Xn Interface

TP00005-V-1701 V0 - S03M02 Ed1

TP00005-V-1701 V0 - S03M02 Ed1

1

Learning objectives
Upon completion of this module, you should be able to:

Describe Xn-C protocol stack and signaling messages
Describe Xn-U protocol stack and GTPU header

Table of contents
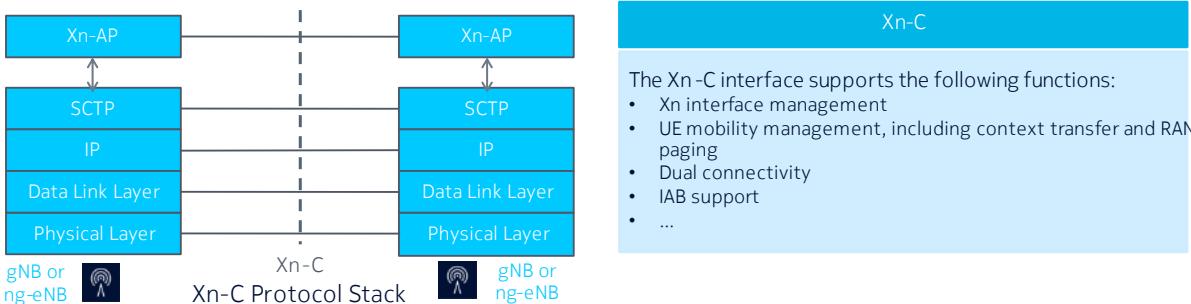
Nokia Confidential

Xn-C Interface

Xn-C Interface Protocols

Xn-C Protocol Stack

Xn-C

The Xn-C interface supports the following functions:
- Xn interface management
- UE mobility management, including context transfer and RAN paging
- Dual connectivity
- IAB support
- …

The control plane protocol stack of the Xn interface is shown on Figure 7.1-1. The transport network layer is built on IP transport. For the reliable transport of signalling messages, SCTP is added on top of IP. The application layer signalling protocol is referred to as XnAP (Xn Application Protocol).

The Xn-C interface supports the following functions:
- Xn interface management: managing of signalling associations between NG-RAN nodes, surveying the Xn interface and recovering from errors.
- UE mobility management, including context transfer and RAN paging: exchange of information between source and target NG-RAN nodes in order to initiate the handover of a certain UE to the target.
- Dual connectivity
- IAB support
- …

List of XnAP Elementary Procedure - Class 1 (excerption)

Elementary Procedure	Initiating Message	Successful Outcome Response message	Unsuccessful Outcome Response message
Handover Preparation	HANDOVER REQUEST	HANDOVER REQUEST ACKNOWLEDGE	HANDOVER PREPARATION FAILURE
Retrieve UE Context	RETRIEVE UE CONTEXT REQUEST	RETRIEVE UE CONTEXT RESPONSE	RETRIEVE UE CONTEXT FAILURE
S-NG-RAN node Addition Preparation	S-NODE ADDITION REQUEST	S-NODE ADDITION REQUEST ACKNOWLEDGE	S-NODE ADDITION REQUEST REJECT
M-NG-RAN node initiated S-NG-RAN node Modification Preparation	S-NODE MODIFICATION REQUEST	S-NODE MODIFICATION REQUEST ACKNOWLEDGE	S-NODE MODIFICATION REQUEST REJECT
S-NG-RAN node initiated S-NG-RAN node Modification	S-NODE MODIFICATION REQUIRED	S-NODE MODIFICATION CONFIRM	S-NODE MODIFICATION REFUSE
S-NG-RAN node initiated S-NG-RAN node CHANGE	S-NODE CHANGE REQUIRED	S-NODE CHANGE CONFIRM	S-NODE CHANGE REFUSE
M-NG-RAN node initiated S-NG-RAN node Release	S-NODE RELEASE REQUEST	S-NODE RELEASE REQUEST ACKNOWLEDGE	S-NODE RELEASE REJECT
S-NG-RAN node initiated S-NG-RAN node Release	S-NODE RELEASE REQUIRED	S-NODE RELEASE CONFIRM	
Xn Setup	Xn SETUP REQUEST	Xn SETUP RESPONSE	Xn SETUP FAILURE
NG-RAN node Configuration Update	NG-RAN NODE CONFIGURATION UPDATE	NG-RAN NODE CONFIGURATION UPDATE ACKNOWLEDGE	NG-RAN NODE CONFIGURATION UPDATE FAILURE

The complete lists are defined in 3GPP TS 38.423

XnAP protocol consists of Elementary Procedures (EPs). An XnAP Elementary Procedure is a unit of interaction between two NG-RAN nodes. An EP consists of an initiating message and possibly a response message. Two kinds of EPs are used:

- **Class 1**: Elementary Procedures with response (success or failure),

- **Class 2**: Elementary Procedures without response.

