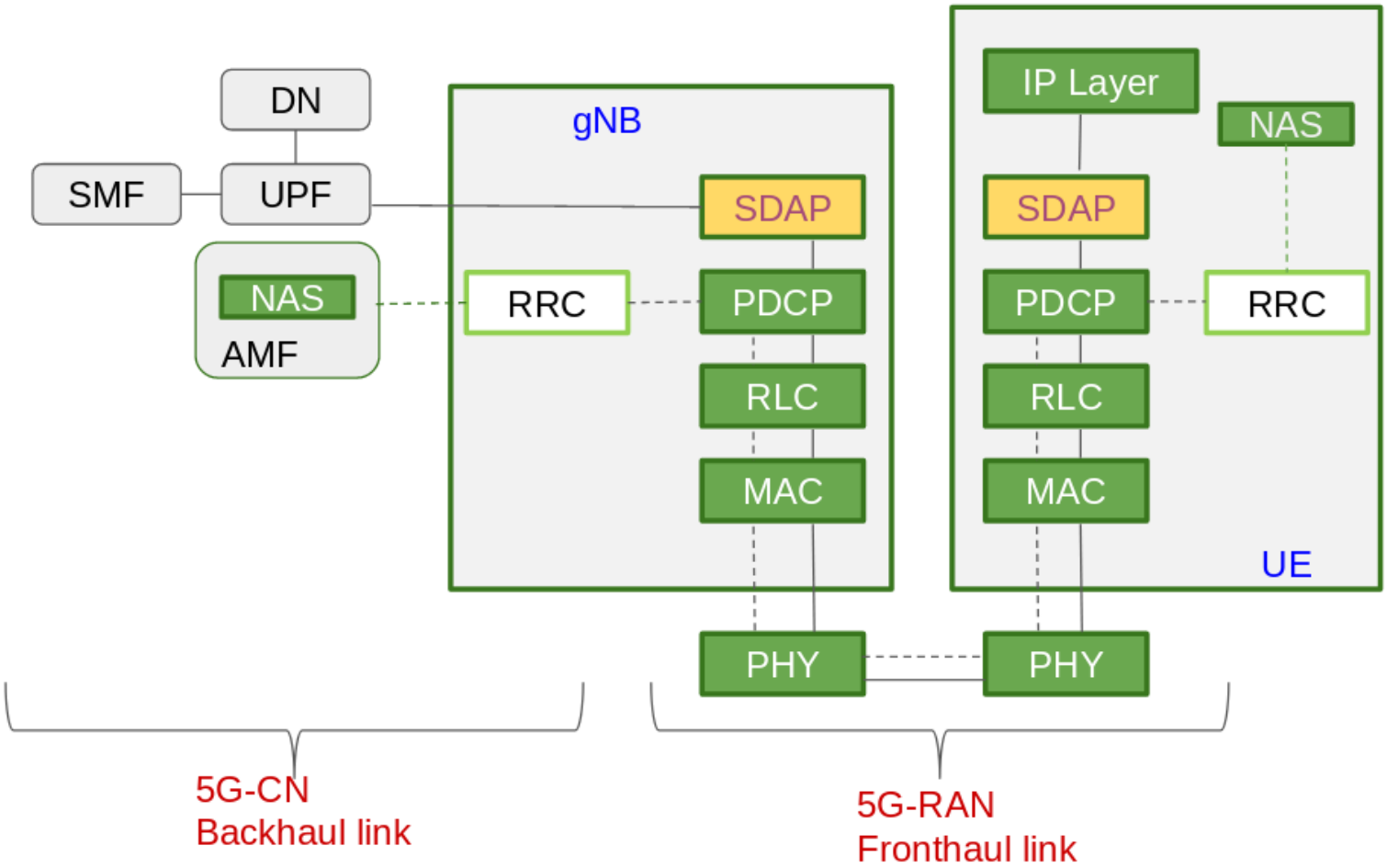
Modules and Architecture

5G-NR Architecture



Differences between 4G and 5G protocol stack

Differences



Differences

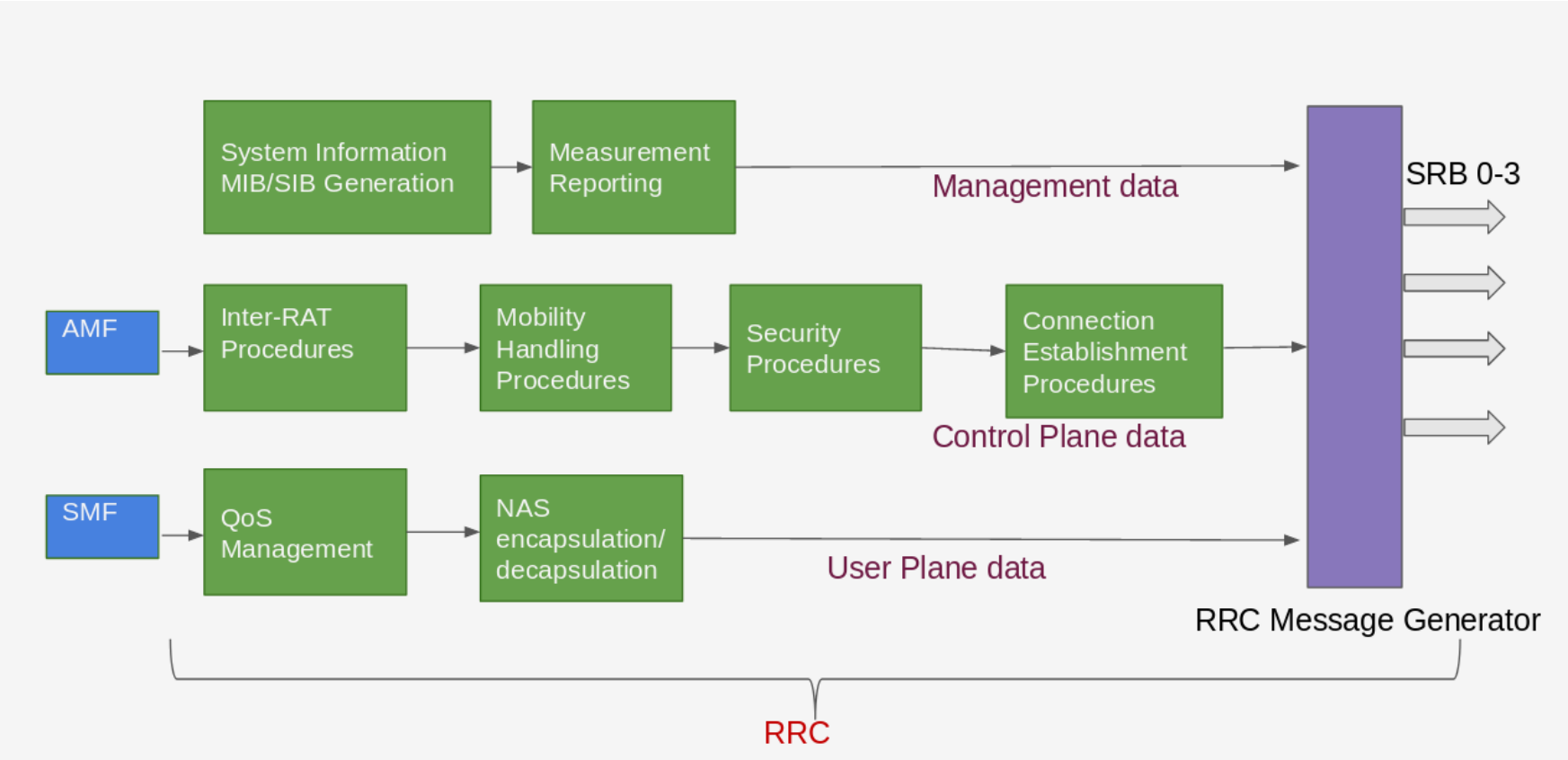
- New Module : SDAP for handling different QoS requirements
- Data rate and Latency Requirements
- Functionality changes in other modules (PDCP, RLC) and handling of PDU's in MAC

