

ETSI TS 138 401 V17.1.1 (2022-08)



**5G;
NG-RAN;
Architecture description
(3GPP TS 38.401 version 17.1.1 Release 17)**

[ETSI TS 138 401 V17.1.1 \(2022-08\)](https://standards.iteh.ai/catalog/standards/sist/05c230a8-b49f-42b6-b9a1-b705d0419bf4/etsi-ts-138-401-v17-1-1-2022-08)

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Reference

RTS/TSGR-0338401vh11

Keywords

5G

ETSI

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Contents

Intellectual Property Rights	2
Legal Notice	2
Modal verbs terminology.....	2
Foreword.....	7
1 Scope	8
2 References	8
3 Definitions and abbreviations.....	9
3.1 Definitions.....	9
3.2 Abbreviations	11
4 General principles	12
5 General architecture	12
5.1 General	12
5.2 User plane.....	13
5.3 Control plane	13
6 NG-RAN architecture.....	14
6.1 Overview	14
6.1.1 Overall Architecture of NG-RAN.....	14
6.1.2 Overall architecture for separation of gNB-CU-CP and gNB-CU-UP	15
6.1.3 Overall Architecture of IAB	16
6.1.4 Protocol stacks of IAB	17
6.1.5 Overall Architecture of NR MBS	19
6.1.6 Protocol stacks of L2 UE-to-Network Relay	19
6.2 NG-RAN identifiers	20
6.2.1 Principle of handling Application Protocol Identities.....	20
6.2.2 gNB-DU ID	22
6.2.3 ng-eNB-DU ID	22
6.2.4 gNB-CU-UP ID	22
6.3 Transport addresses	22
6.4 UE associations in NG-RAN Node	23
6.5 MBS Session associations in NG-RAN Node	24
7 NG-RAN functions description.....	25
7.0 General	25
7.1 NG-RAN sharing.....	25
7.2 Remote Interference Management	25
7.3 Cross-Link Interference Management	25
7.4 Support for Non-Public Networks.....	25
7.5 RACH Optimisation Function.....	25
7.6 Positioning.....	25
7.7 Support for NR MBS.....	26
7.7.1 Support of dynamic PTP and PTM switching.....	26
7.8 PCI Optimisation Function.....	26
7.9 Support for CCO	26
7.9.1 General.....	26
7.9.2 OAM requirements	26
7.9.3 Dynamic coverage configuration changes	26
7.10 Support of RAN visible QoE measurement.....	26
8 Overall procedures in gNB-CU/gNB-DU Architecture	27
8.1 UE Initial Access.....	27
8.2 Intra-gNB-CU Mobility.....	28
8.2.1 Intra-NR Mobility	28
8.2.1.1 Inter-gNB-DU Mobility	28

