5G Release 17: Network Architecture

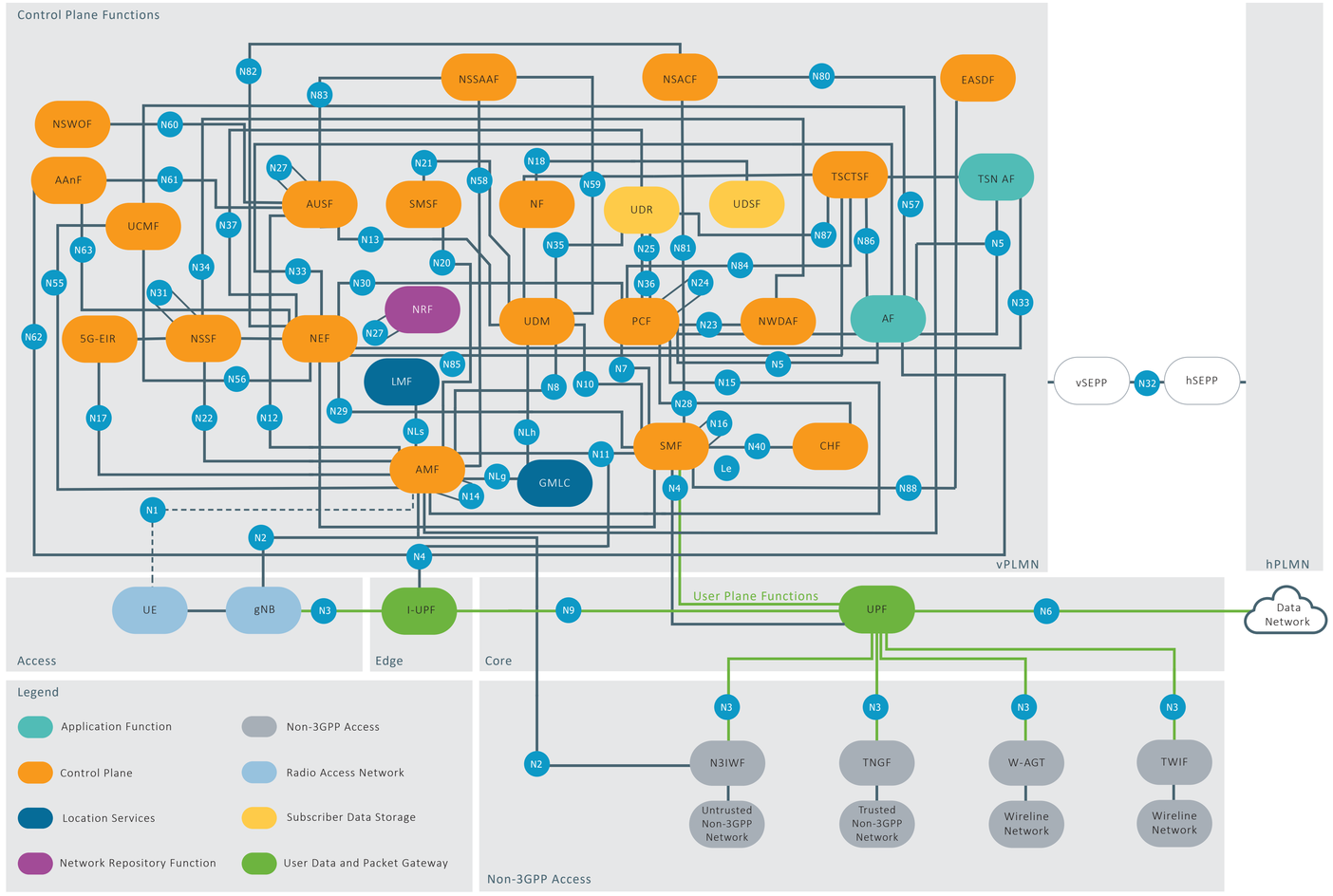
RADCOM

5GC Reference Points

* a Service-based Interface

Reference Point	Between	Between	3GPP Spec	Protocol Stack
N1	UE	AMF	TS 23.501	IP | SCTP | NG-AP | NAS
N2	(R)AN	AMF	TS 23.501	IP | SCTP | NG-AP
N3	(R)AN	UPF	TS 23.501	IP | UDP | GTP-U
N4	UPF	SMF	TS 23.501	N4-C: IP | UDP | PFCP N4-U: IP | UDP | GTP-U
N5 *	PCF	AF	TS 23.501	IP | TCP | HTTP2 | JSON
N6	UPF	DN	TS 23.501	IP | UDP | GTP-U | Application
N7 *	SMF	PCF	TS 23.501	IP | TCP | HTTP2 | JSON
N8 *	AMF	UDM	TS 23.501	IP | TCP | HTTP2 | JSON
N9	UPF	UPF	TS 23.501	IP | UDP | GTP-U
N10 *	SMF	UDM	TS 23.501	IP | TCP | HTTP2 | JSON
N11 *	AMF	SMF	TS 23.501	IP | TCP | HTTP2 | JSON
N12 *	AMF	AUSF	TS 23.501	IP | TCP | HTTP2 | JSON
N13 *	AUSF	UDM	TS 23.501	IP | TCP | HTTP2 | JSON
N14 *	AMF	AMF	TS 23.501	IP | TCP | HTTP2 | JSON
N15 *	AMF	PCF	TS 23.501	IP | TCP | HTTP2 | JSON
N16 *	SMF	SMF	TS 23.501	IP | TCP | HTTP2 | JSON
N17 *	AMF	5G-EIR	TS 23.501	IP | TCP | HTTP2 | JSON
N18 *	NF	UDSF	TS 23.501	IP | TCP | HTTP2 | JSON
N19	PSA	PSA	TS 23.501	IP | UDP | GTP-U
N20 *	AMF	SMSF	TS 23.501	IP | TCP | HTTP2 | JSON
N21 *	SMSF	UDM	TS 23.501	IP | TCP | HTTP2 | JSON
N22 *	AMF	NSSF	TS 23.501	IP | TCP | HTTP2 | JSON
N23 *	PCF	NWDAF	TS 23.501	IP | TCP | HTTP2 | JSON
N24 *	PCF	PCF	TS 23.501	IP | TCP | HTTP2 | JSON
N25 *	UDR	PCF	TS 29.513	IP | TCP | HTTP2 | JSON
N26	AMF	MME	TS 23.502	IP | UDP | GTP-C
N27 *	NRF	NRF	TS 23.501	IP | TCP | HTTP2 | JSON
N28 *	PCF	CHF	TS 32.240	IP | TCP | HTTP2 | JSON
N29 *	NEF	SMF	Depreciated	IP | TCP | HTTP2 | JSON
N30 *	NEF	PCF	TS 29.554	IP | TCP | HTTP2 | JSON
N31 *	NSSF	NSSF	TS 23.501	IP | TCP | HTTP2 | JSON
N32 *	SEPP	SEPP	TS 23.501	IP | TCP | HTTP2 | JSON
N33 *	NEF	AF	TS 23.501	IP | TCP | HTTP2 | JSON