All Elementary Procedures are divided into Class 1 and Class 2 Eps.

List of XnAP Elementary procedure – Class 2 (excerption)

| Elementary Procedure	Initiating Message
Handover Cancel	HANDOVER CANCEL
SN Status Transfer	SN STATUS TRANSFER
RAN Paging	RAN PAGING
S-NG-RAN node Reconfiguration Completion	S-NODE RECONFIGURATION COMPLETE
UE Context Release	UE CONTEXT RELEASE
RRC Transfer	RRC TRANSFER
Error Indication	ERROR INDICATION
Secondary RAT Data Usage Report	SECONDARY RAT DATA USAGE REPORT
Trace Start	TRACE START
Deactivate Trace	DEACTIVATE TRACE
Handover Success	HANDOVER SUCCESS
Conditional Handover Cancel	CONDITIONAL HANDOVER CANCEL
Handover Report	HANDOVER REPORT
Resource Status Reporting	RESOURCE STATUS UPDATE
Access And Mobility Indication	ACCESS AND MOBILITY INDICATION
Cell Traffic Trace	CELL TRAFFIC TRACE
SCG Failure Information Report	SCG FAILURE INFORMATION REPORT
SCG Failure Transfer	SCG FAILURE TRANSFER
Retrieve UE Context Confirm	RETRIEVE UE CONTEXT CONFIRM
Conditional PSCell Change Cancel	CONDITIONAL PSCELL CHANGE CANCEL

Nokia Confidential

The complete lists are defined in 3GPP TS 38.423

All Elementary Procedures are divided into Class 1 and Class 2 Eps.

Global Procedures

8
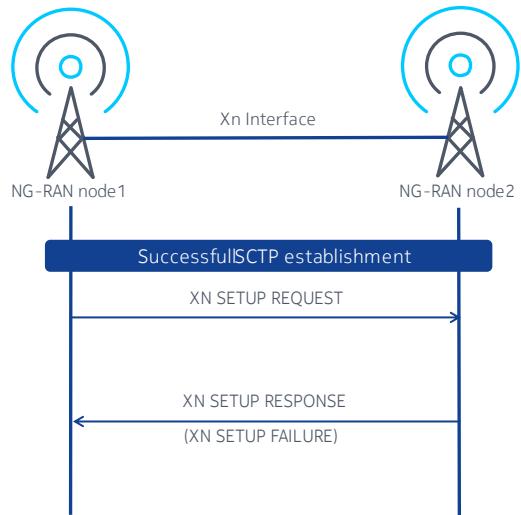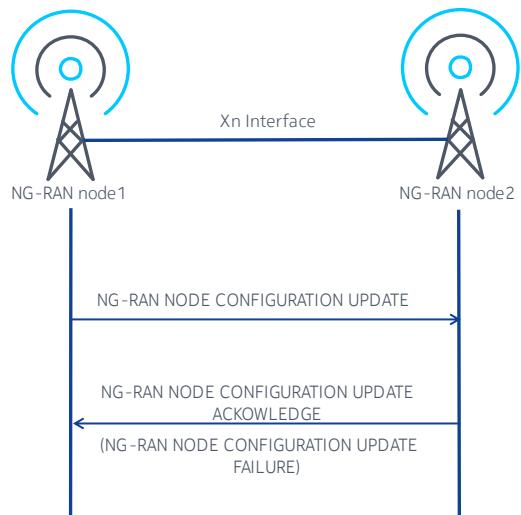
Xn Setup

This procedure is used to exchange application level configuration data needed for two NG -RAN nodes to interoperate correctly over the Xn-C interface.