8.2.1.2	Intra-gNB-DU handover	30
8.2.1.3	Inter-gNB-DU Conditional Handover or Conditional PSCell Change.....	30
8.2.2	EN-DC Mobility	32
8.2.2.1	Inter-gNB-DU Mobility using MCG SRB	32
8.2.2.2	Inter-gNB-DU Mobility using SCG SRB (SRB3)	34
8.2.2.3	Inter-gNB-DU Conditional PSCell Change using MCG SRB without MN negotiation.....	34
8.2.3	Intra-CU topology adaptation procedure	36
8.2.3.1	Intra-CU topology adaptation procedure in SA.....	36
8.2.3.2	Intra-CU topology adaptation procedure in NSA using MCG SRB.....	39
8.2.3.3	Intra-CU topology adaptation procedure in NSA using SCG SRB (SRB3).....	41
8.2.4	Intra-CU topological redundancy procedure.....	41
8.2.5	Intra-CU Backhaul RLF recovery for IAB-nodes in SA mode.....	44
8.3	Mechanism of centralized retransmission of lost PDUs.....	45
8.3.1	Centralized Retransmission in Intra gNB-CU Cases	45
8.4	Multi-Connectivity operation	46
8.4.1	Secondary Node Addition.....	46
8.4.1.1	EN-DC	46
8.4.2	Secondary Node Release (MN/SN initiated)	47
8.4.2.1	EN-DC	47
8.4.3	SCG suspend/resume in RRC_INACTIVE	48
8.4.4	SCG Deactivation and Activation.....	49
8.4.4.1	SN Addition with SCG Activation or Deactivation	50
8.4.4.2	MN initiated SN Modification with SCG Activation or Deactivation	51
8.4.4.3	SN initiated SN Modification with SCG Activation or Deactivation.....	52
8.5	F1 Startup and cells activation	52
8.6	RRC state transition.....	54
8.6.1	RRC connected to RRC inactive.....	54
8.6.2	RRC inactive to other states.....	54
8.7	RRC connection reestablishment	56
8.8	Multiple TNLAs for F1-C	58
8.9	Overall procedures involving E1 and F1	59
8.9.1	UE Initial Access	59
8.9.2	Bearer context setup over F1-U	60
8.9.3	Bearer context release over F1-U	61
8.9.3.1	gNB-CU-CP initiated bearer context release	61
8.9.3.2	gNB-CU-UP initiated bearer context release	62
8.9.4	Inter-gNB handover involving gNB-CU-UP change	63
8.9.5	Change of gNB-CU-UP	65
8.9.6	RRC State transition	66
8.9.6.1	RRC Connected to RRC Inactive.....	66
8.9.6.2	RRC Inactive to other states.....	67
8.9.7	Trace activation/deactivation over F1 and E1.....	69
8.9.8	BH RLC channel establishment procedure.....	69
8.9.9	Traffic Mapping.....	71
8.9.9.1	Traffic Mapping from IP-layer to Layer-2	71
8.9.9.2	BH RLC Channel Mapping on BAP Layer.....	71
8.9.10	IAB-node release	71
8.9.10.1	IAB-node orderly release	72
8.9.10.2	IAB-node disorderly release.....	72
8.9.11	IAB-node OAM	72
8.9.12	Handling of IAB-MTs in INACTIVE State.....	72
8.9.13	IP Address Allocation for IAB-nodes.....	72
8.10	Multiple TNLAs for E1	73
8.11	Support of Network Sharing with multiple cell-ID broadcast.....	75
8.11.1	General.....	75
8.11.2	Initial Registration – separate PLMN signalling.....	75
8.11.3	RRC Connection Reestablishment – separate PLMN signalling.....	76
8.11.4	Support of shared signalling transport	77
8.12	IAB-node Integration Procedure	77
8.12.1	Standalone IAB integration	77
8.12.2	NSA IAB Integration procedure	78
8.13	Overall procedures for MDT	80

8.13.0	General.....	80
8.13.1	Signalling based MDT activation	80
8.13.2	Management based MDT activation	80
8.13.2.1	General	80
8.13.2.2	Management based MDT Activation in gNB-CU-CP.....	81
8.13.2.3	Management based MDT Activation in gNB-DU.....	81
8.13.2.4	Management based MDT Activation in gNB-CU-UP	82
8.13.2.5	User consent propagation in EN-DC.....	83
8.13.2.6	User consent propagation in MR-DC with 5GC	84
8.13.2.7	Management based trace activation in MR-DC with 5GC.....	85
8.13.3	Alignment of MDT and QoE Measurements	86
8.13.4	MDT reporting.....	86
8.14	Self-optimisation	86
8.14.1	Overall procedures for MRO	86
8.14.1.1	Signalling of RLF information from gNB-CU to gNB-DU	87
8.14.1.2	Signalling of RACH information from gNB-CU to gNB-DU	87
8.15	Overall procedures for NR MBS.....	88
8.15.1	General.....	88
8.15.1.1	Broadcast MBS Session Setup	88
8.15.1.2	Multicast MBS Session Context Establishment	89
8.16	Overall procedures for CPAC	91
8.16.1	MN initiated Conditional PSCell Addition.....	91
8.16.2	MN initiated conditional SN Change.....	91
8.16.3	SN initiated conditional inter-SN Change	92
8.17	IAB Inter-CU Topology Management	92
8.17.1	IAB Inter-donor-DU Re-routing	92
8.17.2	IAB Inter-CU Topology Redundancy.....	92
8.17.2.1	IAB Inter-CU topological redundancy procedure	92
8.17.3	IAB Inter-CU Topology Adaptation.....	95
8.17.3.1	IAB inter-CU topology adaptation procedure	95
8.17.3.2	IAB inter-CU topology adaptation procedure with descendant IAB-node.....	98
8.17.4	IAB Inter-CU Backhaul RLF recovery for single connected IAB-node.....	100
8.18	Overall procedure for Small Data Transmission during RRC Inactive	103
8.18.1	RACH based SDT.....	103
8.18.2	CG based SDT	104
8.18.3	RA-SDT or non-SDT with CG-SDT configuration	105
8.19	Overall procedures for L2 UE-to-Network Relay	106
8.19.1	Remote UE initial access	106
8.19.2	Remote UE RRC Reestablishment	109
8.19.3	Remote UE RRC Inactive to other states.....	111
8.19.4	Service Continuity for L2 U2N relay.....	113
8.19.4.1	Inter-gNB-DU switch from direct to indirect path	113
8.19.4.2	Intra-gNB-DU switch from direct to indirect path.....	115
8.20	Void.....	116
9	Synchronization.....	116
9.1	gNB Synchronization	116
10	NG-RAN interfaces.....	117
10.1	NG interface	117
10.2	Xn interface	117
10.3	F1 interface.....	117
10.4	E1 interface	117
10.5	Antenna interface - general principles.....	117
11	Overall procedures in NG-RAN Architecture	118
11.1	Multiple TNLAs for Xn-C	118
Annex A (informative):	Deployment scenarios of gNB/en-gNB	119
Annex B:	NG-RAN Architecture for Radio Access Network Sharing with multiple cell ID broadcast (informative).....	120