N34 *	NSSF	NWDAF	TS 23.501	IP | TCP | HTTP2 | JSON
N35 *	UDM	UDR	TS 23.501	IP | TCP | HTTP2 | JSON
N36 *	PCF	UDR	TS 23.501	IP | TCP | HTTP2 | JSON
N37 *	NEF	UDR	TS 23.501	IP | TCP | HTTP2 | JSON
N40 *	SMF	CHF	TS 23.501	IP | TCP | HTTP2 | JSON
N50 *	AMF	CBCF	TS 23.501	IP | TCP | HTTP2 | JSON
N51 *	AMF	NEF	TS 23.501	IP | TCP | HTTP2 | JSON
N52 *	NEF	UDM	TS 23.501	IP | TCP | HTTP2 | JSON
N53 *	I-NEF	NEF	TS 23.501	IP | TCP | HTTP2 | JSON
N55 *	AMF	UCMF	TS 23.501	IP | TCP | HTTP2 | JSON
N56 *	NEF	UCMF	TS 23.501	IP | TCP | HTTP2 | JSON
N57 *	AF	UCMF	TS 23.501	IP | TCP | HTTP2 | JSON
N58 *	AMF	NSSAAF	TS 23.501	IP | TCP | HTTP2 | JSON
N59 *	UDM	NSSAAF	TS 23.501	IP | TCP | HTTP2 | JSON
N60 *	AUSF	NSWOF	TS 23 501	IP | TCP | HTTP2 | JSON
N61 *	AAnF	AUSF	TS 33.535	IP | TCP | HTTP2 | JSON
N62 *	AAnF	AF (internal)	TS 33.535	IP | TCP | HTTP2 | JSON
N63 *	AAnF	NEF	TS 33.535	IP | TCP | HTTP2 | JSON
N65 *	BSF	HSS	TS 33.220	IP | TCP | HTTP2 | JSON
N66 *	BSF	NAF	TS 33.220	IP | TCP | HTTP2 | JSON
N67 *	Push-NAF	GBA BSF	TS 29.309	IP | TCP | HTTP2 | JSON
N68 *	BSF	UDM	TS 33.220	IP | TCP | HTTP2 | JSON
N70 *	I/S-CSCF	HSS	TS 23.228	IP | TCP | HTTP2 | JSON
N71 *	AS (IMS)	HSS	TS 23.228	IP | TCP | HTTP2 | JSON
N80 *	AMF	NSACF	TS 23 501	IP | TCP | HTTP2 | JSON
N81 *	SMF	NSACF	TS 23 501	IP | TCP | HTTP2 | JSON
N82 *	NSACF	NEF	TS 23 501	IP | TCP | HTTP2 | JSON
N83 *	AUSF	NSSAAF	TS 23 501	IP | TCP | HTTP2 | JSON
N84 *	TSCTSF	PCF	TS 23 501	IP | TCP | HTTP2 | JSON
N85 *	TSCTSF	NEF	TS 23 501	IP | TCP | HTTP2 | JSON
N86 *	TSCTSF	AF	TS 23 501	IP | TCP | HTTP2 | JSON
N87 *	TSCTSF	UDR	TS 23 501	IP | TCP | HTTP2 | JSON
N88 *	SMF	EASDF	TS 23.501	IP | TCP | HTTP2 | JSON
NLg *	GMLC	AMF	TS 23.501	IP | TCP | HTTP2 | JSON
NLh *	GMLC	UDM	TS 23.501	IP | TCP | HTTP2 | JSON
NLs *	AMF	LMF	TS 23.501	IP | TCP | HTTP2 | JSON