Layer-3

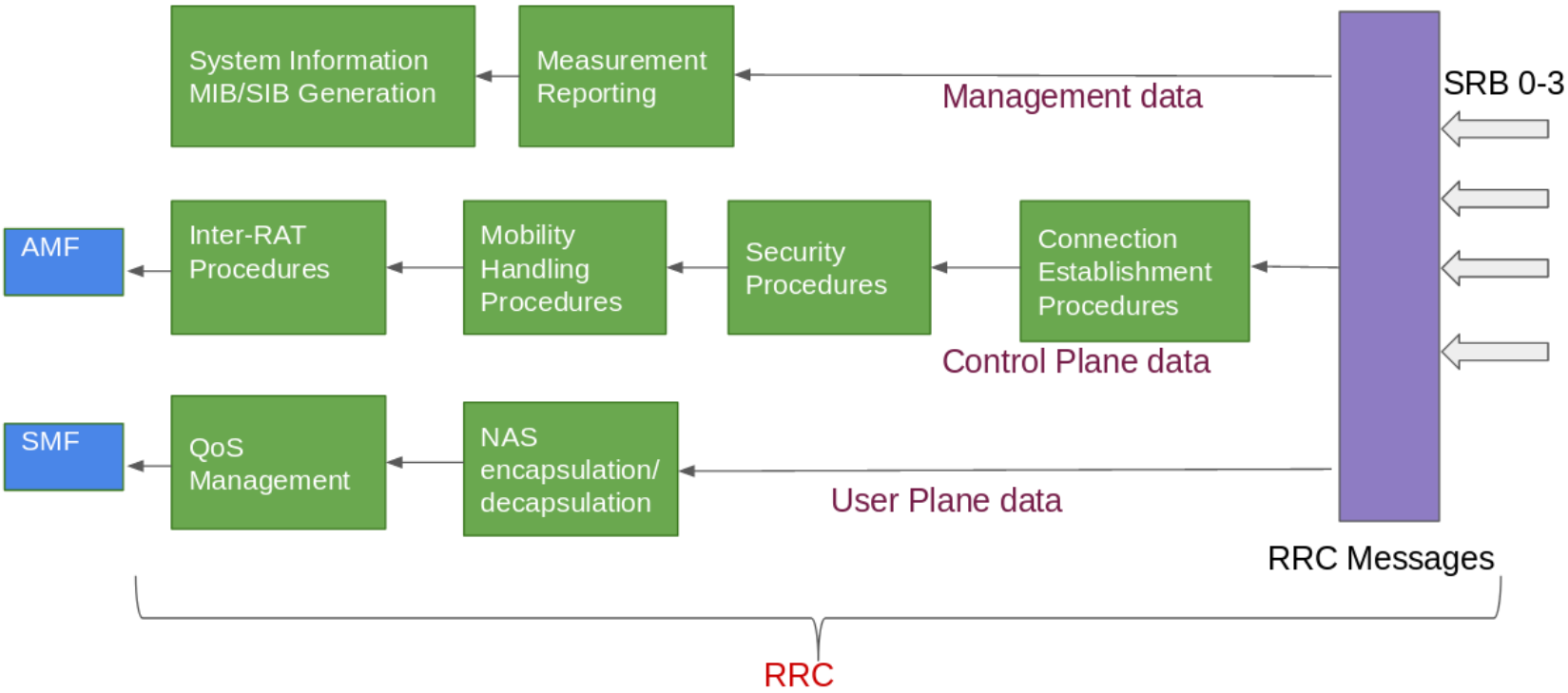
Radio Resource Control

- Broadcast of system information
- Establishment, configuration, maintenance and release of RRC connection between UE and NG-RAN, radio bearers
- Mobility functions including handover, UE selection and reselection, Inter RAT mobility.
- UE measurements reporting.
- Paging indicated by NG RAN.