Annex C (informative):	
Change History	121
History	124

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1 Scope

The present document describes the overall architecture of the NG-RAN, including interfaces NG, Xn and F1 interfaces and their interaction with the radio interface.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 38.300: "NR; Overall description; Stage-2".
- [3] 3GPP TS 23.501: "System Architecture for the 5G System".
- [4] 3GPP TS 38.473: "NG-RAN; F1 application protocol (F1AP)".
- [5] 3GPP TS 38.414: "NG-RAN; NG data transport".
- [6] 3GPP TS 38.424: "NG-RAN; Xn data transport".
- [7] 3GPP TS 38.474: "NG-RAN; F1 data transport". (2022-08)
- [8] ITU-T Recommendation G.823 (2000-03): "The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy".
<https://standards.iteh.ai/catalog/standards/sist/05c23303-8b49642b6-b9a1-4709a102-1-2022-08>
- [9] ITU-T Recommendation G.824 (2000-03): "The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy".
- [10] ITU-T Recommendation G.825 (2001-08): "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)".
- [11] ITU-T Recommendation G.8261/Y.1361 (2008-04): "Timing and Synchronization aspects in Packet networks".
- [12] 3GPP TS 37.340: "NR; Multi-connectivity; Overall description; Stage-2".
- [13] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System".
- [14] 3GPP TS 38.410: "NG-RAN; NG general aspect and principles".
- [15] 3GPP TS 38.420: "NG-RAN; Xn general aspects and principles".
- [16] 3GPP TS 38.470: "NG-RAN; F1 general aspects and principles".
- [17] 3GPP TS 38.460: "NG-RAN; E1 general aspects and principles".
- [18] 3GPP TS 33.210: "3G security; Network Domain Security (NDS); IP Network Layer Security".
- [19] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA), Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".
- [20] 3GPP TS 32.422: "Trace control and configuration management".

- [21] 3GPP TS 37.470: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and NG-RAN; W1 general aspects and principles; Stage-2".
- [22] 3GPP TS 38.340: "NR; Backhaul Adaptation Protocol (BAP) specification".
- [23] 3GPP TS 38.331: "NR; Radio Resource Control (RRC) protocol specification".
- [24] 3GPP TS 38.425: "NG-RAN; NR user plane Protocol".
- [25] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".
- [26] 3GPP TS 38.472: "NG-RAN; F1 signalling transport".
- [27] 3GPP TS 23.247: " Architectural enhancements for 5G multicast-broadcast services; Stage 2".
- [28] 3GPP TS 36.401: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Architecture Description".
- [29] IETF RFC 4555 (2006-06): "RFC IKEv2 Mobility and Multihoming Protocol (MOBIKE)".
- [30] 3GPP TS 38.321 "NR; Medium Access Control (MAC) protocol specification".
- [31] 3GPP TS 37.320: "Radio measurement collection for Minimization of Drive Tests (MDT); Overall description; Stage 2".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Associated QoS Flow: as defined in TS 23.247 [27].