MWu	UE	N3IWF	TS 23.501	CP IP | IPsec | Inner IP | GRE UP IP | IKEv2
PC1	ProSe application in the UE	ProSe Application Server	TS 29 555	IP | TCP | HTTP2 | JSON
PC3a	UE	5G DDNMF	TS 24.334	IP | TCP | HTTP
PC5	ProSe-enabled UE	ProSe-enabled UE	TS 24.587	PHY | MAC | RLC | PDCP | PC5
PC8 *	UE	5G PKMF	TS 29.559	Over IP
Npc2 *	ProSe Application Server	5G DDNMF	TS 29.555	IP | TCP | HTTP2 | JSON
Npc4 *	UDM	5G DDNMF	TS 23.304	IP | TCP | HTTP2 | JSON
Npc6 *	5G DDNMF (in the HPLMN)	5G DDNMF (in a Local PLMN)	TS 23.304	IP | TCP | HTTP2 | JSON
Npc7 *	5G DDNMF (in the HPLMN)	5G DDNMF (in the VPLMN)	TS 23.304	IP | TCP | HTTP2 | JSON
Npc8 *	PCF	5G DDNMF	TS 23.304	IP | TCP | HTTP2 | JSON
Npc9 *	5G PKMF	5G PKMF	TS 33.503	IP | TCP | HTTP2 | JSON
Npc10 *	5G PKMF	UDM	TS 33.503	IP | TCP | HTTP2 | JSON
Y1	UE	Non-3GPP Network	N/A	Not specified by 3GPP
Y2	Non-3GPP Network	N3IWF	N/A	Not specified by 3GPP
Uu	UE	(R)AN	TS 38 305	PHY | MAC | RLC | PDCP | RRC
Nmb1 *	MB-SMF	MBSF	TS 26.502	IP | TCP | HTTP2 | JSON
Nmb2 *	MB-SMF	AF/AS	TS 26.502	IP | TCP | HTTP2 | JSON
Nmb5 *	MBSF	NEF	TS 26.502	IP | TCP | HTTP2 | JSON
Nmb8 *	MBSTF	AF/AS	TS 26.502	IP | TCP | HTTP2 | JSON
Nmb9	MB-UPF	MBSTF	TS 26.502	IP | UDP | GTP-U
Nmb10 *	MBSF	AF/AS	TS 26.502	IP | TCP | HTTP2 | JSON
Nmb12 *	MBSF	PCF	TS 26.502	IP | TCP | HTTP2 | JSON
Nmb13 *	MB-SMF	AF/AS	TS 26.502	IP | TCP | HTTP2 | JSON
N3mb	(R)AN	MB-UPF	TS 26.502	IP | UDP | GTP-U
N4mb	MB-SMF	MB-UPF	TS 26.502	IP | TCP | HTTP2 | JSON
N6mb	MB-UPF	AF/AS	TS 26.502	IP | UDP | GTP-U
N7mb *	MB-SMF	PCF	TS 26.502	IP | TCP | HTTP2 | JSON
N11mb *	MB-SMF	MB-SMF	TS 26.502	IP | TCP | HTTP2 | JSON
N16mb *	SMF	MB-SMF	TS 26.502	IP | TCP | HTTP2 | JSON
N19mb	UPF	MB-UPF	TS 26.502	IP | UDP | GTP-U
N29mb *	MB-SMF	NEF	TS 26.502	IP | TCP | HTTP2 | JSON