RRC gNB DL Architecture

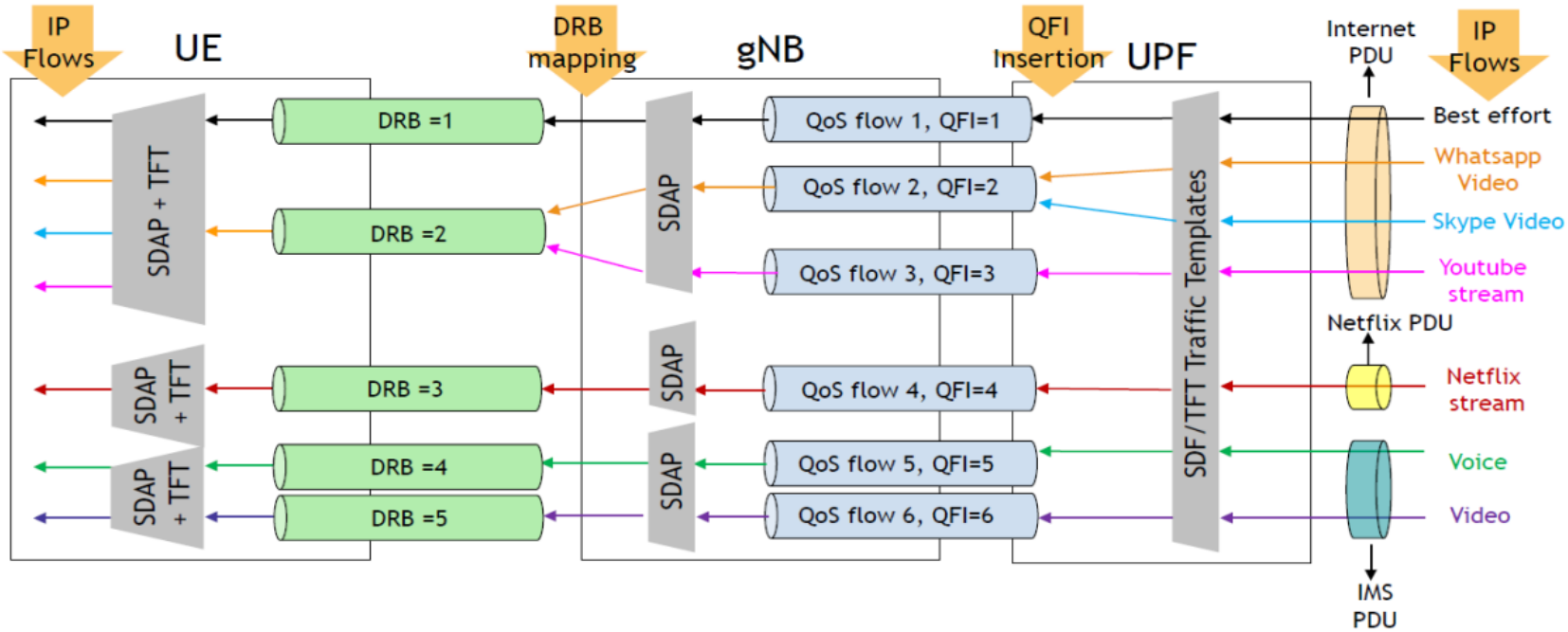


RRC gNB UL Architecture



Layer-2

SDAP Architecture

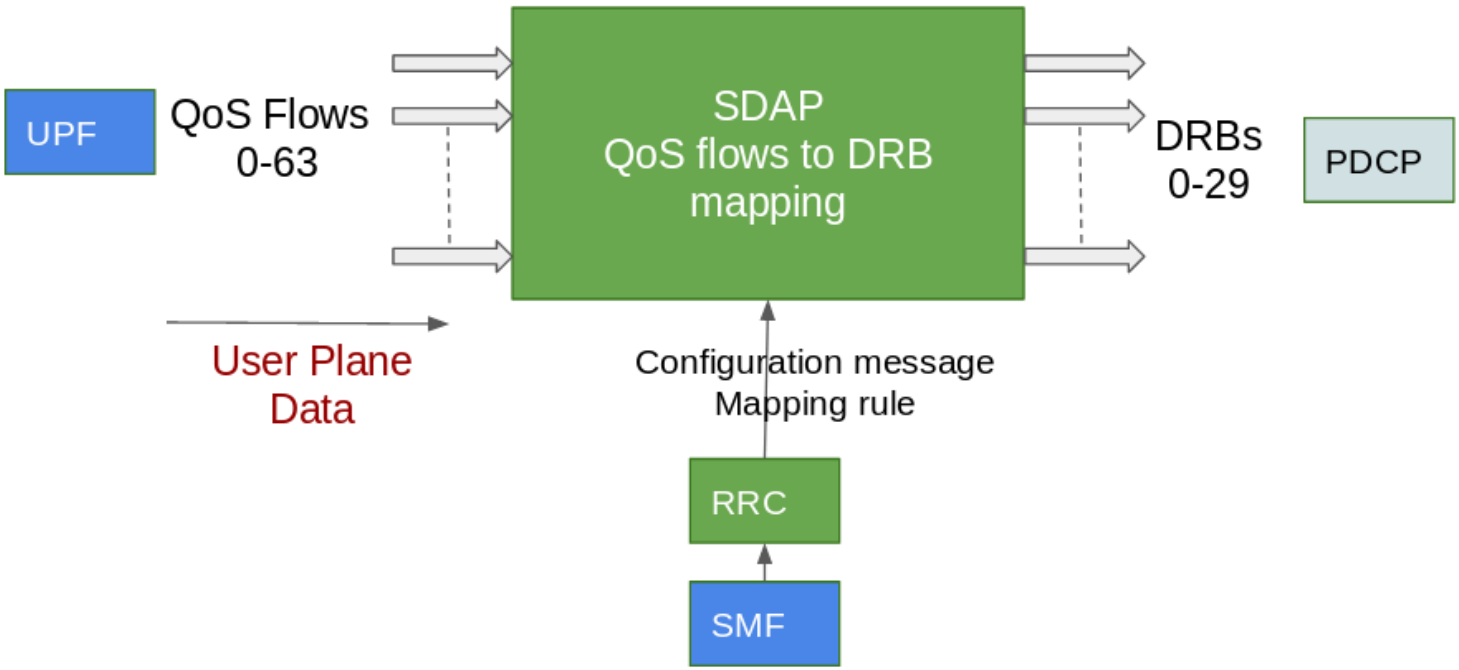


Source: QoS/QoE Developments in 4G-IoT & 5G Technologies by Fernando Rodini, Qualcomm

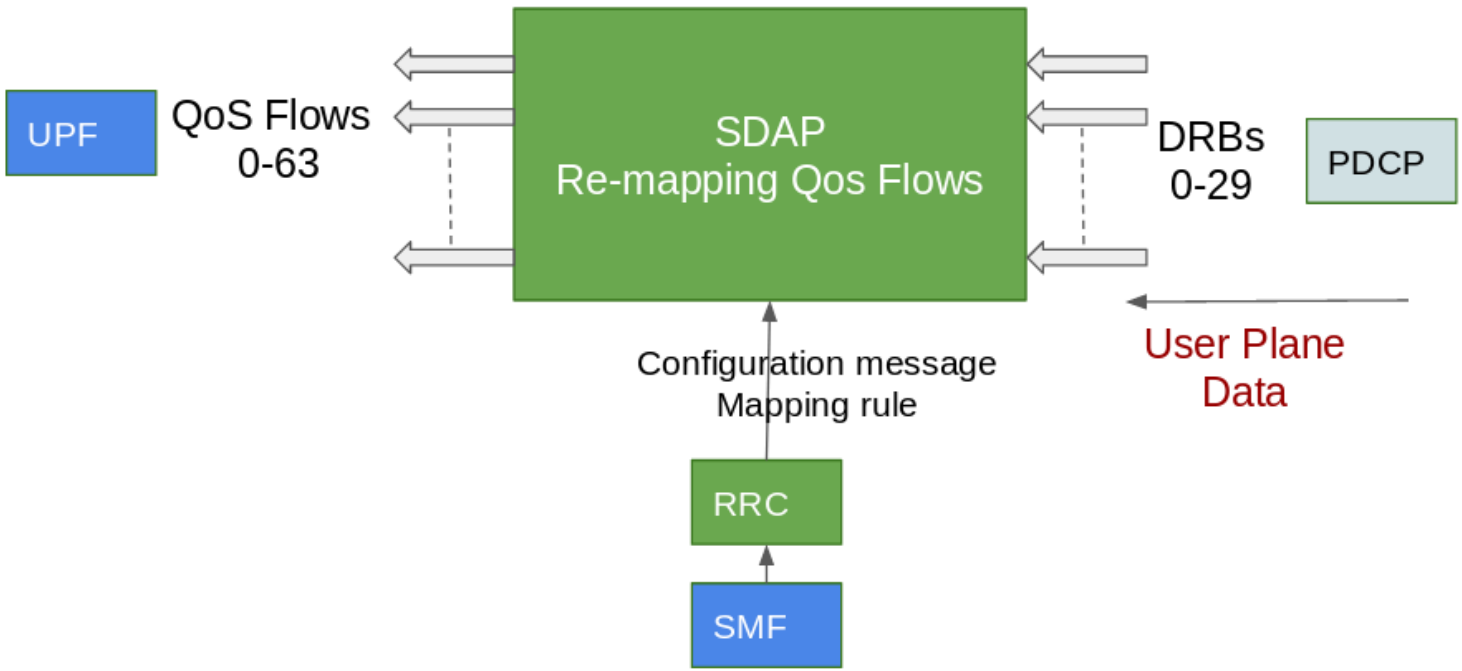
SDAP Functions

- Mapping between a QoS flow and a data radio bearer
- Marking QoS flow ID (QFI) in both DL and UL packets

SDAP gNB DL


UPF
QoS Flows
0-63
SDAP
QoS flows to DRB
mapping
DRBs
0-29
PDCP
User Plane
Data
Configuration message
Mapping rule
RRC
SMF