Xn Interface

NG-RAN node1

NG-RAN node2

Successful SCTP establishment

XN SETUP REQUEST

XN SETUP RESPONSE

(XN SETUP FAILURE)

Nokia Confidential
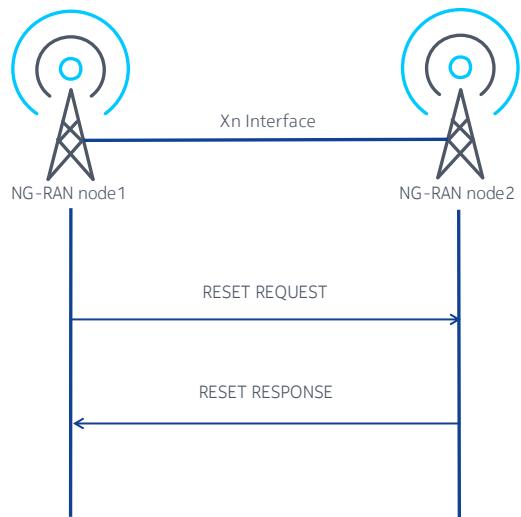
NG-RAN node Configuration Update

This procedure is used to update application level configuration data needed for two NG -RAN nodes to interoperate correctly over the Xn-C interface.

Xn Interface

NG-RAN node1   NG-RAN node2

NG-RAN NODE CONFIGURATION UPDATE

NG-RAN NODE CONFIGURATION UPDATE
ACKOWLEDGE
(NG-RAN NODE CONFIGURATION UPDATE
FAILURE)

Nokia Confidential

Reset

This procedure is used to align the resources in the NG - RAN node$_1$ and the NG-RAN node$_2$ in the event of an abnormal failure. The procedure either resets the Xn interface or selected UE contexts.

Xn Interface

NG-RAN node1   NG-RAN node2

RESET REQUEST

RESET RESPONSE

Nokia Confidential
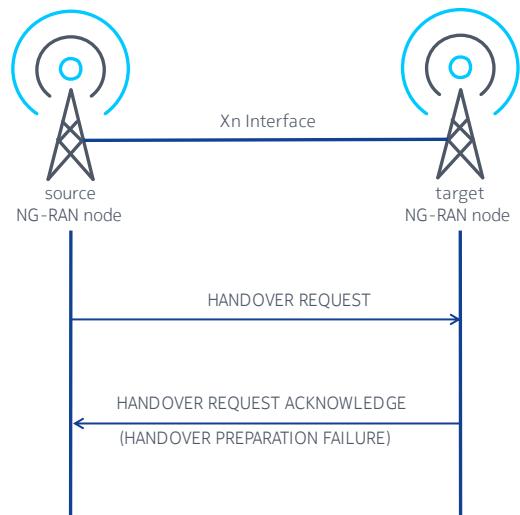
Basic Mobility Procedures
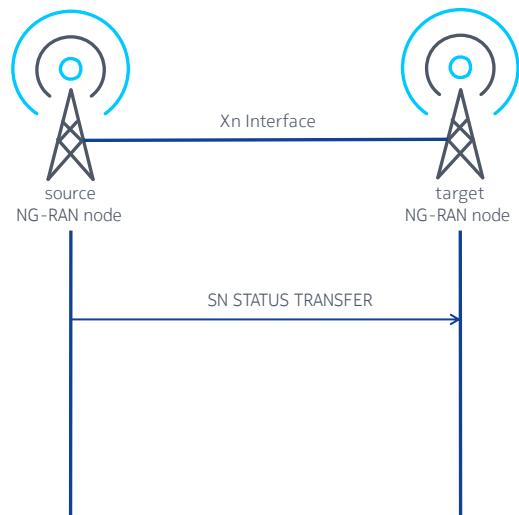
# Handover Preparation

This procedure is used to establish necessary resources in an NG-RAN node for an incoming handover.

