

**3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
NG-RAN;
Architecture description
(Release 15)**



The present document has been developed within the 3rd Generation Partnership Project (3GPP™) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPP Organizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPP only. The Organizational Partners accept no liability for any use of this Specification. Specifications and reports for implementation of the 3GPP™ system should be obtained via the 3GPP Organizational Partners' Publications Offices.

Keywords

NG-RAN, Radio**3GPP**

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

<http://www.3gpp.org>

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© 2017, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).
All rights reserved.

UMTS™ is a Trade Mark of ETSI registered for the benefit of its members

3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners

LTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners

GSM® and the GSM logo are registered and owned by the GSM Association

Contents

Foreword	4
1 Scope	5
2 References	5
3 Definitions and abbreviations	6
3.1 Definitions	6
3.2 Abbreviations	6
4 General principles	7
5 General architecture	7
5.1 General	7
5.2 User plane	7
5.3 Control plane	8
6 NG-RAN architecture	9
6.1 Overview	9
6.2 NG-RAN identifiers	10
6.2.1 Principle of handling Application Protocol Identities	10
6.2.2 gNB-DU ID	11
6.3 Transport addresses	11
6.4 UE associations in NG-RAN Node	11
7 NG-RAN functions description	12
7.0 General	12
7.1 Void	12
8 Overall procedures in gNB-CU/gNB-DU Architecture	12
8.1 Void	12
8.2 Intra-gNB-CU Mobility	12
8.2.1 Intra-NR Mobility	12
8.2.1.1 Inter-gNB-DU Mobility	12
8.2.1.2 Intra-gNB-DU inter-cell mobility	14
8.2.2 EN-DC Mobility	14
8.2.2.1 Inter-gNB-DU Mobility using MCG SRB	14
8.2.2.2 Inter-gNB-DU Mobility using SCG SRB	15
8.3 Mechanism of centralized retransmission of lost PDUs	15
8.3.1 Centralized Retransmission in Intra gNB-CU Cases	15
8.4 Multi-Connectivity operation	17
8.4.1 Secondary Node Addition	17
8.4.1.1 EN-DC	17
8.4.2 Secondary Node Release (MN/SN initiated)	17
8.4.2.1 EN-DC	17
8.5 F1 Startup and cells activation	19
8.6 Void	19
9 Synchronization	20
9.1 gNB Synchronization	20
10 NG-RAN interfaces	20
10.1 NG interface	20
10.2 Xn interface	20
10.3 F1 interface	21
Annex A (informative): Deployment scenarios of gNB/en-gNB	22
Annex B (informative): Change History	23

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

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".
- [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".
- [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".

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].

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

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.

NG-RAN node: 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
CM	Connection Management
CMAS	Commercial Mobile Alert Service
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
GTP-U	GPRS Tunnelling Protocol
IP	Internet Protocol
NAS	Non-Access Stratum
O&M	Operation and Maintenance
PWS	Public Warning System
QoS	Quality of Service
RNL	Radio Network Layer
RRC	Radio Resource Control
SAP	Service Access Point
SCTP	Stream Control Transmission Protocol
SFN	System Frame Number
SM	Session Management
SMF	Session Management Function
TDD	Time Division Duplex
TDM	Time Division Multiplexing
TNL	Transport Network Layer

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**

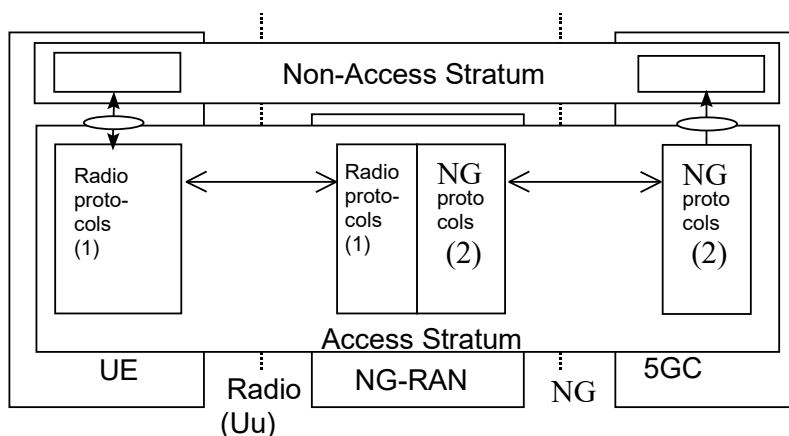
These are the protocols implementing the actual PDU Session service, i.e. carrying user data through the access stratum.

- **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.



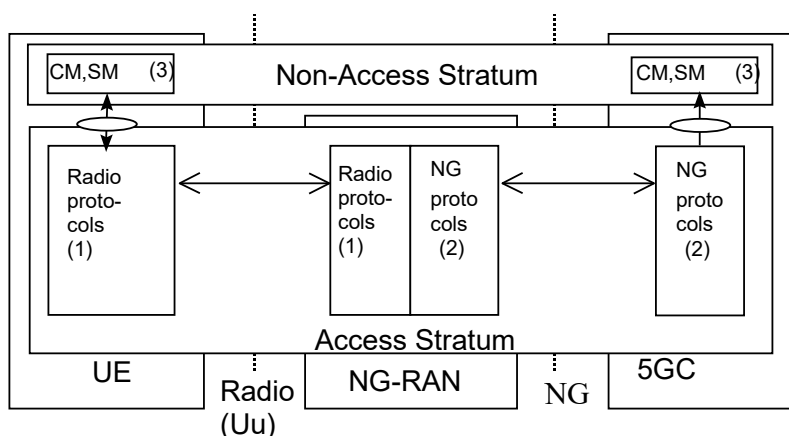
NOTE 1: The radio interface protocols are defined in 3GPP TS 38.2xx and TS 38.3xx.

NOTE 2: The NG interface protocols are defined in 3GPP 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 3GPP TS 38.2xx and TS 38.3xx.

