5G NR Radio Protocol Stack (Layer 2 and Layer 3)

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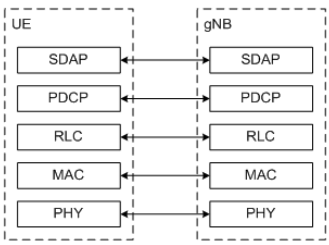
3GPP has released specification 38.300 V1 this month about NR and NG-RAN Overall Description: Stage 2, This standard comes with the detailed descriptions about 5G NR network and Protocol architecture.

NR Radio User plane and Control Protocol Stack is shown in below figures:



(http://www.techplayon.com/wp-content/uploads/2017/09/UserPlane.png)

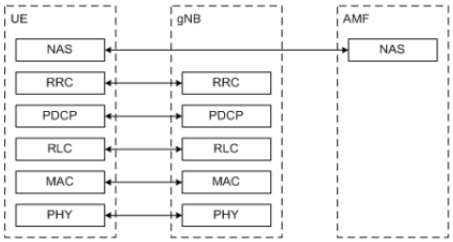


Figure #1 User Plane Protocol Stack **Figure #2**

Control Plane Protocol Stack

When we closely see both the protocol stack we could see many similarities between LTE protocol stack and 5G-NR protocol stack because LTE protocol stack is being taken as the base line for the development 5G-NR.

5G-NR User plane contains Phy, MAC, RLC, and PDCP same as LTE and has introduced a new layer named as SDAP (Service Data Adaptation Protocol).

On another side, the control plane of 5G-NR is identical to LTE, here MME equivalent node named as AMF (Access and Management Mobility Function).

5G-NR Layer 3 (RRC) Functions:

The main services and functions of the RRC sub layer include:

- Broadcast of System Information related to AS and NAS;
- Paging initiated by 5GC or NG-RAN;
- Establishment, maintenance, and release of an RRC connection between the UE and NG-RAN including Addition, modification, and release of carrier aggregation, Addition, modification, and release of Dual Connectivity in NR or between E-UTRA and NR.
- Security functions including key management;
- Establishment, configuration, maintenance, and release of Signalling Radio Bearers (SRBs) and Data Radio Bearers (DRBs);
- Mobility functions including Handover and context transfer; UE cell selection and reselection and control of cell selection and reselection; Inter-RAT mobility.
- QoS management functions;
- UE measurement reporting and control of the reporting;
- Detection of and recovery from radio link failure;
- NAS message transfer to/from NAS from/to UE.

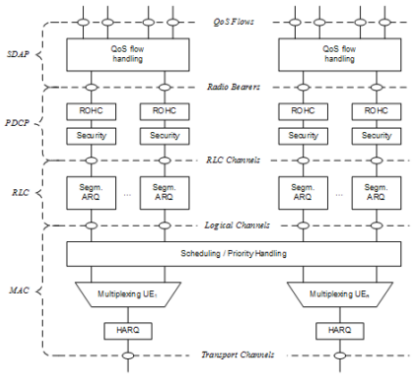
5G-NR Layer 2 Functions:

The layer 2 of NR is split into the following sub layers:

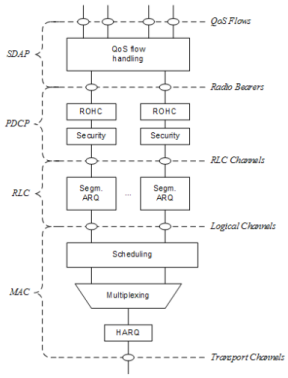
- Service Data Adaptation Protocol (SDAP)
- Packet Data Convergence Protocol (PDCP)
- Radio Link Control (RLC)
- and Medium Access Control (MAC)

The two figures below depict the Layer 2 architecture for downlink and uplink, where:

- The physical layer offers to the MAC sublayer transport channels;
- The MAC sub layer offers to the RLC sublayer logical channels;
- The RLC sub layer offers to the PDCP sublayer RLC channels;
- The PDCP su blayer offers to the SDAP sublayer radio bearers;
- The SDAP su blayer offers to 5GC QoS flows;
- *Comp.* refers to header compression and *segm.* to segmentation;
- Control channels (BCCH, PCCH are not depicted for clarity).



(http://www.techplayon.com/wp-content/uploads/2017/09/Downlink-L2-5GNR.png)



(http://www.techplayon.com/wp-content/uploads/2017/09/Uplink-L2-5GNR.png)

Figure #3 Downlink Layer 2 Structure **Figure #4 Uplink Layer 2 Structure**

SDAP (Service Data Adaptation Protocol) Protocol Functions :

The main services and functions of SDAP include:

- Mapping between a QoS flow and a data radio bearer (Due to new QoS framework)
- Marking QoS flow ID (QFI) in both DL and UL packets (DL: due to reflective QoS and UL: due to new QoS framework)

A single protocol entity of SDAP is configured for each individual PDU session, except for DC where two entities can be configured.

PDCP (Packet Data Convergence Protocol) Layer Functions:

The main services and functions of the PDCP sublayer for the user plane include:

- Sequence Numbering
- Header compression and decompression: ROHC only
- Transfer of user data
- **Reordering and Duplicate detection** (if in order delivery to layers above PDCP is required)
- PDCP PDU routing (in case of split bearers)
- Retransmission of PDCP SDUs
- Ciphering and **Deciphering**
- PDCP SDU discard
- PDCP re-establishment and data recovery for RLC AM
- **Duplication of PDCP PDUs**

The main services and functions of the PDCP sublayer for the control plane include:

- Sequence Numbering;
- Ciphering, deciphering and integrity protection;
- Transfer of control plane data;
- Duplicate detection;
- Duplication of PDCP PDUs.

RLC (Radio Link Control) Layer Functions:

The main services and functions of the RLC sublayer depend on the transmission mode and include:

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

Note: no concatenation and no reordering

MAC (Media Access Control) Layer Functions

The main services and functions of the MAC sub layer include:

- 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

A single MAC entity can support one or multiple numerologies and/or TTI durations and mapping restrictions in logical channel prioritization controls which numerology and/or TTI duration a logical channel can use.

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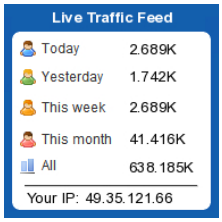

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