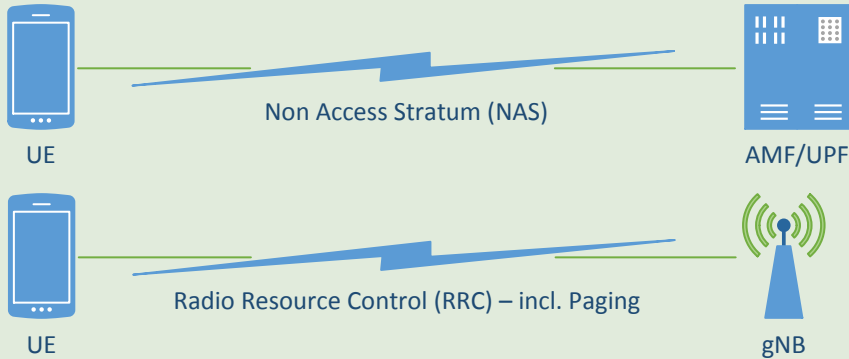
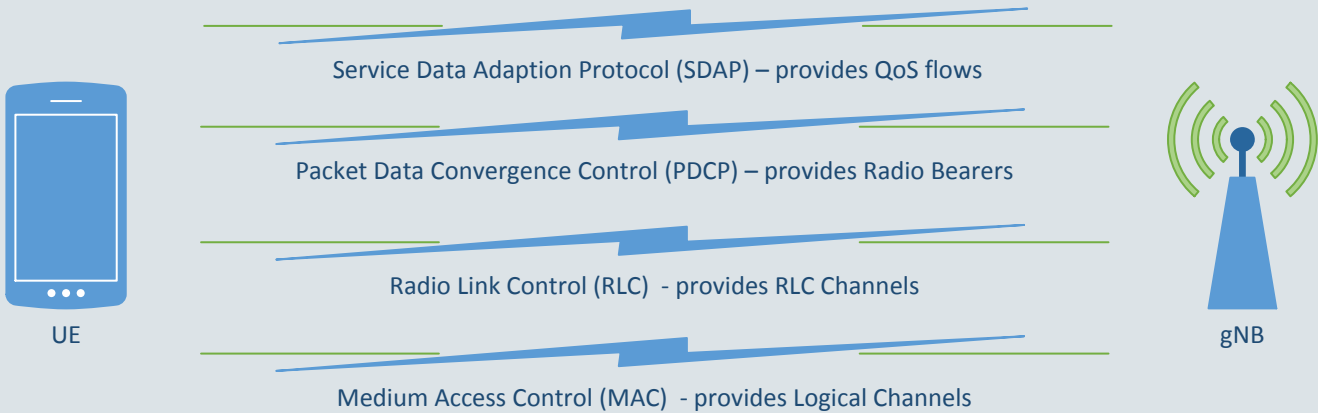


Layer 4 – 7

Layer 3



Layer 2



Layer 1 – Physical Layer



Frequency Range 1 [\[ edit \]](#)