NOTE 2: The protocol is defined in 3GPP 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

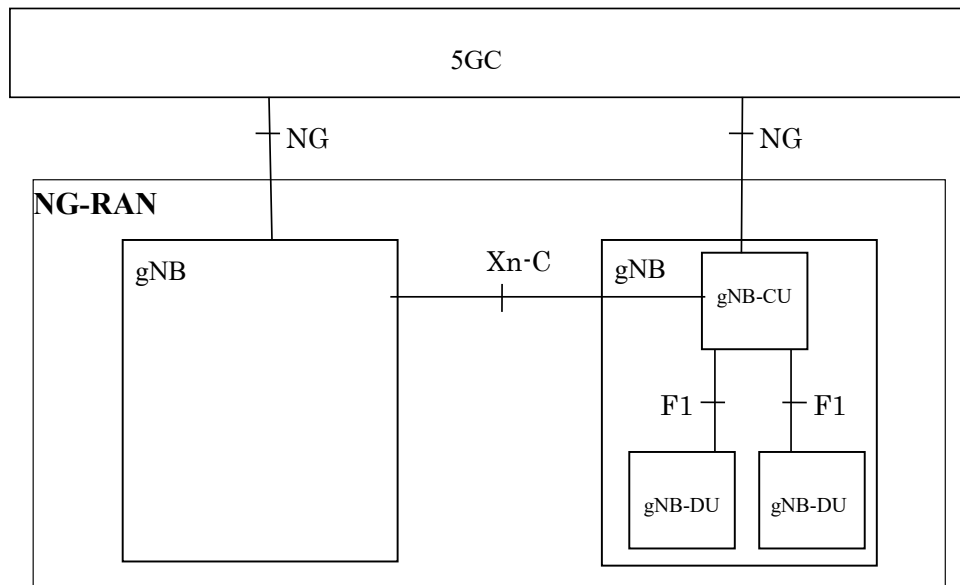


Figure 6.1-1: Overall architecture

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

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: For resiliency, a gNB-DU may be connected to multiple gNB-CU 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.

The NG-RAN is layered into a Radio Network Layer (RNL) and a Transport Network Layer (TNL).

The NG-RAN architecture, i.e. the NG-RAN logical nodes and interfaces between them, is defined as part of the RNL.

For each NG-RAN interface (NG, Xn, F1) the related TNL protocol and the functionality are specified. The TNL provides services for user plane transport, signalling transport.

In NG-Flex configuration, each gNB is connected to all AMFs within an AMF Region. The AMF Region is defined in 3GPP TS 23.501 [3].

If security protection for control plane and user plane data on TNL of NG-RAN interfaces has to be supported, NDS/IP 3GPP TS 33.501 [13] shall be applied.

6.2 NG-RAN identifiers

6.2.1 Principle of handling Application Protocol Identities

An Application Protocol Identity (AP ID) is allocated when a new UE-associated logical connection is created in either an NG-RAN node or an AMF. An AP ID shall uniquely identify a logical connection associated to a UE over the NG interface or Xn interface within a node (NG-RAN node or AMF) or over the F1 interface. Upon receipt of a message that has a new AP ID from the sending node, the receiving node shall store the AP ID of the sending node for the duration of the logical connection. The receiving node shall assign the AP ID to be used to identify the logical connection associated to the UE and include it as well as the previously received new AP ID from the sending node, in the first returned message to the sending node. In all subsequent messages to and from sending node, both AP IDs of sending node and receiving node shall be included.

The definitions of AP IDs as used on NG interface or Xn interface or F1 interface are shown below:

RAN UE NGAP ID:

ARAN UE NGAP ID shall be allocated so as to uniquely identify the UE over the NG interface within an gNB. When an AMF receives an RAN UE NGAP ID it shall store it for the duration of the UE-associated logical NG-connection for this UE. Once known to an AMF this is included in all UE associated NGAP signalling.

The RAN UE NGAP ID shall be unique within the logical NG-RAN node.

AMF UE NGAP ID:

An AMF UE NGAP ID shall be allocated so as to uniquely identify the UE over the NG interface within the AMF. When a NG-RAN node receives an AMF UE NGAP ID it shall store it for the duration of the UE-associated logical NG-connection for this UE. Once known to a NG-RAN node this ID is included in all UE associated NGAP signalling.

The AMF UE NGAP ID shall be unique within the AMF logical node.

Old NG-RAN node UE XnAP ID:

An Old NG-RAN node UE XnAP ID shall be allocated so as to uniquely identify the UE over the Xn interface within a source NG-RAN node. When a target NG-RAN node receives an Old NG-RAN node UE XnAP ID it shall store it for the duration of the UE-associated logical Xn-connection for this UE. Once known to a target NG-RAN node this ID is included in all UE associated XnAP signalling. The Old NG-RAN node UE XnAP ID shall be unique within the logical NG-RAN node.

New NG-RAN node UE XnAP ID:

A New NG-RAN node UE XnAP ID shall be allocated so as to uniquely identify the UE over the Xn interface within a target NG-RAN node. When a source NG-RAN node receives a New NG-RAN node UE XnAP ID it shall store it for the duration of the UE-associated logical Xn-connection for this UE. Once known to a source NG-RAN node this ID is included in all UE associated XnAP signalling. The New NG-RAN node UE XnAP ID shall be unique within the logical NG-RAN node.

M-NG-RAN node UE XnAP ID:

An M-NG-RAN node UE XnAP ID shall be allocated so as to uniquely identify the UE over the Xn interface within an M-NG-RAN node for dual connectivity. When an S-NG-RAN node receives an M-NG-RAN node UE XnAP ID it shall store it for the duration of the UE-associated logical Xn-connection for this UE. Once known to an S-NG-RAN node this ID is included in all UE associated XnAP signalling. The M-NG-RAN node UE XnAP ID shall be unique within the logical NG-RAN node.