5G Service-based Architecture (SBA)



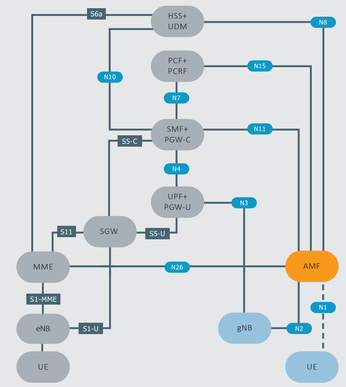
5GC Network Entities

Abbreviation	Network Function	Role
5G DDNMF	Direct Discovery Name Management Function	The logical function handling network related actions required for dynamic 5G ProSe Direct Discovery.
5G-EIR	5G-Equipment Identity Register	Enables authentication of devices in the network. Protects networks and revenues against the use of stolen and unauthorized devices.
AAnF	AKMA Anchor Function	The anchor function in the HPLMN that generates the key material to be used between the UE and the AF and maintains UE AKMA contexts.
ADRF	Analytical Data Repository Function	Stores and retrieves analytics generated by NWDAFs and other collected data.
AF	Application Function	Performs the same function as the EPC AF.
AnLF	Analytical Logical Function	Responsible for collecting the analytical request and sending the response to the consumer. AnLF requires the model endpoints, which is provided by the MTLF (Model Training Logical Function).
AKMA	Authentication and Key Management for Applications	Similar to the Generic Bootstrapping Architecture (GBA) in earlier generations, this function leverages an operator authentication infrastructure in order to secure the communication between the UE and an Application Function (AF).
AMF	Access and Mobility Management Function	Performs most of the functions that the MME performs in a 4G network.
AUSF	Authentication Server Function	Performs the authentication function of 4G HSS.
CBCF	Cell Broadcast Center Function	Supports public warning system functionality.
CCS	Convergent Charging System Function	Provides account management, rating and charging functions.
CHF	Charging Function	Allows charging services to be offered to authorized network functions
DCCF	Data Collection Coordination Function	Multiple NWDAFs may need the same raw data (the input to the NWDAF) and multiple network functions may need the same analytics data (the output of the NWDAF). To avoid duplicate requests for the same data the DCCF function coordinates these interactions.
DN	Data Network	e.g. Internet access or 3rd party services.
EASDF	Edge Application Server Discovery Function	Registers to the NRF for EASDF discovery and selection. Handles the DNS messages according to the instructions from the SMF, exchanges DNS messages from the UE. Forwards DNS messages to C-DNS or L-DNS for DNS Queries.
GMLC	Gateway Mobile Location Centre	The Gateway Mobile Location Centre (GMLC) also provides functionality required to support location-based services (LBS). The GMLC is the first node an external LBS client accesses in a PLMN. AFs and NFs may access GMLC directly or via the NEF.
I-NEF	Intermediate Network Exposure Function	Provides a mechanism for securely exposing services and features of the 5G core.
I-UPF	Network not defined by 3GPP	Examples of these are a Wi-Fi, and DSL network.
LMF	Location Management Function	The Location Management Function (LMF) supports location-based services (LBS) for a UE.
MBSF	Multicast/Broadcast Service Function	Performs service level functionality and interworking with MBMS. Interacting with AF and MB-SMF for MBS session operations, determination of transport parameters, and session transport.
MB-SMF	Multicast Broadcast Session Management Function	Handles MBS session management (including QoS control), configures the MB-UPF for multicast and broadcast data transport and allocates/de-allocates TMGIs.
MBSTF	Multicast/Broadcast Service Transport Function	Functions as a media anchor for MBS data traffic. Sources IP Multicast and generic packet transport functionalities available to any IP multicast enabled application.
MB-UPF	Multicast–Broadcast User Plane Function	Handles packet filtering of incoming downlink packets for multicast and broadcast flows. QoS enforcement (MFBR) and interactions with MB-SMF for receiving multicast and broadcast data.
MFAF	Messaging Framework Adaptor Function	The messaging framework in which the analytics or event notifications (carrying raw data for the NWDAF to process) can be distributed around the network. Its operation is not standardized by the 3GPP.
MTLF	Model Training Logical Function	AnLF requires the model endpoints, which is provided by the MTLF. The MTLF trains and deploys the model inference microservice.
N3IWF	Non-3GPP Interworking Function	Responsible for interworking between untrusted non-3GPP networks and the 5G Core.
NAF	Network Application Function	Identifies a Service-based Interface for the Application Function.