Xn Interface

source
NG-RAN node

target
NG-RAN node

HANDOVER REQUEST

HANDOVER REQUEST ACKNOWLEDGE

(HANDOVER PREPARATION FAILURE)

Nokia Confidential
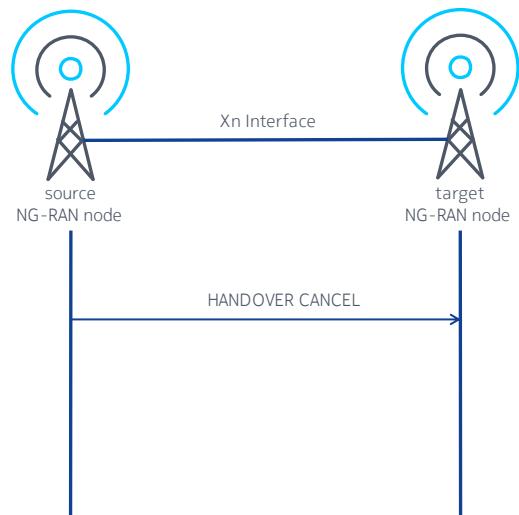
SN Status Transfer

This procedure is used to transfer the uplink PDCP SN and HFN receiver status and the downlink PDCP SN and HFN transmitter status either, from the source to the target NG - RAN node during an Xn handover, between the NG-RAN nodes involved in dual connectivity, or after retrieval of a UE context for RRC reestablishment, for each respective DRB.

Xn Interface

source
NG-RAN node

target
NG-RAN node

SN STATUS TRANSFER
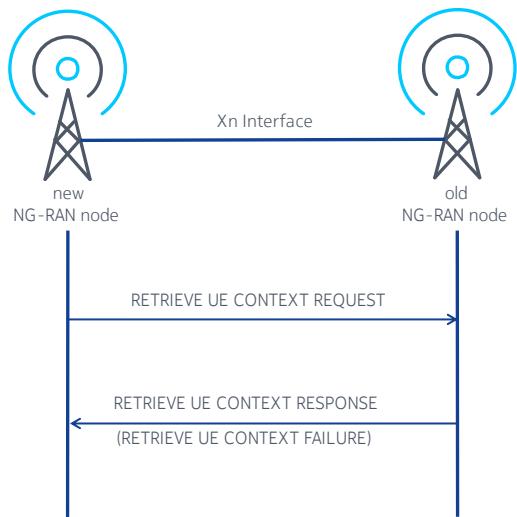
# Handover Cancel

This procedure is used to enable a source NG -RAN node to cancel an ongoing handover preparation or an already prepared handover.

source
NG-RAN node

target
NG-RAN node

Xn Interface

HANDOVER CANCEL
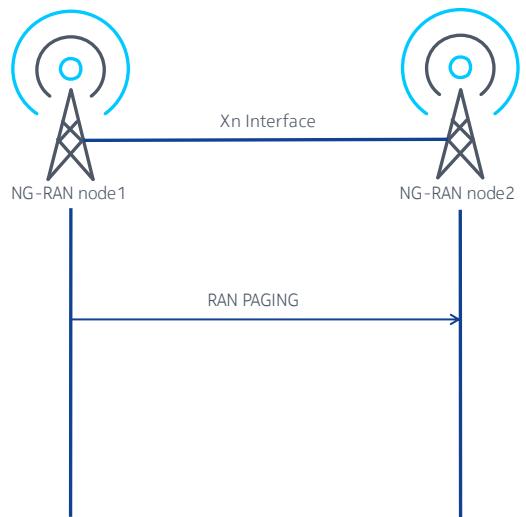
Retrieve UE Context

This procedure is used to retrieve the UE context from the
old NG-RAN node and transfer it to the NG-RAN node
where the UE RRC Connection has been requested to be
established.

Xn Interface

new
NG-RAN node

old
NG-RAN node

RETRIEVE UE CONTEXT REQUEST

RETRIEVE UE CONTEXT RESPONSE

(RETRIEVE UE CONTEXT FAILURE)