S-NG-RAN node UE XnAP ID:

A S-NG-RAN node UE XnAP ID shall be allocated so as to uniquely identify the UE over the Xn interface within an S-NG-RAN node for dual connectivity. When an M-NG-RAN node receives a S-NG-RAN node UE XnAP ID it shall store it for the duration of the UE-associated logical Xn-connection for this UE. Once known to an M-NG-RAN node this ID is included in all UE associated XnAP signalling. The S-NG-RAN node UE XnAP ID shall be unique within the logical NG-RAN node.

gNB-CU UE F1AP ID:

A gNB-CU UE F1AP ID shall be allocated so as to uniquely identify the UE over the F1 interface within a gNB-CU. When a gNB-DU receives a gNB-CU UE F1AP ID it shall store it for the duration of the UE-associated logical F1-connection for this UE. The gNB-CU UE F1AP ID shall be unique within the gNB-CU logical node.

gNB-DU UE F1AP ID:

A gNB-DU UE F1AP ID shall be allocated so as to uniquely identify the UE over the F1 interface within a gNB-DU. When a gNB-CU receives a gNB-DU UE F1AP ID it shall store it for the duration of the UE-associated logical F1-connection for this UE. The gNB-DU UE F1AP ID shall be unique within the gNB-DU logical node.

6.2.2 gNB-DU ID

The gNB-DU ID is configured at the gNB-DU and used to uniquely identify the gNB-DU at least within a gNB-CU. The gNB-DU provides its gNB-DU ID to the gNB-CU during the F1 Setup procedure. The gNB-DU ID is used only within F1AP procedures.

6.3 Transport addresses

The transport layer address parameter is transported in the radio network application signalling procedures that result in establishment of transport bearer connections.

The transport layer address parameter shall not be interpreted in the radio network application protocols and reveal the addressing format used in the transport layer.

The formats of the transport layer addresses are further described in 3GPP TS 38.414 [5], 3GPP TS 38.424 [6] and 3GPP TS 38.474 [7].

6.4 UE associations in NG-RAN Node

There are several types of UE associations needed in the NG-RAN node: the "NG-RAN node UE context" used to store all information needed for a UE and the associations between the UE and the logical NG and Xn connections used for NG/XnAP UE associated messages. An "NG-RAN node UE context" exists for a UE in CM_CONNECTED.

Definitions:**NG-RAN node UE context:**

An NG-RAN node UE context is a block of information in an NG-RAN node associated to one UE. The block of information contains the necessary information required to maintain the NG-RAN services towards the active UE. An NG-RAN node UE context is established when the transition to RRC CONNECTED for a UE is completed or in the target NG-RAN node after completion of handover resource allocation during handover preparation, in which case at least UE state information, security information, UE capability information and the identities of the UE-associated logical NG-connection shall be included in the NG-RAN node UE context.

For Dual Connectivity an NG-RAN node UE context is also established in the S-NG-RAN node after completion of S-NG-RAN node Addition Preparation procedure.

UE-associated logical NG/Xn/F1 -connection:

NGAP, XnAP and F1AP provide means to exchange control plane messages associated with the UE over the respectively NG-C, Xn-C or F1-C interface.

A UE-associated logical connection is established during the first NGAP/XnAP/F1AP message exchange between the NG/Xn/F1 peer nodes.

The connection is maintained as long as UE associated NG/XnAP/F1AP messages need to be exchanged over the NG/Xn/F1 interface.

The UE-associated logical NG-connection uses the identities AMF UE NGAP ID and RAN UE NGAP ID.

The UE-associated logical Xn-connection uses the identities Old NG-RAN node UE XnAP ID and New NG-RAN node UE XnAP ID, or M-NG-RAN node UE XnAP ID and S-NG-RAN node UE XnAP ID.

The UE-associated logical F1-connection uses the identities gNB-CU UE F1AP ID and gNB-DU UE F1AP ID.

When a node (AMF or gNB) receives a UE associated NGAP/XnAP/F1AP message the node retrieves the associated UE based on the NGAP/XnAP/F1AP ID.

UE-associated signalling:

UE-associated signalling is an exchange of NGAP/XnAP/F1AP messages associated with one UE over the UE-associated logical NG/Xn/F1-connection.

NOTE: The UE-associated logical NG-connection may exist before the NG-RAN node UE context is setup in the NG-RAN node.

The UE-associated logical Xn-connection may exist before the NG-RAN node UE context is setup in the target NG-RAN node.

The UE-associated logical F1-connection may exist before the UE context is setup in the gNB-DU.

7 NG-RAN functions description

7.0 General

For the list of functions refer to TS 38.300 [2].

7.1 Void

Reserve for future use.

8 Overall procedures in gNB-CU/gNB-DU Architecture

8.1 Void

Reserve for future use.

8.2 Intra-gNB-CU Mobility

8.2.1 Intra-NR Mobility

8.2.1.1 Inter-gNB-DU Mobility

This procedure is used for the case when the UE moves from one gNB-DU to another gNB-DU within the same gNB-CU during NR operation. Figure 8.2.1.1-1 shows the inter-gNB-DU mobility procedure for intra-NR.