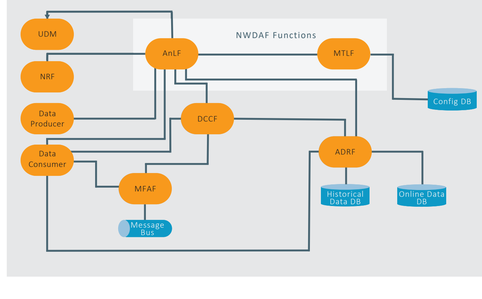
Abbreviation	Network Function	Role
NEF	Network Exposure Function	Network Slice-Specific Authentication and Authorization Function
NF	Network Function	a logical node within the network that has well-defined external interfaces and well-defined functional behavior
Non-3GPP Network	Networks not defined by 3GPP	Examples of these are a Wi-Fi, and DSL network.
NRF	Network Repository Function	Allows every network function to discover the services offered by other network functions.
NSACF	Network Slice Access Control Function	Monitors and controls the number of registered UEs per network slice and/or the number of PDU Sessions per network slice for the network slices that are subject to Network Slice Admission Control (NSAC).
NSSAAF	Network Slice-Specific Authentication and Authorization Function	Provides slice-specific authentication and authorization for a given UE. The NSSAAF acts as a NF Service Producer, while the AMF is the NF Service Consumer.
NSSF	Network Slice Selection Function	Redirects traffic to a network slice.
NSWOF	Non-Seamless WLAN Offload Function	Interfaces to the WLAN access network using the SWa interface and interfaces to the AUSF using the Nausf Service Based Interface (SBI) to support WLAN connection using 5G credentials without 5GS registration.
NWDAF	Network Data Analytics Function	Responsible for providing network analysis information upon request from network functions.
PCF	Policy Control Function	Governs the network behavior by supporting a unified policy framework. Also, provides policy rules to Control Plane functions.
PSA	PDU Session Anchor	The user plane function that terminates the N6 interface of a PDU session within a 5G core network.
RAN	Radio Access Network	Using radio technology provides access to the core network.
SCP	Service Communication Proxy	A new network function enabling dynamic scaling and management of communication and services in the 5G network. The SCP has a role similar to the Diameter Signaling Controller (DSC) in 4G.
SEPP	Security Edge Protection Proxy	Protects control plane traffic that is exchanged between different 5G operator networks.
SMF	Session Management Function	Handles management of UE sessions.
SMSF	Short Message Service Function	Supports the transfer of SMS over NAS.
TNGF	Trusted Non-3GPP Gateway Function	Enables the UE to connect to the 5G Core over WLAN access technology.
TSCTSF	Time Sensitive Communication Time Synchronization Function	TSCTSF controls the DS-TT(s) and NW-TT for the (g)PTP based time synchronization service. In addition, TSCTSF supports TSC assistance container related functionalities.
TSN AF	Time-Sensitive Networking Application Function	Stores the binding relationship between a port on UE/DS-TT side and a PDU Session during reporting of 5GS TSN bridge information. The TSN AF also stores the information about ports on the UPF/NW-TT side.
TWIF	Trusted WLAN Interworking Function	A new 5G function for interoperability with legacy devices. Some devices may support 5G SIM authentication but do not support 5G NAS signaling over trusted Wi-Fi access. TWIF contains the NAS protocol stack and exchanges NAS messages with the AMF on behalf of these types of devices.
UCMF	UE radio Capability Management Function	Allows NF service consumers to create, update and delete UCMF dictionary entries for Manufacturer-assigned UE Radio Capability IDs.
UDM	Unified Data Management	Performs parts of the 4G HSS function.
UDR	Unified Data Repository	A converged repository of subscriber information that can be used to service a number of network functions.
UDSF	Unstructured Data Storage Function	Part of the UDM entity. Network Functions (NFs) can store/retrieve "unstructured" data from an Unstructured Data Storage Function (UDSF).
UE	User Equipment	Any device used directly by an end-user to communicate (a handheld phone, laptop etc.).
UPF	User Plane Function	A combination of the data plane parts of the SGW and PGW in 4G.
W-AGT	Wireline Access Gateway Function	Enables wireline access to the 5G Core.