Associated QoS flow information: Information encompassing: QoS flow QoS parameters for associated QoS flows and mapping information between mapped (unicast) QoS flows and associated QoS flows. The respective information is included in a way that non-supporting RAN nodes would not establish respective RAN resources irrespective the multicast session state.

Boundary IAB-node: an IAB-node with one RRC interface terminating at a different IAB-donor-CU than the F1 interface. This definition applies to partial migration, inter-donor redundancy and inter-donor RLF recovery.

Conditional Handover: as defined in TS 38.300 [2].

Conditional PSCell Addition: as defined in TS 37.340 [12].

Conditional PSCell Change: as defined in TS 37.340 [12].

DAPS Handover: as defined in TS 38.300 [2].

eNB-CP: as defined in TS 36.401 [28].

eNB-UP: as defined in TS 36.401 [28].

en-gNB: as defined in TS 37.340 [12].

Early Data Forwarding: as defined in TS 38.300 [2].

F1-terminating IAB-donor of boundary IAB-node: Refers to the IAB-donor that terminates F1 for the boundary IAB-node.

gNB: as defined in TS 38.300 [2].

gNB Central Unit (gNB-CU): a logical node hosting RRC, SDAP and PDCP protocols of the gNB or RRC and PDCP protocols of the en-gNB that controls the operation of one or more gNB-DUs. The gNB-CU terminates the F1 interface connected with the gNB-DU.

gNB Distributed Unit (gNB-DU): a logical node hosting RLC, MAC and PHY layers of the gNB or en-gNB, and its operation is partly controlled by gNB-CU. One gNB-DU supports one or multiple cells. One cell is supported by only one gNB-DU. The gNB-DU terminates the F1 interface connected with the gNB-CU. For DC operation, the MgNB-DU designates the gNB-DU of an en-gNB or a gNB acting as master node, and the SgNB-DU designates the gNB-DU of an en-gNB or a gNB acting as secondary node.

gNB-CU-Control Plane (gNB-CU-CP): a logical node hosting the RRC and the control plane part of the PDCP protocol of the gNB-CU for an en-gNB or a gNB. The gNB-CU-CP terminates the E1 interface connected with the gNB-CU-UP and the F1-C interface connected with the gNB-DU. For DC operation, the MgNB-CU-CP designates the gNB-CU-CP of the gNB-CU for an en-gNB or a gNB acting as master node, and the SgNB-CU-CP designates the gNB-CU-CP of the gNB-CU for an en-gNB or a gNB acting as secondary node.

gNB-CU-User Plane (gNB-CU-UP): a logical node hosting the user plane part of the PDCP protocol of the gNB-CU for an en-gNB, and the user plane part of the PDCP protocol and the SDAP protocol of the gNB-CU for a gNB. The gNB-CU-UP terminates the E1 interface connected with the gNB-CU-CP and the F1-U interface connected with the gNB-DU. For DC operation, the MgNB-CU-UP designates the gNB-CU-UP of the gNB-CU for an en-gNB or a gNB acting as master node, and the SgNB-CU-UP designates the gNB-CU-UP of the gNB-CU for an en-gNB or a gNB acting as secondary node.

IAB-node: as defined in TS 38.300 [2].

IAB-donor: as defined in TS 38.300 [2].

IAB-donor-CU: the gNB-CU of an IAB-donor, terminating the F1 interface towards IAB-nodes and IAB-donor-DU.

IAB-donor-DU: the gNB-DU of an IAB-donor, hosting the IAB BAP sublayer (as defined in TS 38.340 [22]), providing wireless backhaul to IAB-nodes.

IAB-DU: as defined in TS 38.300 [2].

IAB-MT: as defined in TS 38.300 [2].

IAB Topology: as defined in TS 38.300 [2].