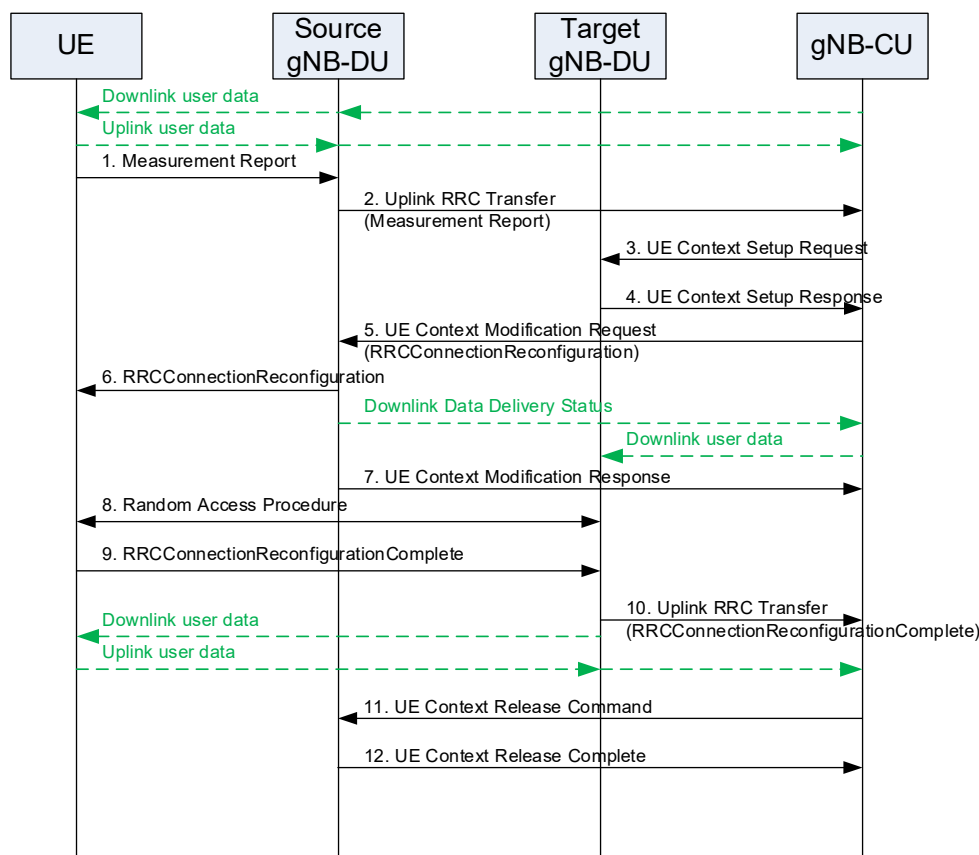


Figure 8.2.1.1-1: Inter-gNB-DU Mobility for intra-NR

1. The UE sends a *Measurement Report* message to the source gNB-DU.
2. The source gNB-DU sends an Uplink RRC Transfer message to the gNB-CU to convey the received *Measurement Report*.
3. The gNB-CU sends an UE Context Setup Request message to the target gNB-DU to create an UE context and setup one or more bearers.
4. The target gNB-DU responds to the gNB-CU with an UE Context Setup Response message.
5. The gNB-CU sends a UE Context Modification Request message to the source gNB-DU, which includes a generated *RRCCONNECTIONRECONFIGURATION* message and indicates to stop the data transmission for the UE. The source gNB-DU also sends a Downlink Data Delivery Status frame to inform the gNB-CU about the unsuccessfully transmitted downlink data to the UE. Downlink packets, which may include PDCP PDUs not successfully transmitted in the source gNB-DU, are sent from the gNB-CU to the target gNB-DU.
6. The source gNB-DU forwards the received *RRCCONNECTIONRECONFIGURATION* to the UE.
7. The source gNB-DU responds to the gNB-CU with the UE Context Modification Response message.
8. A Random Access procedure is performed at the target gNB-DU.
9. The UE responds to the target gNB-DU with an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message.
10. The target gNB-DU sends an Uplink RRC Transfer message to the gNB-CU to convey the received *RRCCONNECTIONRECONFIGURATIONCOMPLETE*. Downlink packets are sent to the UE. Also, uplink packets are sent from the UE, which are forwarded to the gNB-CU through the target gNB-DU.
11. The gNB-CU sends an UE Context Release Command message to the source gNB-DU.

12. The source gNB-DU releases the UE context and responds the gNB-CU with an UE Context Release Complete message.

8.2.1.2 Intra-gNB-DU inter-cell mobility

This procedure is used for the case that UE moves from one cell to another cell within the same gNB-DU during NR operation, and supported by UE Context Modification (gNB-CU initiated) procedure as specified in TS 38.473 [4].

8.2.2 EN-DC Mobility

8.2.2.1 Inter-gNB-DU Mobility using MCG SRB

This procedure is used for the case the UE moves from one gNB-DU to another gNB-DU within the same gNB-CU when only MCG SRB is available during EN-DC operation. Figure 8.2.2.1-1 shows the inter-gNB-DU mobility procedure using MCG SRB in EN-DC.

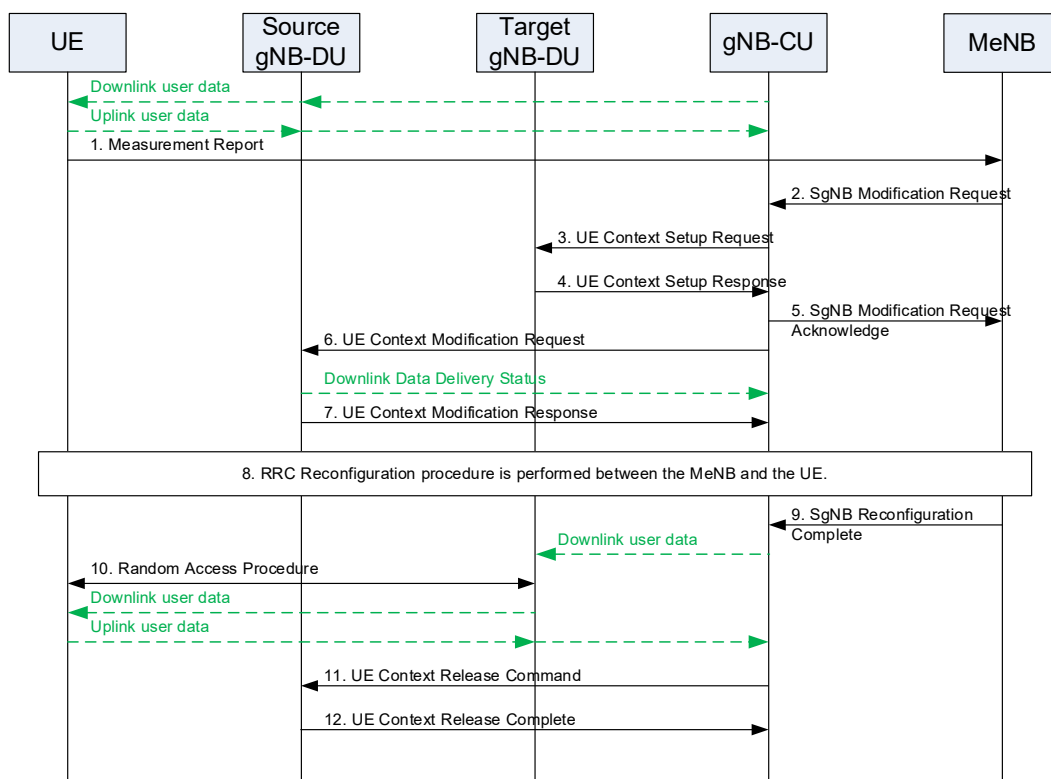


Figure 8.2.2.1-1: Inter-gNB-DU Mobility using MCG SRB in EN-DC

1. The UE sends a *Measurement Report* message to the MeNB.
2. The MeNB sends an SgNB Modification Request.
3. The gNB-CU sends an UE Context Setup Request message to the target gNB-DU to create an UE context and setup one or more bearers.
4. The target gNB-DU responds the gNB-CU with an UE Context Setup Response message.
5. The gNB-CU responds the MeNB with an SgNB Modification Request Acknowledge message.
6. The gNB-CU sends a UE Context Modification Request message to the source gNB-DU indicating to stop the data transmission to the UE. The source gNB-DU also sends a Downlink Data Delivery Status frame to inform the gNB-CU about the unsuccessfully transmitted downlink data to the UE.