NWDAF, Broadcast/Multicast, and Proximity Service Architectures and Interworking between 4G and 5G

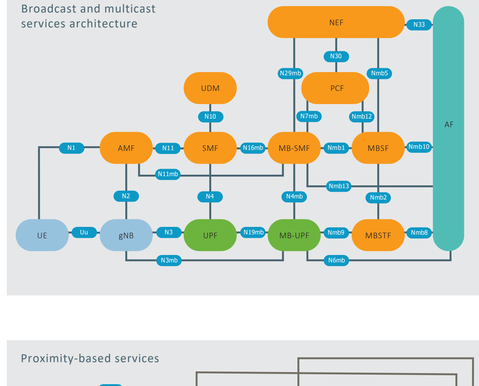
Non-roaming architecture for interworking between 4G EPC and 5G core



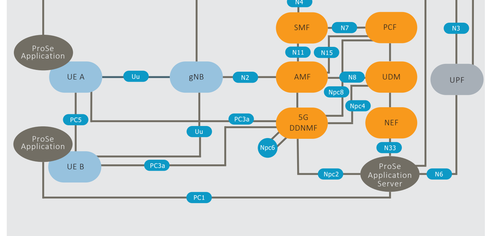
NWDAF analytics architecture



Broadcast and multicast services architecture



Proximity-based services



5G Open RAN Evolution Path

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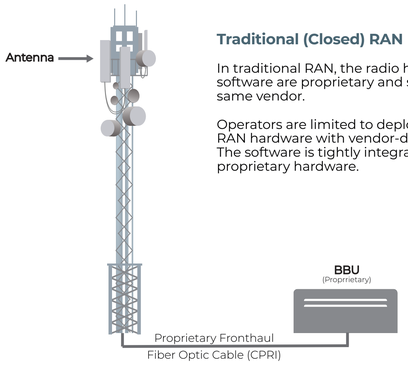
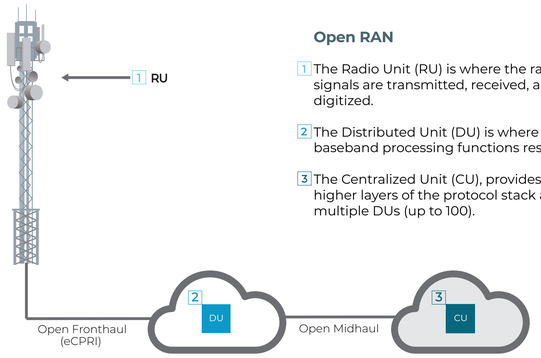
Transitioning to Open RAN



Traditional (Closed) RAN

In traditional RAN, the radio hardware and software are proprietary and supplied by the same vendor.

Operators are limited to deploying proprietary RAN hardware with vendor-defined interfaces. The software is tightly integrated with the proprietary hardware.