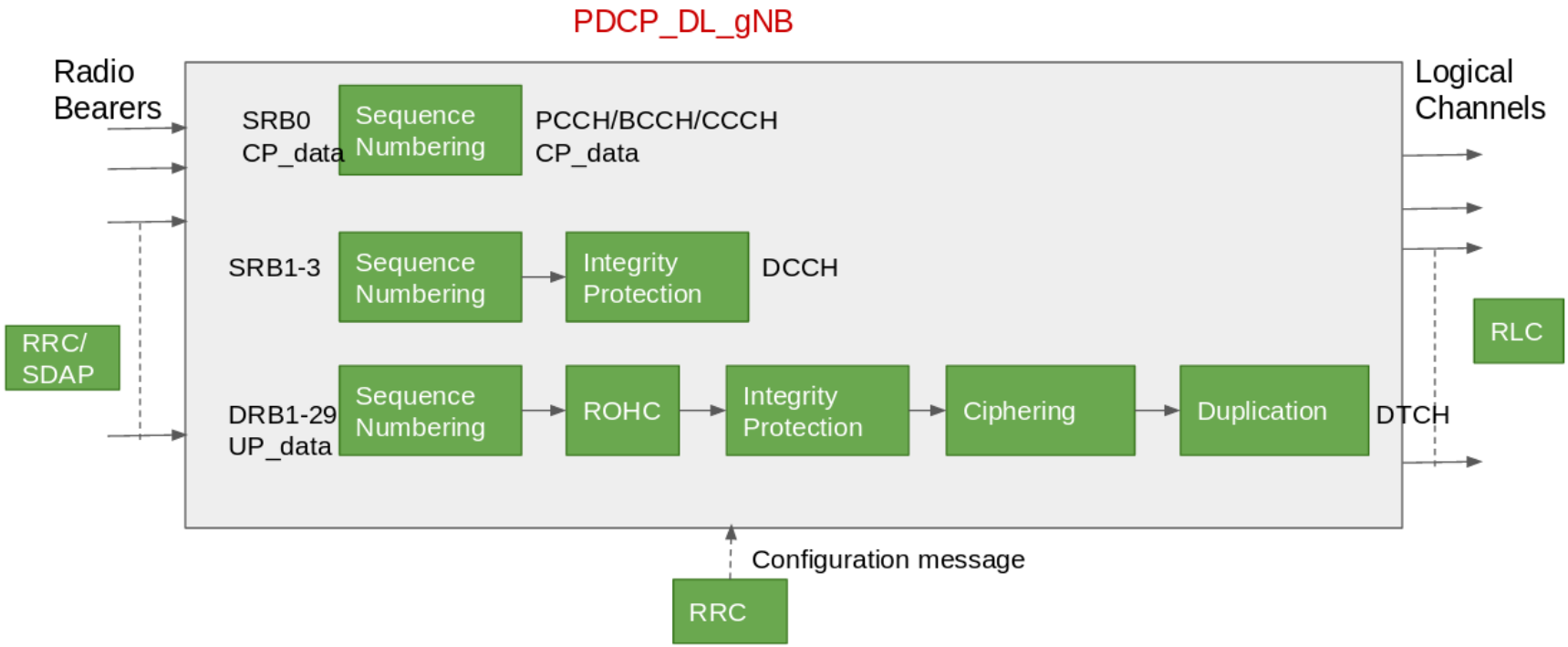
SDAP gNB UL


UPF
QoS Flows
0-63
SDAP
Re-mapping Qos Flows
DRBs
0-29
PDCP
User Plane
Data
Configuration message
Mapping rule
RRC
SMF

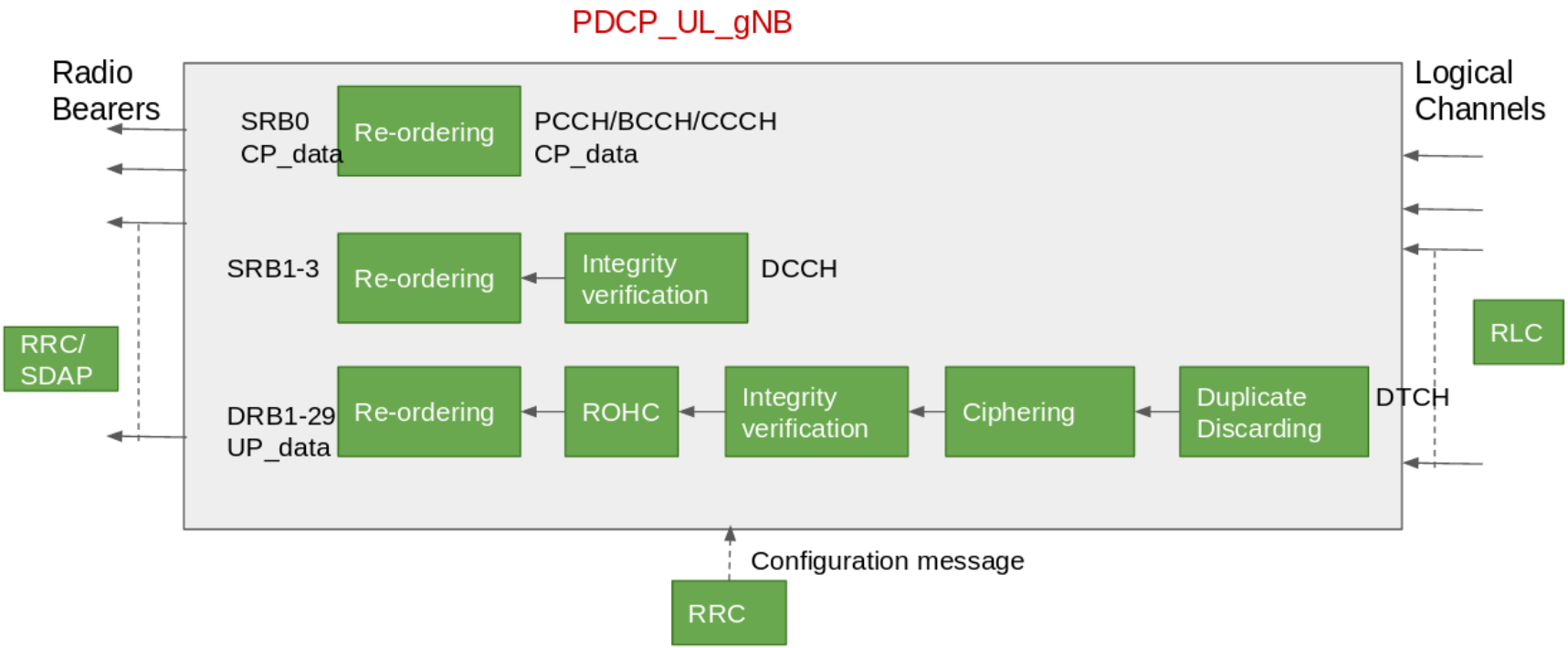
PDCP Functions

- Addition and Removal and sequence number
- Header compression and de-compression
- Ciphering and de-ciphering
- Integrity Protection
- Duplicate detection and reordering of packets (if in-order delivery is required for upper layers)