7. The source gNB-DU responds the gNB-CU with an UE Context Modification Response message.
8. The MeNB and the UE perform RRC Reconfiguration procedure.
9. The MeNB sends an SgNB Reconfiguration Complete message to the gNB-CU. Downlink packets, which may include PDCP PDUs not successfully transmitted in the source gNB-DU, are sent from the gNB-CU to the target gNB-DU.
10. Random Access procedure is performed at the target gNB-DU. Downlink packets are sent to the UE. Also, uplink packets are sent from the UE, which are forwarded to the gNB-CU through the target gNB-DU.
11. The gNB-CU sends an UE Context Release Command message to the source gNB-DU.
12. The source gNB-DU releases the UE context and responds the gNB-CU with an UE Context Release Complete message.

8.2.2.2 Inter-gNB-DU Mobility using SCG SRB

This procedure is used for the case the UE moves from one gNB-DU to another gNB-DU when SCG SRB is available during EN-DC operation. The procedure is the same as inter-gNB-DU Mobility for intra-NR as defined in clause 8.2.1.1.

8.3 Mechanism of centralized retransmission of lost PDUs

8.3.1 Centralized Retransmission in Intra gNB-CU Cases

This mechanism allows to perform the retransmission of the PDCP PDUs that are not delivered by a gNB-DU (gNB-DU1) because the corresponding radio links toward the UE are subject to outage. When such outage occurs, the gNB-DU affected by outage informs the gNB-CU of such event. The gNB-CU can switch transmission of data traffic, as well as perform retransmission of undelivered PDCP PDUs, from the gNB-DU affected by outage to other available gNB-DUs (e.g. gNB-DU2 in Figure 8.3.1-1) with a well-functioning radio link toward the UE.

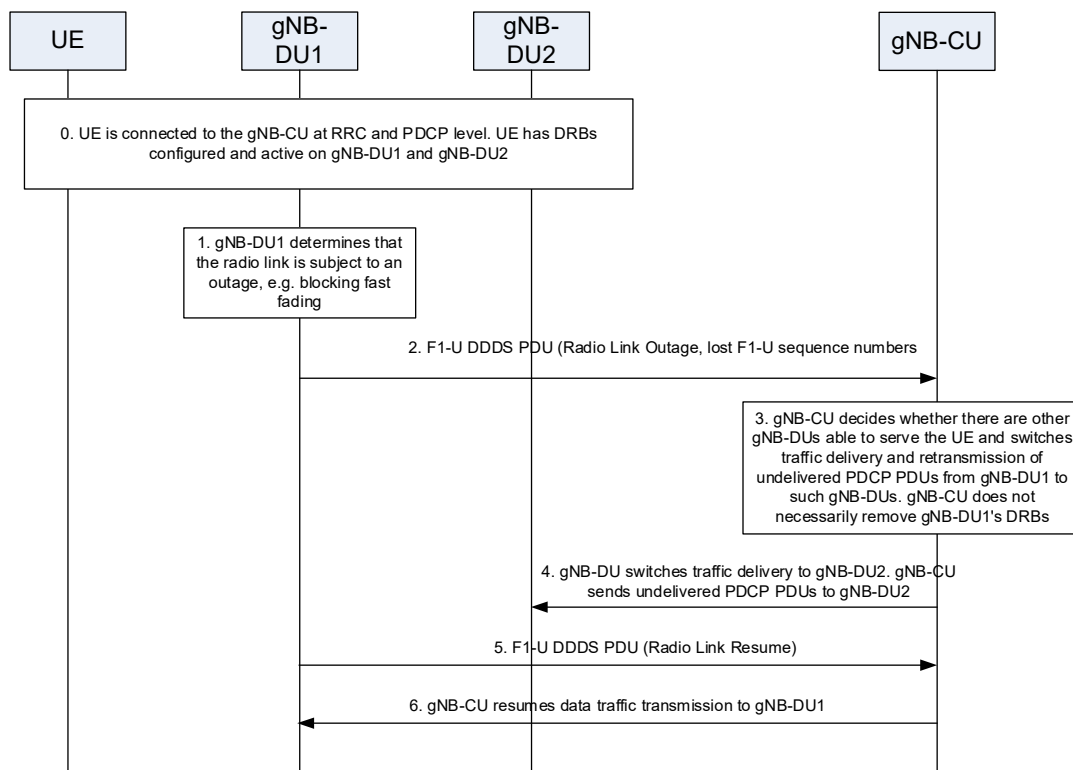


Figure 8.3.1-1: Procedure for centralized retransmission in intra gNB-CU scenarios

The mechanism is shown in Figure 8.3.1-1 and targets the multi-connectivity scenario, where a UE is served by multiple data radio bearers established at least on two DUs, and it includes the following steps:

0. The UE is connected and can transmit/receive data to/from gNB-DU1 and gNB-DU2.
1. gNB-DU1 realizes that the radio link towards the UE is experiencing outage.
2. gNB-DU1 sends the "Radio Link Outage" notification message to the gNB-CU over the F1-U interface, as part of the DDDS PDU of the concerned data radio bearer. The message may include the *Number of lost F1-U Sequence Number ranges reported* corresponding to the PDCP PDUs partially (and/or totally) undelivered in gNB-DU1.
3. gNB-CU decides to switch data traffic transmission and retransmission of PDCP PDUs that were undelivered in gNB-DU1 via gNB-DU2. gNB-CU stops sending downlink traffic to gNB-DU1. The radio leg between gNB-DU1 and the UE is not necessarily removed.
4. gNB-CU starts sending traffic (namely new PDUs and potentially retransmitted PDUs) to gNB-DU2.
5. If gNB-DU1 realizes that the radio link of the concerned data radio bearer is back in normal operation, it may send a "Radio Link Resume" notification message as part of the DDDS PDU over the F1-U interface to inform the gNB-CU that the radio link can be used again for the concerned data radio bearer.
6. gNB-CU may start sending traffic (namely new PDUs and potentially retransmitted PDUs) of the concerned data radio bearer via gNB-DU1 again.