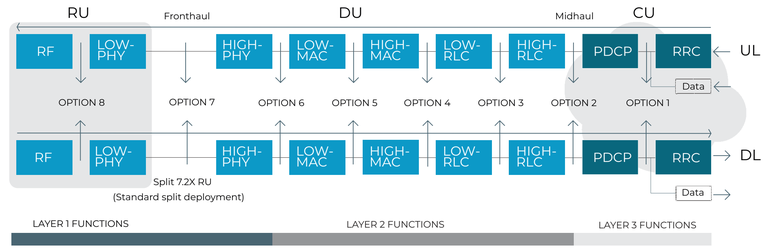
Open RAN

1 The Radio Unit (RU) is where the radio frequency signals are transmitted, received, amplified and digitized.

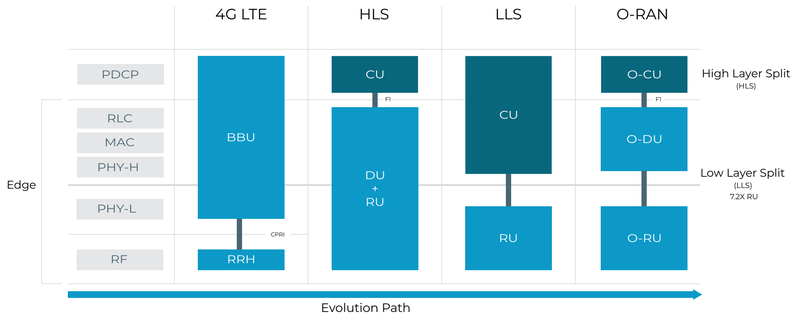
2 The Distributed Unit (DU) is where the real-time baseband processing functions reside.

3 The Centralized Unit (CU), provides support for the higher layers of the protocol stack and controls multiple DUs (up to 100).

RAN Functional Split Options for 5G



Evolution of RAN Component Split from 4G to 5G O-RAN



4G vs. 5G RAN Protocols and Specifications

3GPP Specification	4G Advanced	5G New Radio (NR)
Service Data Adaption Protocol		SDAP: 3GPP TS 37.324
Radio Resource Control	RRC: 3GPP TS 36.331	NR-RRC: 3GPP TS 38.331
Packet Data Convergence Protocol	PDCP: 3GPP TS 36.323	NR-PDCP: 3GPP TS 38.323
Radio Link Control	RLC: 3GPP TS 36.322	NR-RLC: 3GPP TS 38.322
Medium Access Control	MAC: 3GPP TS 36.321	NR-MAC: 3GPP TS 38.321
Physical Layer	PHY	NR-PHY
Physical channels and modulation	3GPP TS 36.211	3GPP TS 38.211
Multiplexing and channel coding	3GPP TS 36.212	3GPP TS 38.212
Physical layer procedures	3GPP TS 36.213	3GPP TS 38.213 (control) 3GPP TS 38.214 (data)
Physical layer measurements	3GPP TS 36.214	3GPP TS 38.215
User Equipment (UE) radio transmission and reception	3GPP TS 36.101	3GPP TS 38.101-1: Part 1: Range 1 Standalo 3GPP TS 38.101-2: Part 2: Range 2 Standalone 3GPP TS 38.101-3: Part 3: Range 1 and Range 2 Interworking operation with other radios radios 3GPP TS 38.101-4: Part 4: Performance requirements
Base Station (BS) radio transmission and reception	3GPP TS 36.104	3GPP TS 38.104
Requirements for support of radio resource management	3GPP TS 36.133	3GPP TS 38.133
Physical layer; General description	3GPP TS 36.201	3GPP TS 38.201
Services provided by the physical layer	3GPP TS 36.302	3GPP TS 38.202
User Equipment (UE) procedures in idle mode	3GPP TS 36.304	3GPP TS 38.304
Multi-RAT Co-Existence	3GPP TR 37.872: Supplementary uplink (SUL) and LTE-NR co-existence	

Acronyms

Acronym/Abbreviation	Description
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
AMF	Access and Mobility Management Function
AS	Access Stratum
AWGN	Additive White Gaussian Noise
BHR	Backhaul Rate
BM-SC	Broadcast Multicast Service Center
BS	Base Station
BSS	Business Support System
BW	Bandwidth
BWP	Bandwidth Part
CA	Carrier Aggregation
CBRS	Citizens Broadband Radio Service
CC	Component Carrier
CoMP	Coordinated Multipoint
CP	Control Plane
CP-OFDM	Cyclic Prefix-OFDM
CPRI	Common Public Radio Interface
CU	Central Unit
CUPS	Control and User Plane Seperation
CW	Continuous Wave
DC	Data Center
DFT-s-OFDM	Discrete Fourier Transform-spread-OFDM
DL	Downlink
DN	Data Network
DU	Distributed Unit
eCPRI	Enhanced Common Public Radio Interface
eMBB	Enhanced Mobile Broadband
EN-DC	E-UTRA-NR Dual Connectivity
EPC	Evolved Packet Core
EPS	Evolved Packet System
FDD	Frequency Division Duplex
FFT	Fast Fourier Transform
FR	Frequency Range
gNB	gNodeB (5G NR Base Station)
HLS	Higher Layer Split
LDPC	Low Density Parity Check
LLS	Lower Layer Split
MAC	Medium Access Control
MBMS	Multimedia Broadcast Multicast Service
MBMS-GW	MBMS Gateway
MIMO	Multiple-Input Multiple-Output
MME	Mobility Management Entity
mMTC	Massive Machine Type Communication
mmWave	Millimeter-wave
MN	Master Node
NAS	Non-Access Stratum
NB-IoT	Narrow Band Internet of Things