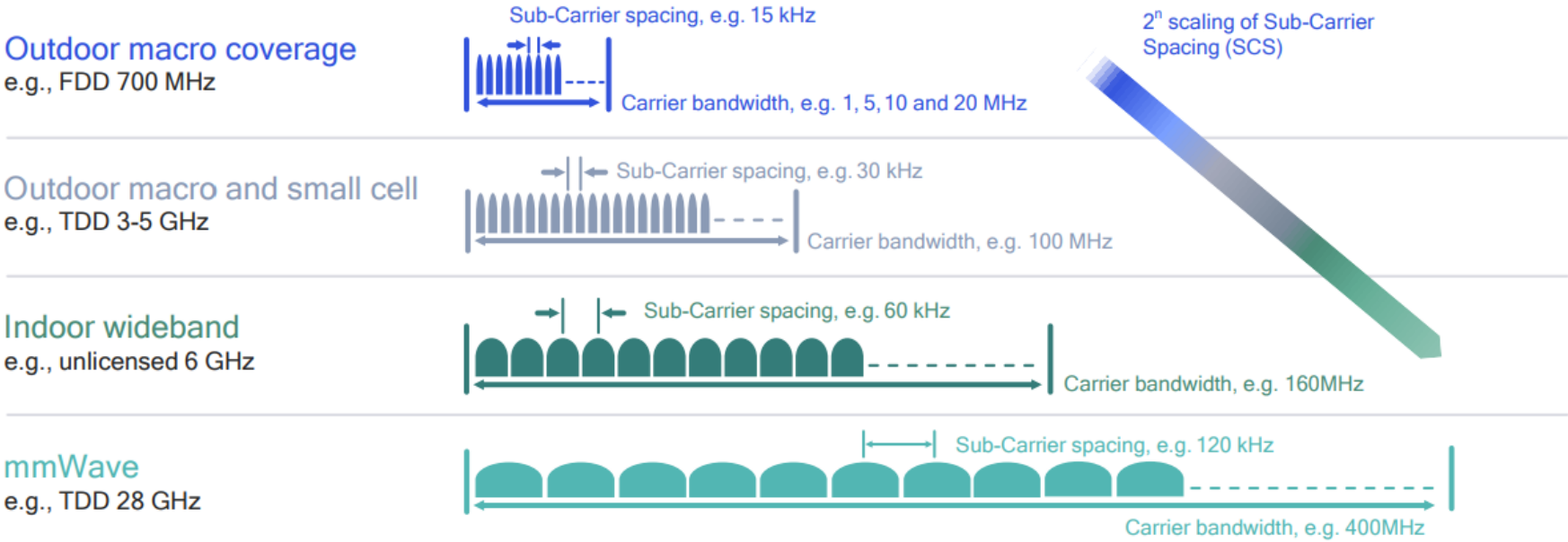
Band <sup>⚡</sup>	Duplex mode <sup>[A 1]</sup> <sup>⚡</sup>	<i>f</i> (MHz) <sup>⚡</sup>	Common name <sup>⚡</sup>	Subset of band <sup>⚡</sup>	Uplink <sup>[A 2]</sup> (MHz) <sup>⚡</sup>	Downlink <sup>[A 3]</sup> (MHz) <sup>⚡</sup>	Duplex spacing (MHz) <sup>⚡</sup>	Channel bandwidths <sup>[5]</sup> (MHz)
n1	FDD	2100	IMT		1920 – 1980	2110 – 2170	190	5, 10, 15, 20
n2	FDD	1900	PCS <sup>[A 4]</sup>	n25	1850 – 1910	1930 – 1990	80	5, 10, 15, 20
n3	FDD	1800	DCS		1710 – 1785	1805 – 1880	95	5, 10, 15, 20, 25, 30
n5	FDD	850	CLR		824 – 849	869 – 894	45	5, 10, 15, 20
n7	FDD	2600	IMT-E		2500 – 2570	2620 – 2690	120	5, 10, 15, 20
n8	FDD	900	Extended GSM		880 – 915	925 – 960	45	5, 10, 15, 20
n12	FDD	700	Lower SMH		699 – 716	729 – 746	30	5, 10, 15
n20	FDD	800	Digital Dividend (EU)		832 – 862	791 – 821	−41	5, 10, 15, 20
n25	FDD	1900	Extended PCS		1850 – 1915	1930 – 1995	80	5, 10, 15, 20
n28	FDD	700	APT		703 – 748	758 – 803	55	5, 10, 15, 20
n34	TDD	2100	IMT		2010 – 2025		N/A	5
n38	TDD	2600	IMT-E <sup>[A 5]</sup>	n41	2570 – 2620		N/A	5, 10, 15, 20
n39	TDD	1900	DCS–IMT Gap		1880 – 1920		N/A	5, 10, 15, 20, 25, 30, 40
n40	TDD	2300	S-Band		2300 – 2400		N/A	5, 10, 15, 20, 25, 30, 40, 50, 60, 80
n41	TDD	2500	BRS		2496 – 2690		N/A	5, 10, 15, 20, 40, 50, 60, 80, 100
n50	TDD	1500	L-Band (EU)		1432 – 1517		N/A	5, 10, 15, 20, 40, 50, 60, 80 <sup>[A 6]</sup>
n51	TDD	1500	Extended L-Band (EU)		1427 – 1432		N/A	5
n66	FDD	1700	Extended AWS <sup>[A 7]</sup>		1710 – 1780	2110 – 2200 <sup>[6]</sup>	400	5, 10, 15, 20, 40
n70	FDD	2000	AWS-4		1695 – 1710	1995 – 2020	300	5, 10, 15, 20 <sup>[A 6]</sup> , 25 <sup>[A 6]</sup>
n71	FDD	600	Digital Dividend (US)		663 – 698	617 – 652	−46	5, 10, 15, 20
n74	FDD	1500	Lower L-Band (US)		1427 – 1470	1475 – 1518	48	5, 10, 15, 20
n75	SDL <sup>[A 8]</sup>	1500	L-Band (EU)		N/A	1432 – 1517	N/A	5, 10, 15, 20
n76	SDL <sup>[A 8]</sup>	1500	Extended L-Band (EU)		N/A	1427 – 1432	N/A	5
n77	TDD	3700	C-Band		3300 – 4200		N/A	10, 20, 40, 50, 60, 80, 100
n78	TDD	3500	C-Band	n77	3300 – 3800		N/A	10, 20, 40, 50, 60, 80, 100
n79	TDD	4700	C-Band		4400 – 5000		N/A	40, 50, 60, 80, 100
n80	SUL <sup>[A 9]</sup>	1800	DCS		1710 – 1785	N/A	N/A	5, 10, 15, 20, 25, 30
n81	SUL <sup>[A 9]</sup>	900	Extended GSM		880 – 915	N/A	N/A	5, 10, 15, 20
n82	SUL <sup>[A 9]</sup>	800	Digital Dividend (EU)		832 – 862	N/A	N/A	5, 10, 15, 20
n83	SUL <sup>[A 9]</sup>	700	APT		703 – 748	N/A	N/A	5, 10, 15, 20
n84	SUL <sup>[A 9]</sup>	1900	IMT		1920 – 1980	N/A	N/A	5, 10, 15, 20
n86	SUL <sup>[A 9]</sup>	1700	Extended AWS	n80	1710 – 1780	N/A	N/A	5, 10, 15, 20, 40
Band	Duplex mode <sup>[A 1]</sup>	<i>f</i> (MHz)	Common name	Subset of band	Uplink <sup>[A 2]</sup> (MHz)	Downlink <sup>[A 3]</sup> (MHz)	Duplex spacing (MHz)	Channel bandwidths <sup>[5]</sup> (MHz)