8.4 Multi-Connectivity operation

8.4.1 Secondary Node Addition

8.4.1.1 EN-DC

This clause gives the SgNB addition procedure in EN-DC given that en-gNB consists of gNB-CU and gNB-DU(s), as shown in Figure 8.4.1.1-1.

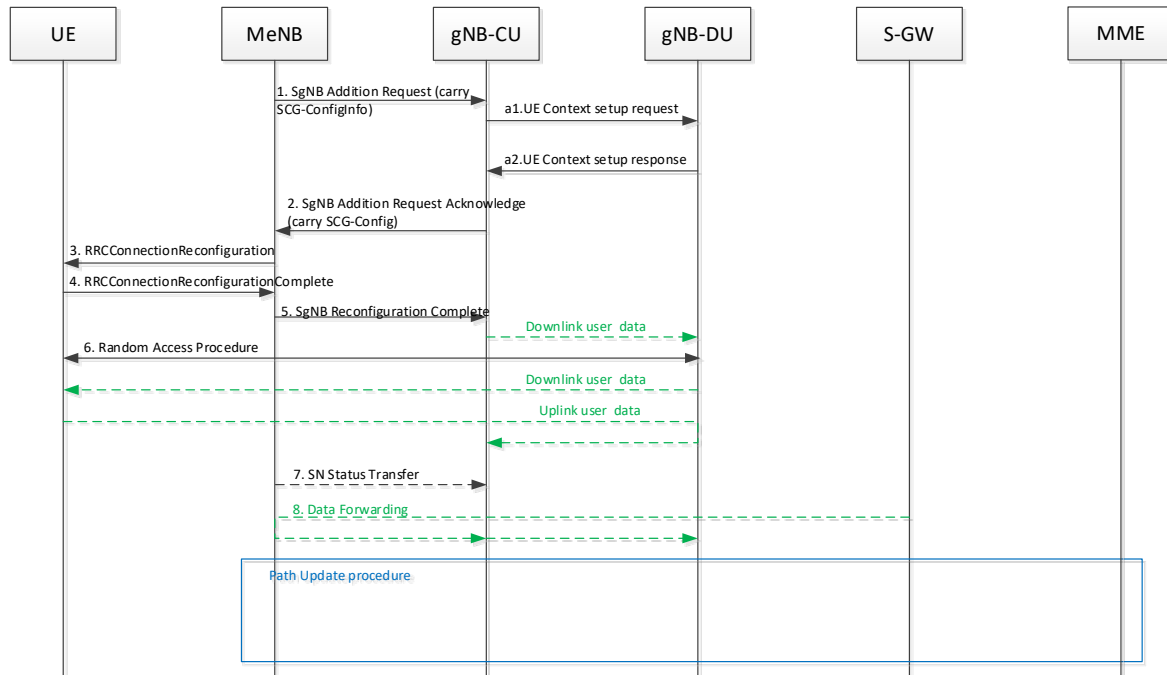


Figure 8.4.1.1-1: SgNB addition procedure in EN-DC

1~8: refer to TS 37.340 [12]

a1. After receiving the SgNB Addition Request message from MeNB, the gNB-CU sends the UE Context Setup Request message to the gNB-DU to create a UE context

a2. The gNB-DU responds to the gNB-CU with the UE Context Setup Response message

8.4.2 Secondary Node Release (MN/SN initiated)

8.4.2.1 EN-DC

This clause gives the SgNB release procedure in EN-DC given that the en-gNB consists of a gNB-CU and gNB-DU(s).

MN initiated SN Release

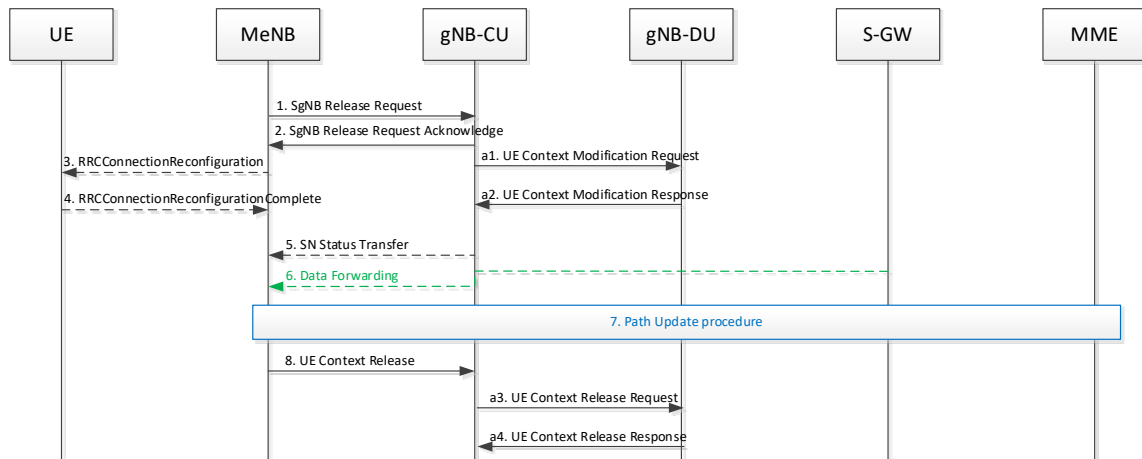


Figure 8.4.2.1-1 SgNB release procedure in EN-DC (MN initiated)

1~8: refer to TS 37.340 [12]

NOTE: The timing of sending the Step 2 SgNB Release Request Acknowledge message is an example, it may be sent e.g. after step a1 or after a2 and it is up to implementation.