Mapped QoS flows: Unicast QoS flows requested to be established, i.e. included in the legacy QoS flow lists in a way, that non-support RAN nodes would attempt to establish unicast QoS flows and supporting RAN nodes can identify them as mapped QoS flows based on the associated QoS information.

Master node: as defined in TS 37.340 [12].

Master gNB: see TS 37.340 [12].

ng-eNB: as defined in TS 38.300 [2].

ng-eNB Central Unit (ng-eNB-CU): as defined in TS 37.470 [21].

ng-eNB Distributed Unit (ng-eNB-DU): as defined in TS 37.470 [21].

ng-eNB-CU-Control Plane (ng-eNB-CU-CP): a logical node hosting the RRC and the control plane part of the PDCP protocol of the ng-eNB-CU for an ng-eNB. The ng-eNB-CU-CP terminates the E1 interface connected with the ng-eNB-CU-UP and the W1-C interface connected with the ng-eNB-DU.

ng-eNB-CU-User Plane (ng-eNB-CU-UP): a logical node hosting the user plane part of the PDCP protocol and the SDAP protocol of the ng-eNB-CU for an ng-eNB. The ng-eNB-CU-UP terminates the E1 interface connected with the ng-eNB-CU-CP and the W1-U interface connected with the ng-eNB-DU.

NG-RAN node: as defined in TS 38.300 [2].

Non-F1-terminating IAB-donor of boundary IAB-node: Refers to the IAB-donor that has an RRC connection with the boundary node but does not terminate F1 with this boundary node.

PDU Session Resource: This term is used for specification of NG, Xn, and E1 interfaces. It denotes NG-RAN interface and radio resources provided to support a PDU Session.

Public Network Integrated NPN: as defined in TS 23.501 [3].

Secondary gNB: see TS 37.340 [12].

Stand-alone Non-Public Network: as defined in TS 23.501 [3].

U2N Relay UE: as defined in TS 38.300 [2].

U2N Remote UE: as defined in TS 38.300 [2].

3.2 Abbreviations

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

5GC	5G Core Network
AMF	Access and Mobility Management Function
AP	Application Protocol
AS	Access Stratum
BH	Backhaul
CAG	Closed Access Group
CHO	Conditional Handover
CLI	Cross-Link Interference
CM	Connection Management
CMAS	Commercial Mobile Alert Service
CPA	Conditional PSCell Addition
CPC	Conditional PSCell Change
DAPS	Dual Active Protocol Stack
EM	Element Manager
EN-DC	E-UTRA-NR Dual Connectivity
ETWS	Earthquake and Tsunami Warning System
F1-U	F1 User plane interface
F1-C	F1 Control plane interface
F1AP	F1 Application Protocol
FDD	Frequency Division Duplex
FTEID	Fully Qualified TEID
GTP-U	GPRS Tunnelling Protocol
IAB	Integrated Access and Backhaul
IP	Internet Protocol
L2	Layer-2
MBS	Multicast Broadcast Service
MCG	Master Cell Group
MDT	Minimization of Drive Tests
MN	Master Node
MgNB	Master gNB
MRB	MBS Radio Bearer
MRDC	Multi-Radio Dual Connectivity
NAS	Non-Access Stratum
NID	Network identifier
NPN	Non-Public Network
NSA	Non Standalone
OAM	Operation, Administration and Maintenance
PNI-NPN	Public Network Integrated Non-Public Network
PTP	Point to Point
PTM	Point to Multipoint
PWS	Public Warning System
QoE	Quality of Experience
QoS	Quality of Service
RET	Remote Electrical Tilting

RIM	Remote Interference Management
RIM-RS	Remote Interference Management Reference Signal
RNL	Radio Network Layer
RRC	Radio Resource Control
SA	Standalone
SAP	Service Access Point
SCG	Secondary Cell Group
SCTP	Stream Control Transmission Protocol
SFN	System Frame Number
SgNB	Secondary gNB
SM	Session Management
SMF	Session Management Function
SN	Secondary Node
SNPN	Stand-alone Non-Public Network
SRAP	Sidelink Relay Adaptation Protocol
TCE	Trace Collection Entity
TDD	Time Division Duplex
TDM	Time Division Multiplexing
TEID	Tunnel Endpoint Identifier
TMA	Tower Mounted Amplifier
TNL	Transport Network Layer
U2N	UE-to-Network