Legend

High-band 5G (mmWave)
24 GHz, 28 GHz, 37 GHz, 39 GHz and 47 GHz bands.

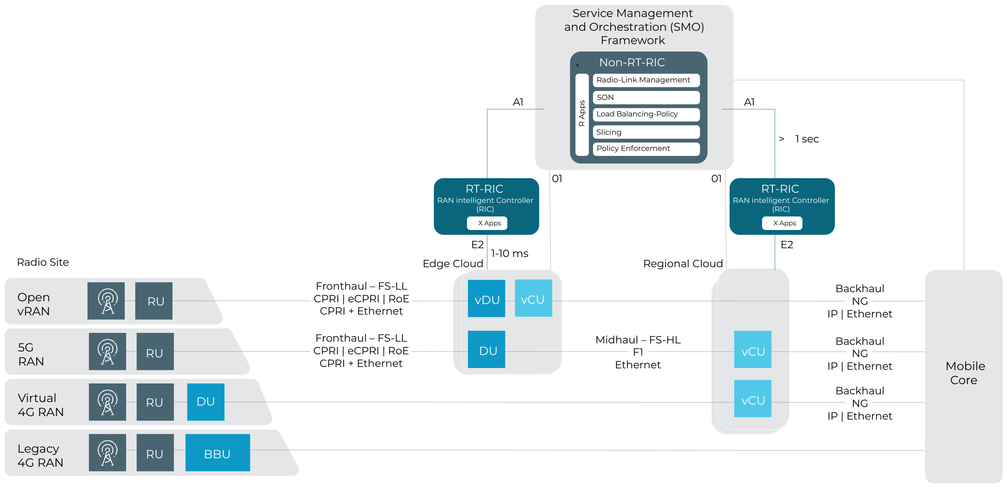
Mid-band 5G
Sub-6 (1-6) GHz spectrum, ranging from 2.5 GHz, 3.5 GHz and 3.7 GHz to 4.2 GHz bands

Low-band 5G
600 MHz, 700 MHz, 800 MHz and 900 MHz bands

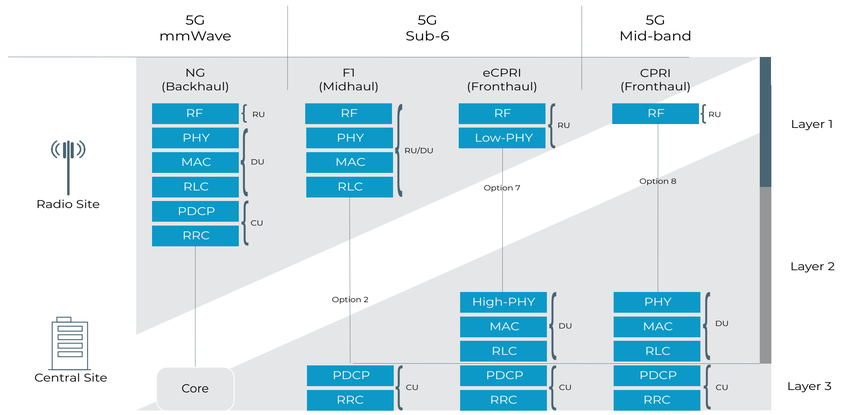
Delivering 5G with Low, Mid and High Band Spectrum

Private wireless network			Public wireless network				
Private Entities	Sports Facility	Shopping Mall	City	Residential Area	Train Station	Airport	Rural Area

Transition from 4G to Open RAN



Protocol Stack by Band Distribution



Fronthaul					
Data Rate (Fiber connection)	10 Gbps	10 Gbps	100 Gbps	1 Tbps
Latency	< 10 ms	< 5 ms	< 200 µs	< 100 us
Distance	200-500 km	100-400 km	< 20 km	< 10 km