PDCP gNB DL


PDCP_DL_gNB
Radio Bearers
Logical Channels
SRB0
CP_data
Sequence Numbering
PCCH/BCCH/CCCH
CP_data
SRB1-3
Sequence Numbering
Integrity Protection
DCCH
RRC/ SDAP
RLC
DRB1-29
UP_data
Sequence Numbering
ROHC
Integrity Protection
Ciphering
Duplication
DTCH
Configuration message
RRC

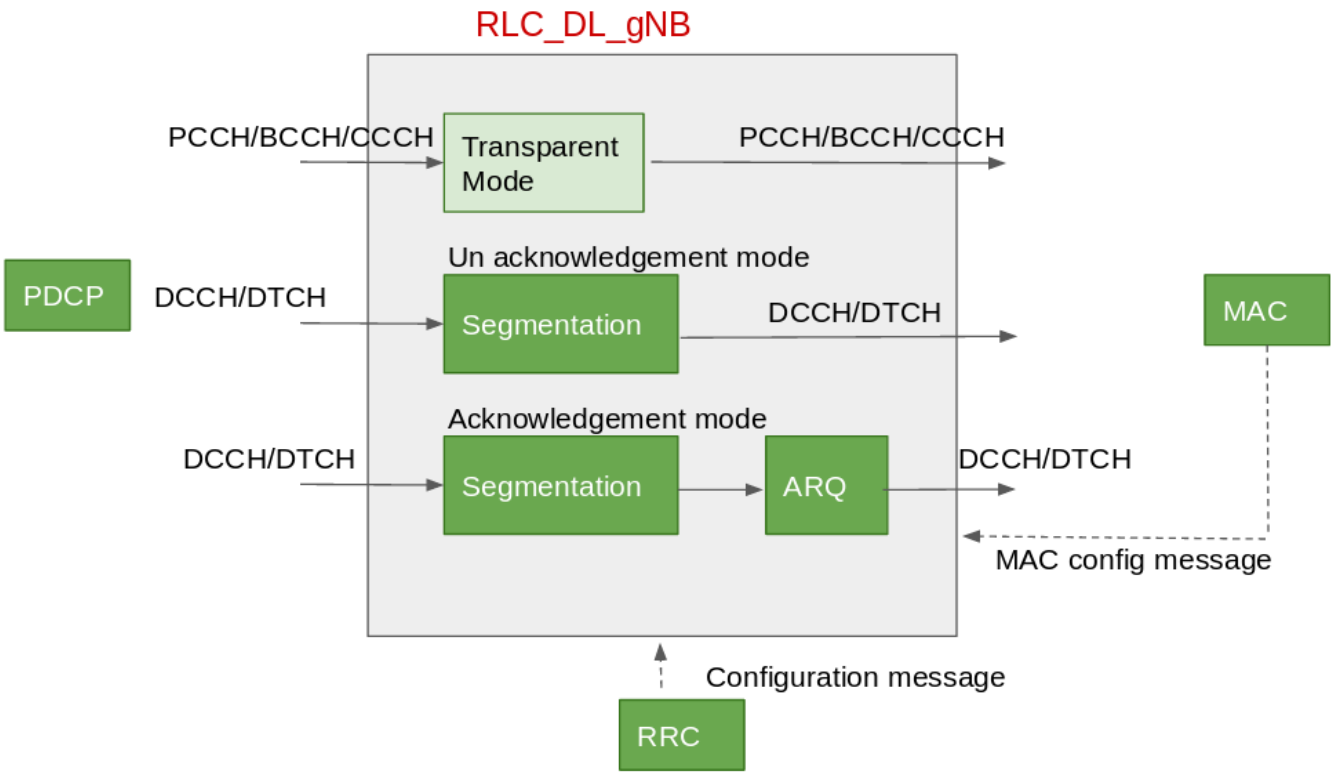
PDCP gNB UL


PDCP_UL_gNB
Radio Bearers
Logical Channels
SRB0
CP_data
Re-ordering
PCCH/BCCH/CCCH
CP_data
SRB1-3
Re-ordering
Integrity verification
DCCH
RRC/ SDAP
RLC
DRB1-29
UP_data
Re-ordering
ROHC
Integrity verification
Ciphering
Duplicate Discarding
DTCH
Configuration message
RRC