- a1. After receiving SgNB Release Request message from MeNB, gNB-CU sends the UE Context Modification Request message to gNB-DU to stop the data transmission for the UE. It is up to gNB-DU implementation when to stop the UE scheduling.
- a2. gNB-DU responds to gNB-CU with UE Context Modification Response message.
- a3. After receiving the UE Context Release message from MeNB, the gNB-CU sends the UE Context Release Request message to the gNB-DU to release the UE context.
- a4. The gNB-DU responds to the gNB-CU with the UE Context Release Response message.

SN initiated SN Release

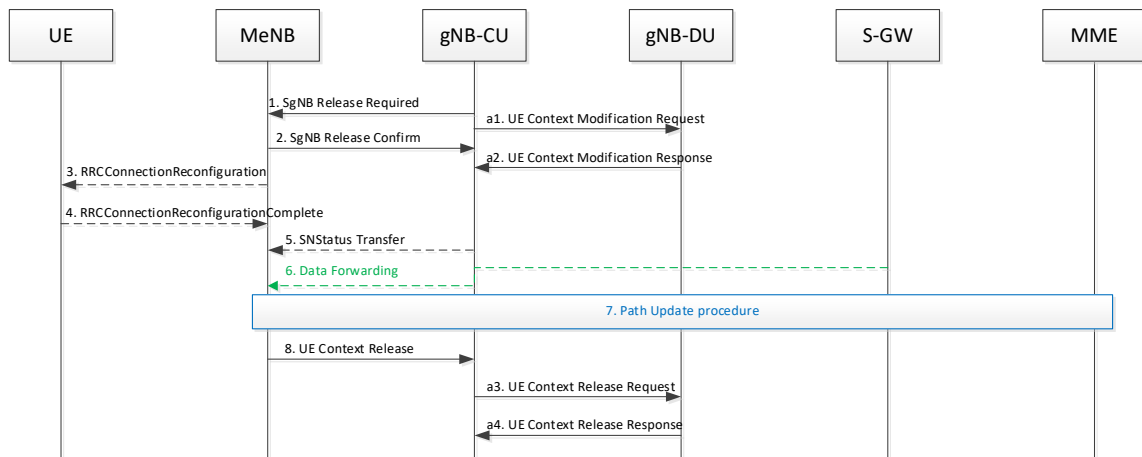


Figure 8.4.2.1-2 SgNB release procedure in EN-DC (SN initiated)

1~8: refer to TS 37.340 [12]

- a1. gNB-CU sends the UE Context Modification Request message to gNB-DU to stop the data transmission for the UE. It is up to gNB-DU implementation when to stop the UE scheduling. This step may occur before step 1.
- a2. gNB-DU responds to gNB-CU with UE Context Modification Response message.
- a3. After receiving the UE Context Release message from MeNB, the gNB-CU sends the UE Context Release Request message to the gNB-DU to release the UE context.

a4. The gNB-DU responds to the gNB-CU with the UE Context Release Response message.

8.5 F1 Startup and cells activation

This function allows to setup the F1 interface between a gNB-DU and a gNB-CU and it allows to activate the gNB-DU cells.

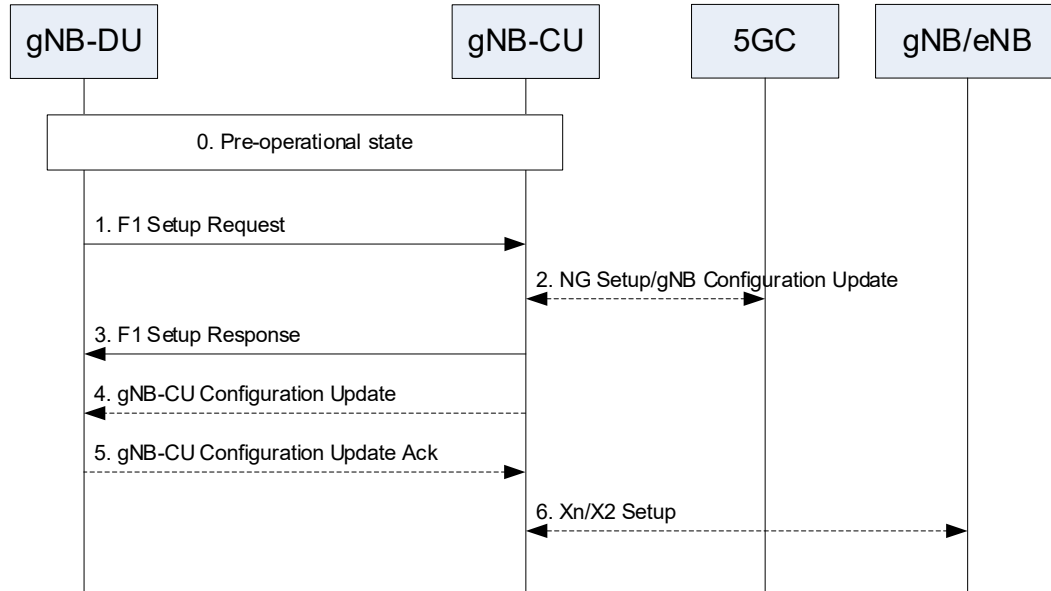


Figure 8.5-1: F1 startup and cell activation

0. The gNB-DU and its cells are configured by OAM in the F1 pre-operational state. The gNB-DU has TNL connectivity toward the gNB-CU.
1. The gNB-DU sends an F1 Setup Request message to the gNB-CU including a list of cells that are configured and ready to be activated.
2. In NG-RAN, the gNB-CU ensures the connectivity toward the core network. For this reason, the gNB-CU may initiate either the NG Setup or the gNB Configuration Update procedure towards 5GC.
3. The gNB-CU sends an F1 Setup Response message to the gNB-DU that optionally includes a list of cells to be activated. If the gNB-DU succeeds to activate the cell(s), then the cells become operational. If the gNB-DU fails to activate some cell(s), the gNB-DU may initiate the gNB-DU Configuration Update procedure towards the gNB-CU.
4. The gNB-CU may send a gNB-CU Configuration Update message to the gNB-DU that optionally includes a list of cells to be activated, e.g., in case that these cells were not activated using the F1 Setup Response message.
5. The gNB-DU replies with a gNB-DU Configuration Update Acknowledge message that optionally includes a list of cells that failed to be activated.
6. The gNB-CU may initiate either the Xn Setup towards a neighbour NG-RAN node or the EN-DC X2 Setup procedure towards a neighbour eNB.