Frequency Range 2 [\[ edit \]](#)

<https://www.qualcomm.com/media/documents/files/making-5g-nr-a-commercial-reality.pdf>

Band <sup>⚡</sup>	<i>f</i> (GHz) <sup>⚡</sup>	Common name <sup>⚡</sup>	Subset of band <sup>⚡</sup>	Uplink / Downlink <sup>[B 1]</sup> (GHz) <sup>⚡</sup>	Channel bandwidths <sup>[5]</sup> (MHz) <sup>⚡</sup>
n257	26	LMDS		26.50 – 29.50	50, 100, 200, 400
n258	24	K-band		24.25 – 27.50	50, 100, 200, 400
n260	39	Ka-band		37.00 – 40.00	50, 100, 200, 400
n261	28	Ka-band	n257	27.50 – 28.35	50, 100, 200, 400
Band	<i>f</i> (GHz)	Common name	Subset of band	Uplink / Downlink <sup>[B 1]</sup> (GHz)	Channel bandwidths <sup>[5]</sup> (MHz)

# Scalable 5G NR OFDM numerology—examples



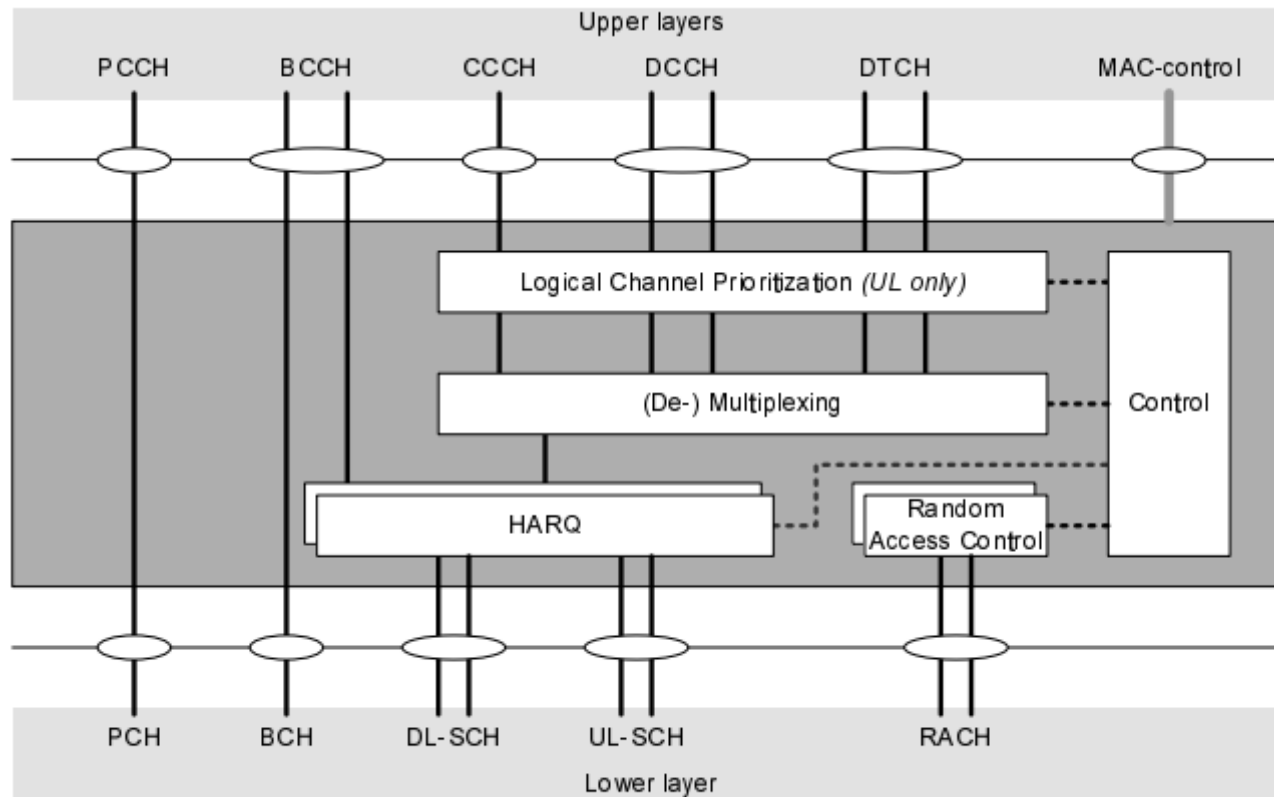
Efficiently address 5G diverse spectrum, deployments and services