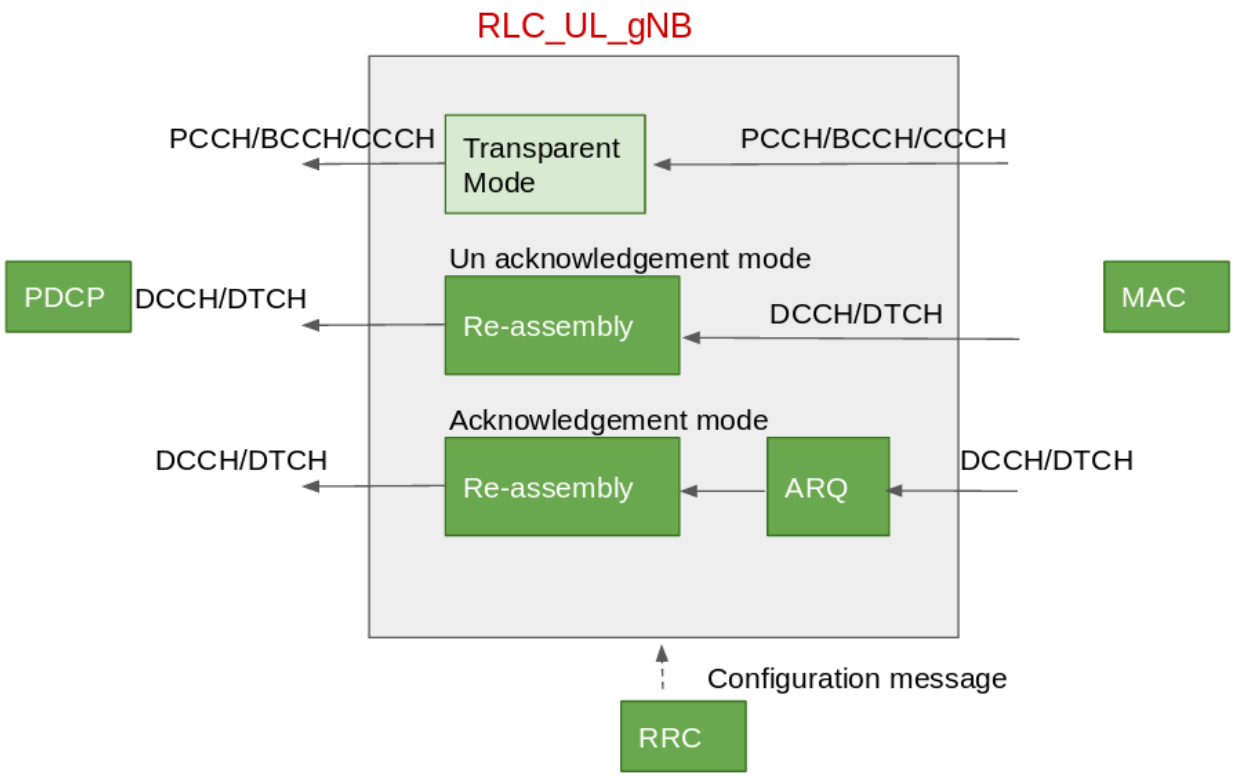
RLC Functions

- Transfer of upper layer PDUs
- Sequence numbering independent of the one in PDCP
- Error Correction through ARQ
- Segmentation and re-segmentation

RLC gNB DL


RLC_DL_gNB
PCCH/BCCH/CCCH
Transparent Mode
PCCH/BCCH/CCCH
Un acknowledgement mode
PDCP
DCCH/DTCH
Segmentation
DCCH/DTCH
MAC
Acknowledgement mode
DCCH/DTCH
Segmentation
ARQ
DCCH/DTCH
MAC config message
Configuration message
RRC

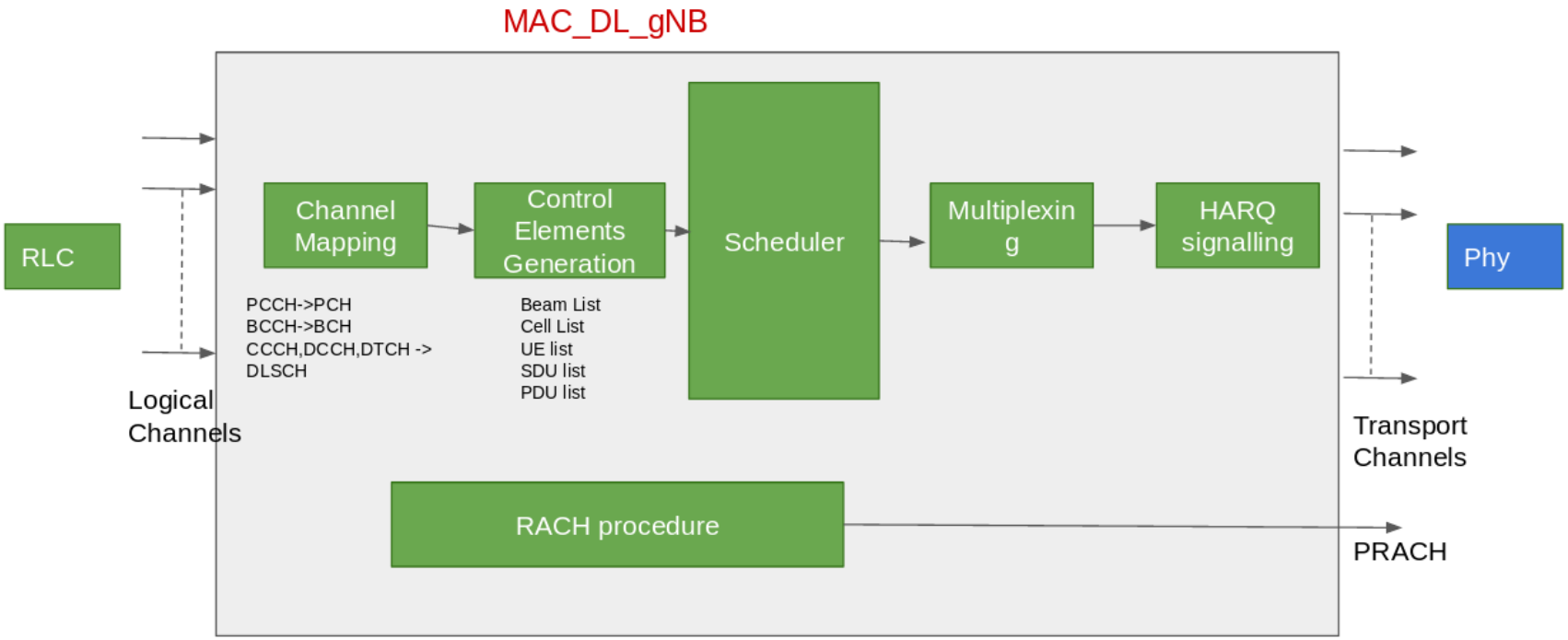
RLC gNB UL


RLC_UL_gNB
PCCH/BCCH/CCCH
Transparent Mode
PCCH/BCCH/CCCH
Un acknowledgement mode
PDCP
DCCH/DTCH
Re-assembly
DCCH/DTCH
MAC
Acknowledgement mode
DCCH/DTCH
Re-assembly
ARQ
DCCH/DTCH
Configuration message
RRC