NOTE: In case that the F1 Setup Response is not used to activate any cell, step 2 may be performed after step 3.

8.6 Void

Reserve for future use.

9 Synchronization

9.1 gNB Synchronization

The gNB shall support a logical synchronization port for phase-, time- and/or frequency synchronization.

Logical synchronization port for phase- and time-synchronization shall provide:

- 1) accuracy that allows to meet the gNB requirements on maximum relative phase difference for all gNBs in synchronized TDD-unicast area;
- 2) continuous time without leap seconds traceable to common time reference for all gNBs in synchronized TDD-unicast area.

A logical synchronization port for phase- and time-synchronization may also be provided for e.g., all gNBs in FDD time domain inter-cell interference coordination synchronization area.

Furthermore common SFN initialization time shall be provided for all gNBs in synchronized TDD-unicast area.

Based on this information, the gNB may derive the SFN according to the following formula:

$$SFN = \{time\} \bmod \{period(SFN)\},$$

where:

time time adjusted by the common SFN initialization time, in units of 10 ms to match the length of radio frame and accuracy accordingly;

period(SFN) SFN period.

In case gNB is connected via TDM interface, it may be used to frequency synchronize the gNB. The characteristics of the clock in the gNB shall be designed taking into account that the jitter and wander performance requirements on the interface are in accordance with network limits for output wander at traffic interfaces of either ITU-T Recommendation G.823 [8], ITU-T Recommendation G.824 [9] or network limits for the maximum output jitter and wander at any hierarchical interface of ITU-T Recommendation G.825 [10], whichever is applicable.

In case gNB is connected via Ethernet interface and the network supports Synchronous Ethernet, the gNB may use this interface to get frequency synchronization. In this case the design of the gNB clock should be done considering the jitter and wander performance requirements on the interface are as specified for output jitter and wander at EEC interfaces of ITU-T Recommendation G.8261/Y.1361 [11], defined in clause 9.2.1. Further considerations on Synchronous Ethernet recommendations and architectural aspects are defined in clause 12.2.1 and Annex A of ITU-T Recommendation G.8261/Y.1361 [11].

A configurable LTE TDD-offset of start frame shall be supported by all gNBs in synchronized TDD-unicast areas in order to achieve interoperability in coexistence scenarios.

10 NG-RAN interfaces

10.1 NG interface

3GPP TS 38.410 [14] specifies NG interface general aspects and principles.

10.2 Xn interface

3GPP TS 38.420 [15] specifies Xn interface general aspects and principles.

10.3 F1 interface

3GPP TS 38.470 [16] specifies F1 interface general aspects and principles.

Annex A (informative): Deployment scenarios of gNB/en-gNB

Figure A-1 shows logical nodes (CU-C, CU-U and DU), internal to a logical gNB/en-gNB. Protocol terminations of the NG and Xn interfaces are depicted as ellipses in Figure A-1. The terms "Central Entity" and "Distributed Entity" shown in Figure A-1 refer to physical network nodes.

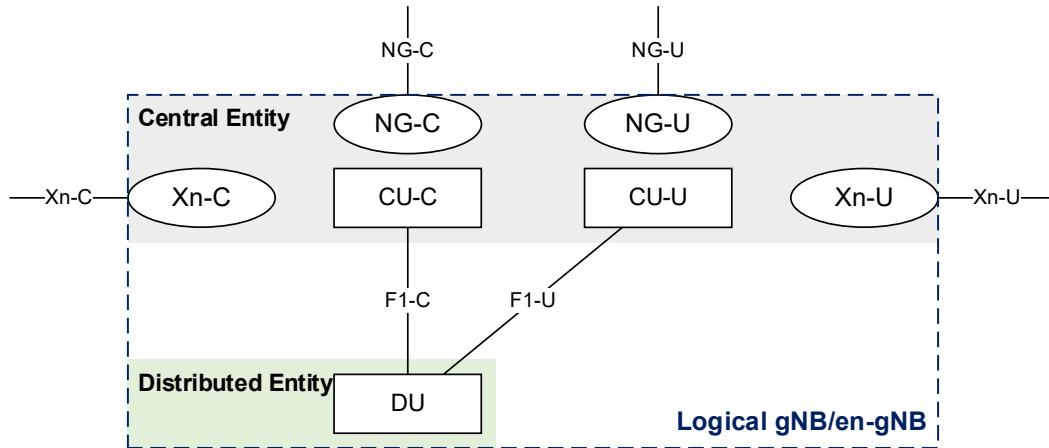


Figure A-1: Example deployment of an Logical gNB/en-gNB

Annex B (informative): Change History

Change history							
Date	Meeting	TDoc	C R	Rev	Cat	Subject/Comment	New version
2017-04	RAN3#95bis	R3-171307				First Draft	0.0.1
2017-05	RAN3#96	R3-171962				Reflected agreed TP in RAN3#96. Added new Clause 8 for overall procedure for gNB-CU/DU architecture	0.1.0
2017-06	RAN3#NR Ad Hoc	R3-172634				Reflected agreed TP in RAN3#NR Ad Hoc in 2017-06 (Qingdao)	0.2.0
2017-08	RAN3#97	R3-173449				Reflected agreed TP in RAN3#97	0.3.0
2017-10	RAN3#97bis	R3-174237				Reflected agreed TP in RAN3#97bis	0.4.0
2017-10	RAN3#97bis	R3-174258				Removed subclauses under 10.3 (moved to 38.470)	0.4.1
2017-11	RAN3#98	R3-175054				Reflected agreed TP in RAN3#98	0.5.0
2017-12	RP-78	RP-172545				Submit to RAN Plenary#78 for approval	1.0.0
2017-12	RP-78					TR Approved by RAN plenary	15.0.0