RAN Paging
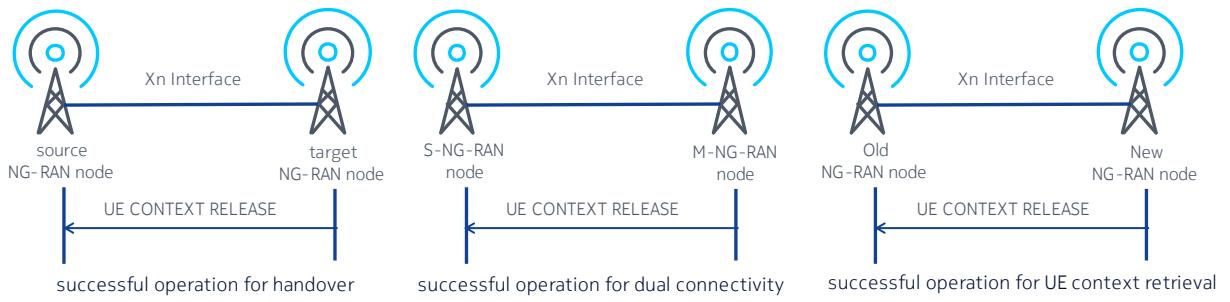
This procedure is used to enable the NG -RAN node$_1$ to request paging of a UE in the NG -RAN node$_2$.

Xn Interface

NG-RAN node1   NG-RAN node2

RAN PAGING

Nokia Confidential

TP00005-V-1701 V0 - S03M02 Ed1

17

UE Context Release

This procedure is used to initiate the release of radio resource   of UE at

- Source NG-RAN node, for handover
- S-NG-RAN node, for dual connectivity
- Old NG-RAN node, for UE context retrieval

source NG-RAN node	Xn Interface	target NG-RAN node

UE CONTEXT RELEASE

successful operation for handover

S-NG-RAN node	Xn Interface	M-NG-RAN node

UE CONTEXT RELEASE

successful operation for dual connectivity

Old NG-RAN node	Xn Interface	New NG-RAN node

UE CONTEXT RELEASE

successful operation for UE context retrieval
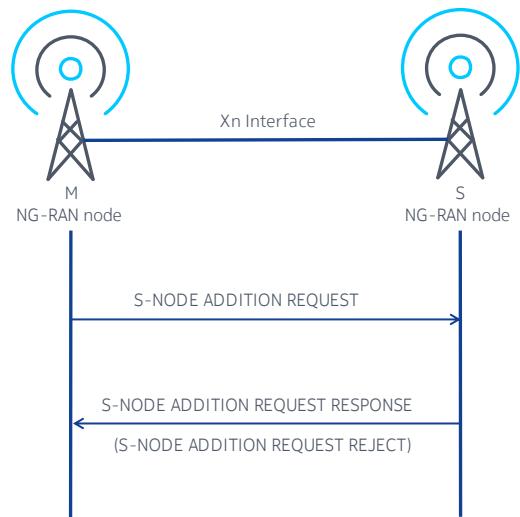
Procedures for Dual Connectivity
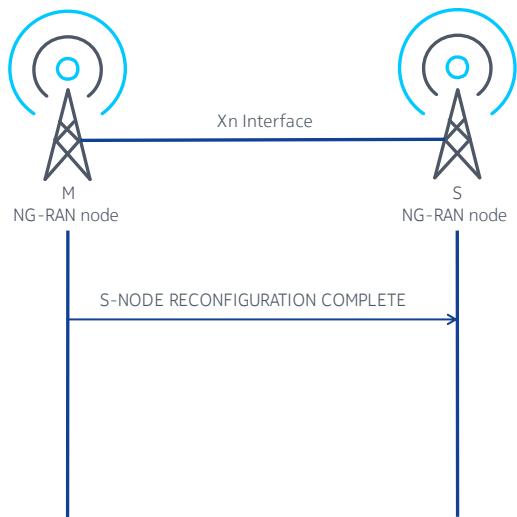
S-NG-RAN node Addition Preparation

This procedure is used to request the S -NG-RAN node to allocate resources for dual connectivity operation for a specific UE.