4 General principles

The general principles guiding the definition of NG-RAN architecture as well as the NG-RAN interfaces are the following:

- Logical separation of signalling and data transport networks.
- NG-RAN and 5GC functions are fully separated from transport functions. Addressing scheme used in NG-RAN and 5GC shall not be tied to the addressing schemes of transport functions. The fact that some NG-RAN or 5GC functions reside in the same equipment as some transport functions does not make the transport functions part of the NG-RAN or the 5GC.
- Mobility for an RRC connection is fully controlled by the NG-RAN.
- The NG-RAN interfaces are defined along the following principles:
 - The functional division across the interfaces have as few options as possible.
 - Interfaces are based on a logical model of the entity controlled through this interface.
 - One physical network element can implement multiple logical nodes.

5 General architecture

5.1 General

The protocols over Uu and NG interfaces are divided into two structures:

- **User plane protocols**

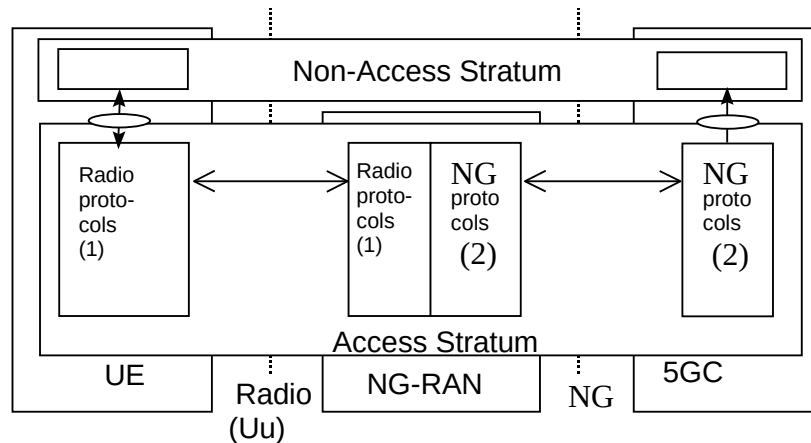
These are the protocols implementing the actual PDU Session service, i.e. carrying user data through the access stratum.

- **Control plane protocols**

These are the protocols for controlling the PDU Sessions and the connection between the UE and the network from different aspects (including requesting the service, controlling different transmission resources, handover etc.). Also a mechanism for transparent transfer of NAS messages is included.

5.2 User plane

The PDU Session Resource service is offered from SAP to SAP by the Access Stratum. Figure 5.2-1 shows the protocols on the Uu and the NG interfaces that linked together provide this PDU Session Resource service.



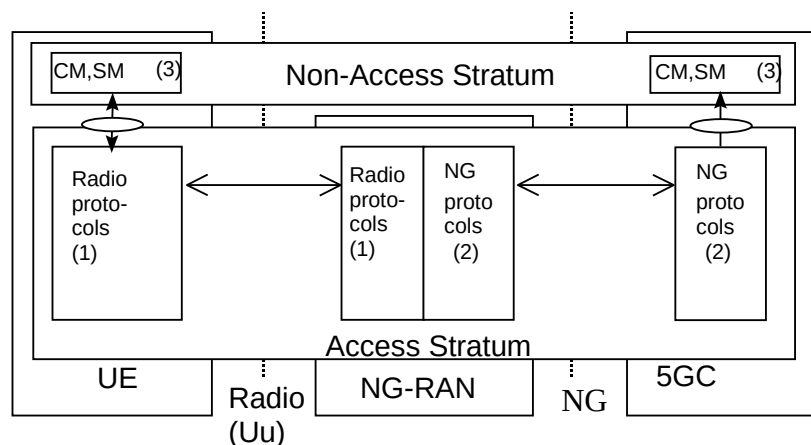
NOTE 1: The radio interface protocols are defined in TS 38.2xx and TS 38.3xx.

NOTE 2: The NG interface protocols are defined in TS 38.41x.

Figure 5.2-1: NG and Uu user plane

5.3 Control plane

Figure 5.3-1 shows the control plane (signalling) protocol stacks on NG and Uu interfaces.