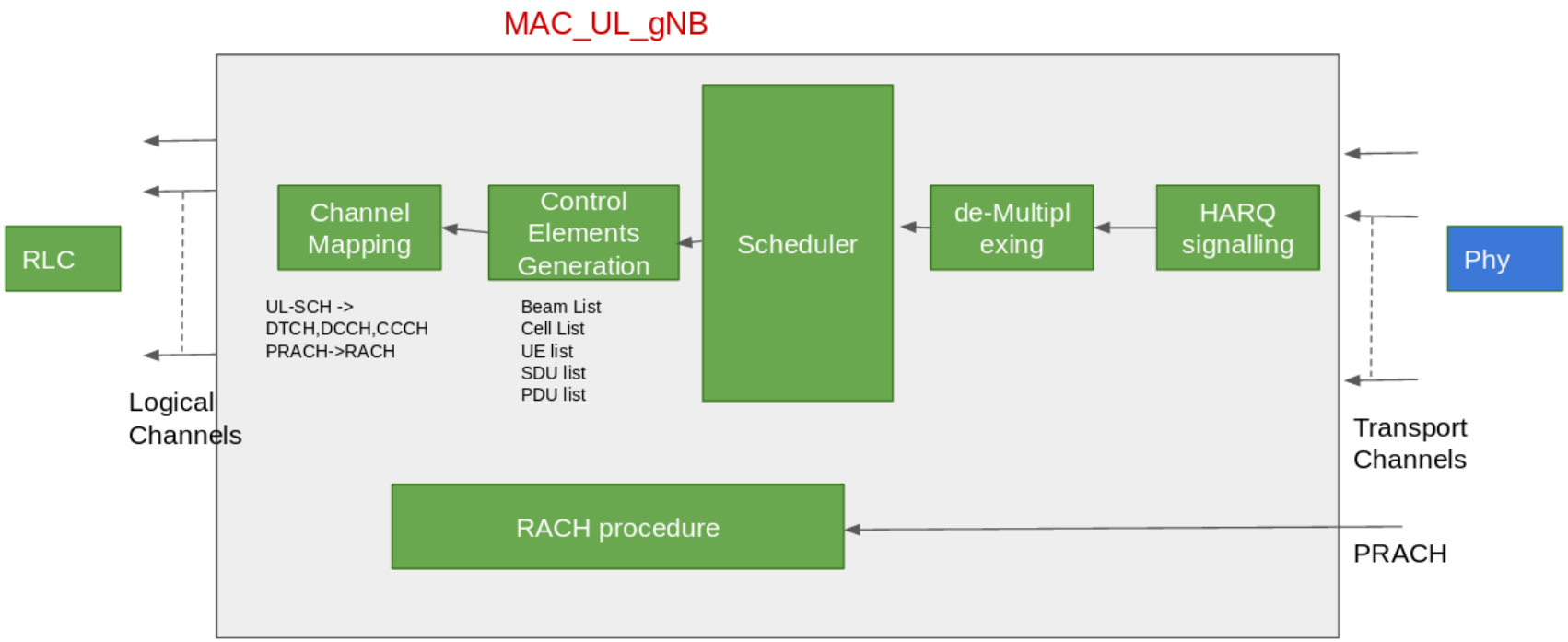
MAC Functions

- Mapping between logical channels and transport channels
- Multiplexing/demultiplexing of MAC SDUs belonging to one or different logical channels into/from transport blocks (TB) delivered to/from the physical layer on transport channels
- Scheduling Information Reporting
- Error correction through HARQ
- Priority handling between UEs by means of dynamic scheduling
- Priority handling between logical channels of one UE by means of logical channel prioritization
- Padding

MAC gNB DL


MAC_DL_gNB
RLC
Channel Mapping
Control Elements Generation
Scheduler
Multiplexing
HARQ signalling
Phy
PCCH->PCH
BCCH->BCH
CCCH,DCCH,DTCH -> DLSCH
Beam List
Cell List
UE list
SDU list
PDU list
Logical Channels
Transport Channels
RACH procedure
PRACH

MAC gNB UL


MAC_UL_gNB
RLC
Channel Mapping
Control Elements Generation
Scheduler
de-Multipl exing
HARQ signalling
Phy
UL-SCH ->
DTCH,DCCH,CCCH
PRACH->RACH
Beam List
Cell List
UE list
SDU list
PDU list
Logical Channels
Transport Channels
RACH procedure
PRACH

5G NR Requirements

Data Rate Requirements

Target parameter	LTE Requirements	LTE Advanced Requirements	5G requirements
Data Rate	500 Mbps	1 Gbps	10 Gbps
Control Plane latency	100 ms from idle mode 50ms from connected mode	50ms from idle mode 10ms from connected mode	10ms from idle mode < 5ms in connected mode
User Plane latency	< 5ms	< 5ms	< 1ms

Latency Requirements

Target parameter	LTE Requirements	LTE Advanced Requirements	5G requirements
Data Rate	500 Mbps	1 Gbps	10 Gbps
Control Plane latency	100 ms from idle mode 50ms from connected mode	50ms from idle mode 10ms from connected mode	10ms from idle mode < 5ms in connected mode
User Plane latency	< 5ms	< 5ms	< 1ms

Thank you.
Questions??