Scaling reduces FFT processing complexity for wider bandwidths with reusable hardware

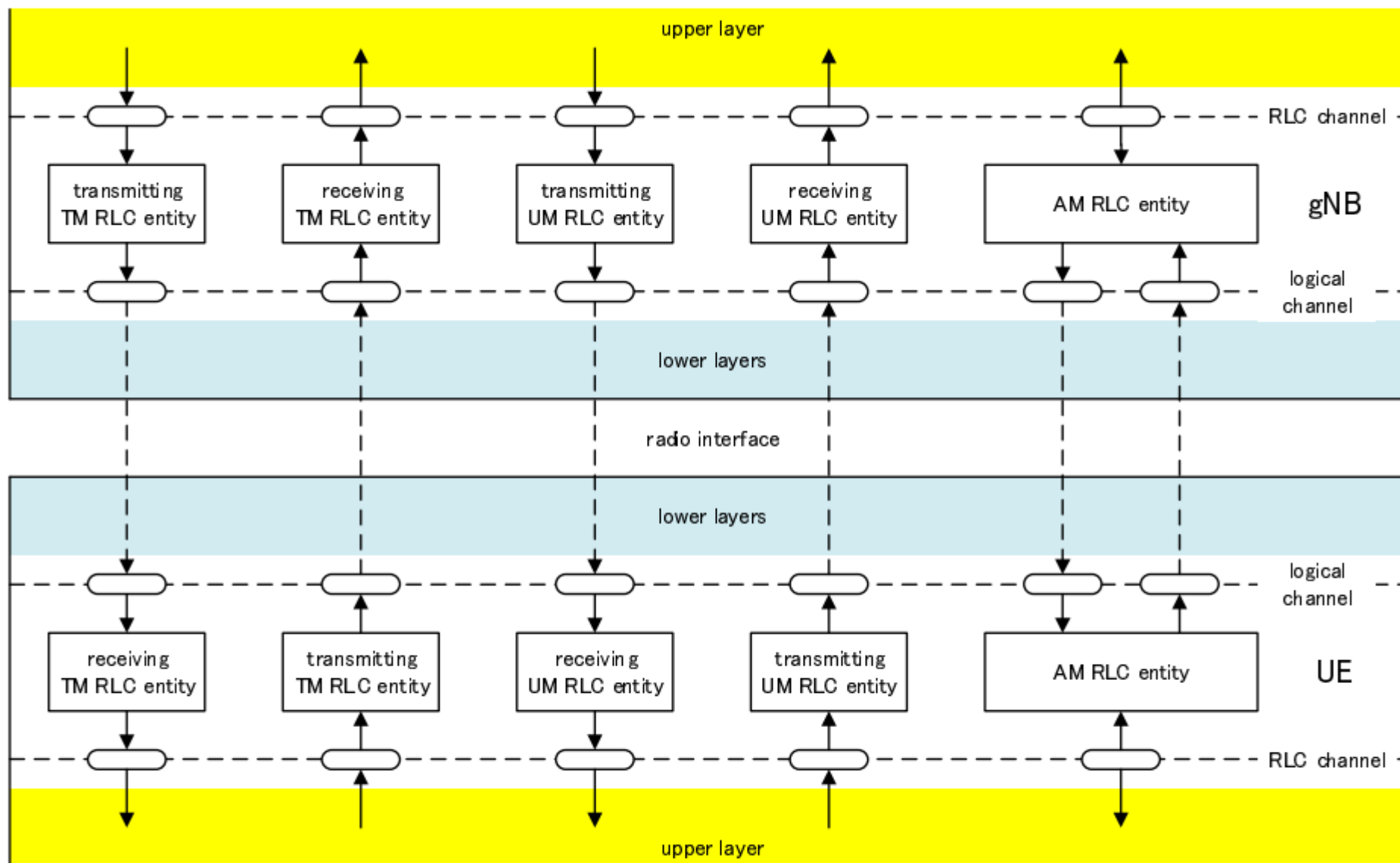
The MAC entity of the UE handles the following transport channels:

- Broadcast Channel (BCH);
- Downlink Shared Channel(s) (DL-SCH);
  - Paging Channel (PCH);
- Uplink Shared Channel(s) (UL-SCH);
- Random Access Channel(s) (RACH).

[https://www.etsi.org/deliver/etsi\\_ts/138300\\_138399/138321/15.03.00\\_60/ts\\_138321v150300p.pdf](https://www.etsi.org/deliver/etsi_ts/138300_138399/138321/15.03.00_60/ts_138321v150300p.pdf)



**Figure 4.2.2-1: MAC structure overview**



**Figure 4.2.1-1: Overview model of the RLC sub layer**

[https://www.etsi.org/deliver/etsi\\_ts/138300\\_138399/138322/15.03.00\\_60/ts\\_138322v150300p.pdf](https://www.etsi.org/deliver/etsi_ts/138300_138399/138322/15.03.00_60/ts_138322v150300p.pdf)

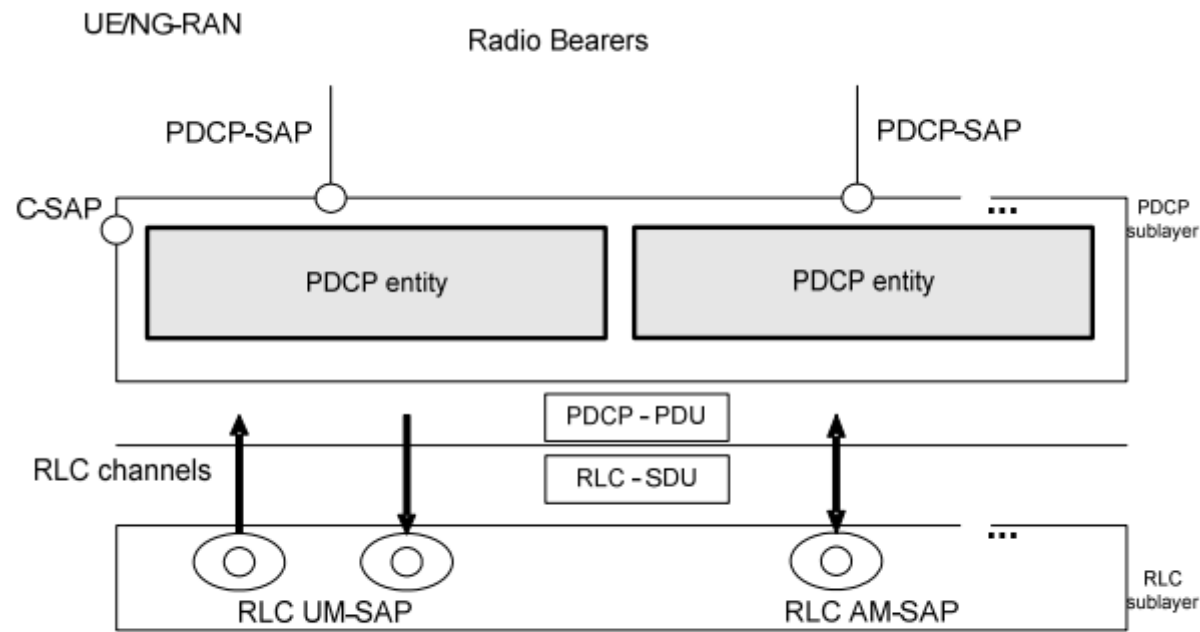


Figure 4.2.1-1: PDCP layer, structure view

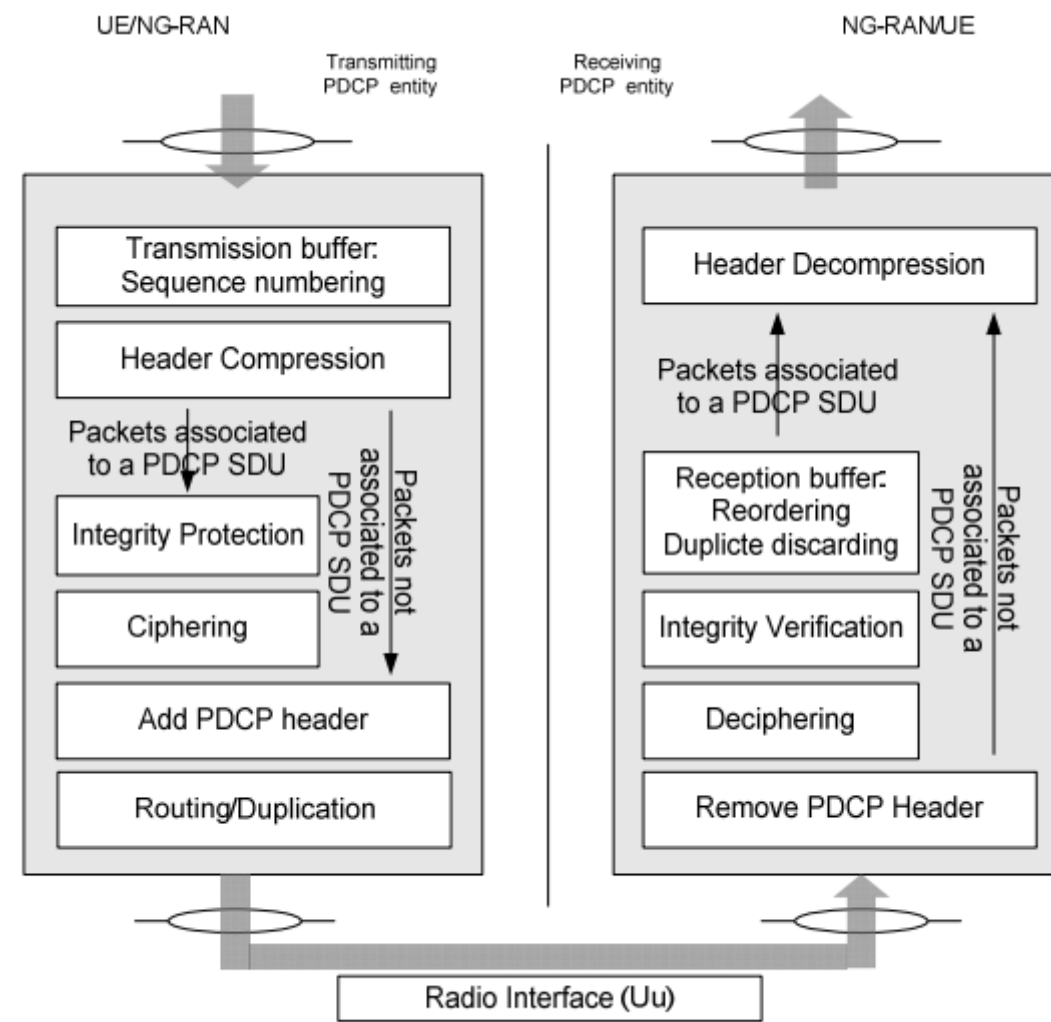


Figure 4.2.2-1: PDCP layer, functional view

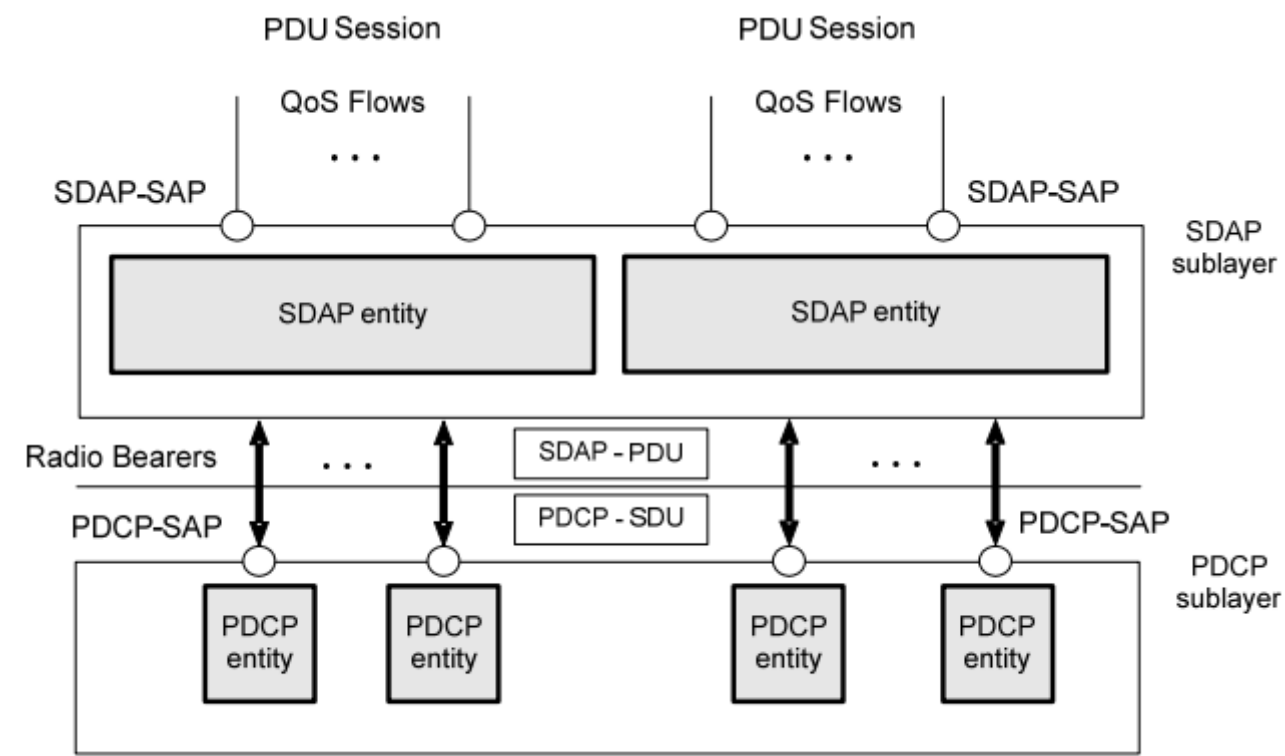


Figure 4.2.1-1: SDAP sublayer, structure view

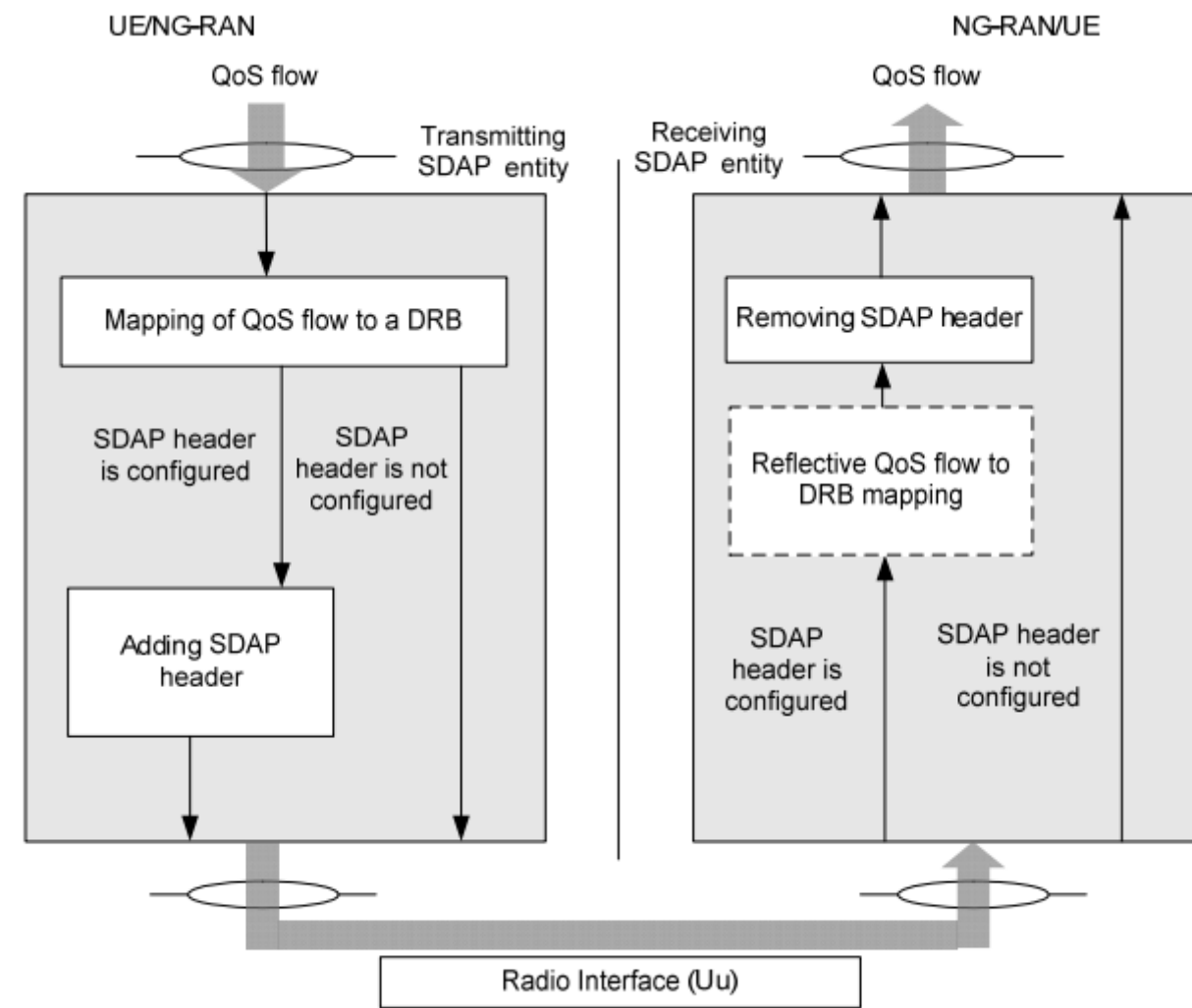


Figure 4.2.2-1: SDAP layer, functional view

The RRC protocol offers the following services to upper layers:

- Broadcast of common control information;