NOTE 1: The radio interface protocols are defined in TS 38.2xx and TS 38.3xx.

NOTE 2: The protocol is defined in TS 38.41x. (Description of NG interface).

NOTE 3: CM, SM: This exemplifies a set of NAS control protocols between UE and 5GC. The evolution of the protocol architecture for these protocols is outside the scope of the present document.

Figure 5.3-1: NG and Uu control plane

NOTE: Both the Radio protocols and the NG protocols contain a mechanism to transparently transfer NAS messages.

6 NG-RAN architecture

6.1 Overview

6.1.1 Overall Architecture of NG-RAN

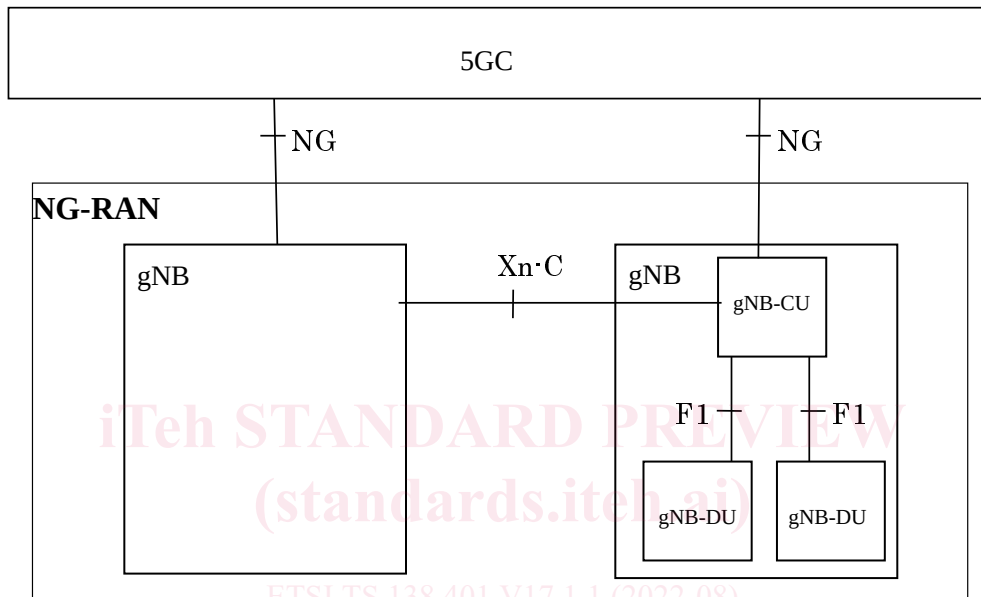


Figure 6.1-1: Overall architecture

The NG-RAN consists of a set of gNBs connected to the 5GC through the NG interface.

NOTE: As specified in TS 38.300 [2], NG-RAN could also consist of a set of ng-eNBs, an ng-eNB may consist of an ng-eNB-CU and one or more ng-eNB-DU(s). An ng-eNB-CU and an ng-eNB-DU is connected via W1 interface. The general principle described in this clause also applies to ng-eNB and W1 interface, if not explicitly specified otherwise.

An gNB can support FDD mode, TDD mode or dual mode operation.

gNBs can be interconnected through the Xn interface.

A gNB may consist of a gNB-CU and one or more gNB-DU(s). A gNB-CU and a gNB-DU is connected via F1 interface.

One gNB-DU is connected to only one gNB-CU.

NOTE: In case of network sharing with multiple cell ID broadcast, each Cell Identity associated with a subset of PLMNs corresponds to a gNB-DU and the gNB-CU it is connected to, i.e. the corresponding gNB-DUs share the same physical layer cell resources.

NOTE: For resiliency, a gNB-DU may be connected to multiple gNB-CUs by appropriate implementation.

NG, Xn and F1 are logical interfaces.

For NG-RAN, the NG and Xn-C interfaces for a gNB consisting of a gNB-CU and gNB-DUs, terminate in the gNB-CU. For EN-DC, the S1-U and X2-C interfaces for a gNB consisting of a gNB-CU and gNB-DUs, terminate in the gNB-CU. The gNB-CU and connected gNB-DUs are only visible to other gNBs and the 5GC as a gNB. A possible deployment scenario is described in Annex A.