- Notification of UEs in RRC\_IDLE, e.g. about a terminating call;
- Notification of UEs about ETWS and/or CMAS
- Transfer of dedicated control information, i.e. information for one specific UE.

In brief, the following are the main services that RRC expects from lower layers:

- Integrity protection, ciphering and loss-less in-sequence delivery of information without duplication;

The RRC protocol includes the following main functions:

- Broadcast of system information;
  - Including NAS common information;
  - Information applicable for UEs in RRC\_IDLE and RRC\_INACTIVE (e.g. cell (re-)selection parameters, neighbouring cell information) and information (also) applicable for UEs in RRC\_CONNECTED (e.g. common channel configuration information);
  - Including ETWS notification, CMAS notification.
  - RRC connection control:
    - Paging;
  - Establishment/modification/suspension/resumption/release of RRC connection, including e.g. assignment/modification of UE identity (C-RNTI, I-RNTI, etc.), establishment/modification/suspension/resumption/release of SRBs (except for SRB0);
  - Access barring;
  - Initial security activation, i.e. initial configuration of AS integrity protection (SRBs, DRBs) and AS ciphering (SRBs, DRBs);
  - RRC connection mobility including e.g. intra-frequency and inter-frequency handover, associated security handling, i.e. key/algorithm change, specification of RRC context information transferred between network nodes;
    - Establishment/modification/suspension/resumption/release of RBs carrying user data (DRBs);
    - Radio configuration control including e.g. assignment/modification of ARQ configuration, HARQ configuration, DRX configuration;
  - In case of DC, cell management including e.g. change of PSCell, addition/modification/release of SCG cell(s);
  - In case of CA, cell management including e.g. addition/modification/release of SCell(s);
  - QoS control including assignment/ modification of semi-persistent scheduling (SPS) configuration and configured grant configuration for DL and UL respectively, assignment/ modification of parameters for UL rate control in the UE, i.e. allocation of a priority and a prioritised bit rate (PBR) for each RB.
- ETSI  
3GPP TS 38.331 version 15.3.0 Release 15 23 ETSI TS 138 331 V15.3.0 (2018-10)
- Recovery from radio link failure.
  - Inter-RAT mobility including e.g. security activation, transfer of RRC context information;
  - Measurement configuration and reporting;
  - Establishment/modification/release of measurement configuration (e.g. intra-frequency, inter-frequency and inter- RAT measurements);
  - Setup and release of measurement gaps;
  - Measurement reporting.
  - Other functions including e.g. generic protocol error handling, transfer of dedicated NAS information, transfer of UE radio access capability information.

[https://www.etsi.org/deliver/etsi\\_ts/138300\\_138399/138331/15.03.00\\_60/ts\\_138331v150300p.pdf](https://www.etsi.org/deliver/etsi_ts/138300_138399/138331/15.03.00_60/ts_138331v150300p.pdf)

The following functions exist in the non-access stratum:

Mobility management: maintaining connectivity and active sessions with user equipment as the user moves

Call control management

Session management: establishing, maintaining and terminating communication links

Identity management