Xn Interface

M
NG-RAN node

S
NG-RAN node

S-NODE ADDITION REQUEST

S-NODE ADDITION REQUEST RESPONSE
(S-NODE ADDITION REQUEST REJECT)
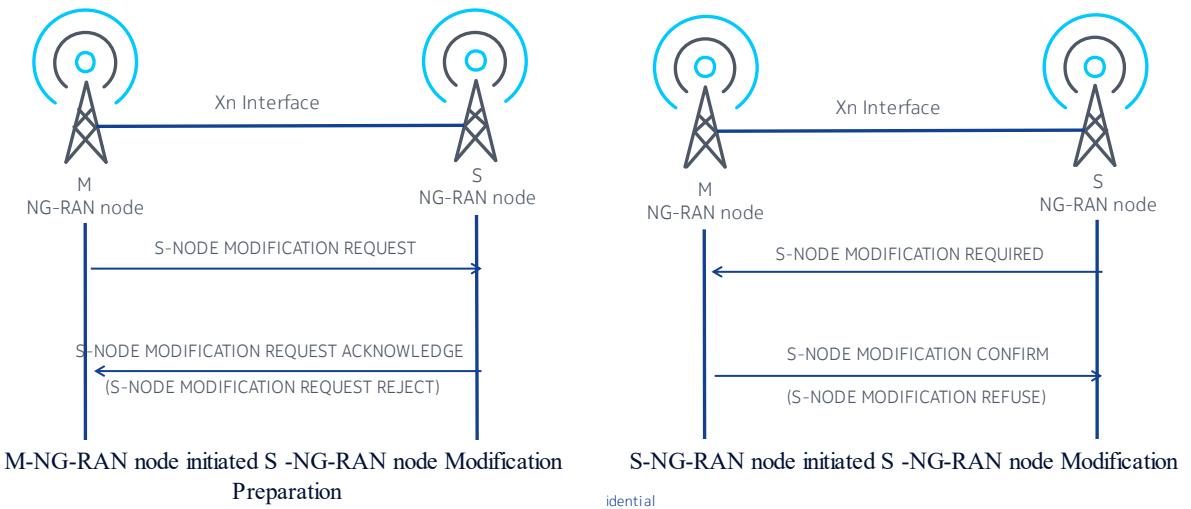
S-NG-RAN node Reconfiguration Completion

This procedure is used to provide information to the S - NG-RAN node whether the requested configuration was successfully applied by the UE.

Xn Interface

M
NG-RAN node

S
NG-RAN node

S-NODE RECONFIGURATION COMPLETE

Nokia Confidential
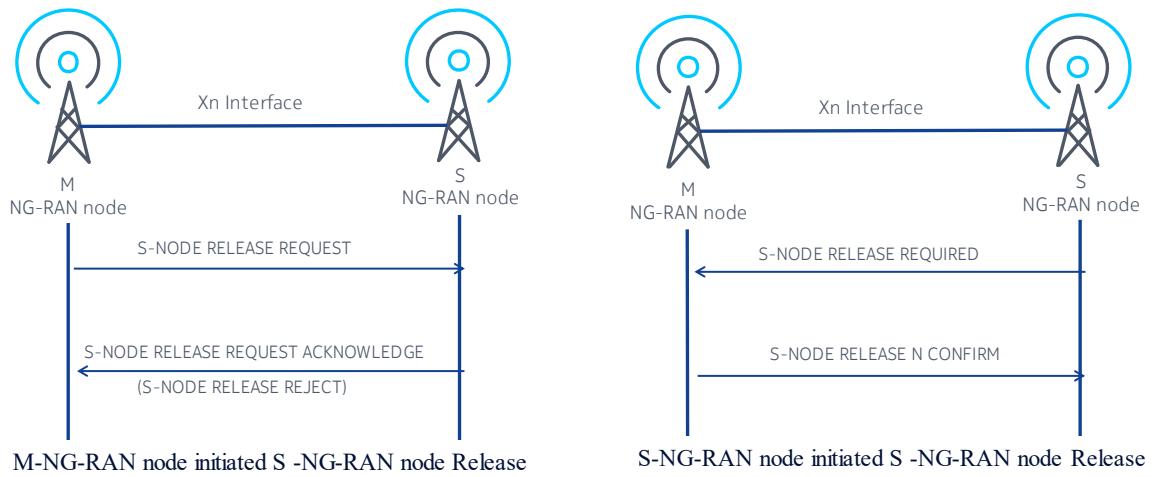
S-NG-RAN node Modification

This procedure is used to modify the UE context in the S-NG-RAN node.

S-NODE MODIFICATION REQUEST

S-NODE MODIFICATION REQUEST ACKNOWLEDGE

(S-NODE MODIFICATION REQUEST REJECT)

M-NG-RAN node initiated S -NG-RAN node Modification Preparation

S-NODE MODIFICATION REQUIRED

S-NODE MODIFICATION CONFIRM

(S-NODE MODIFICATION REFUSE)

S-NG-RAN node initiated S -NG-RAN node Modification

idential
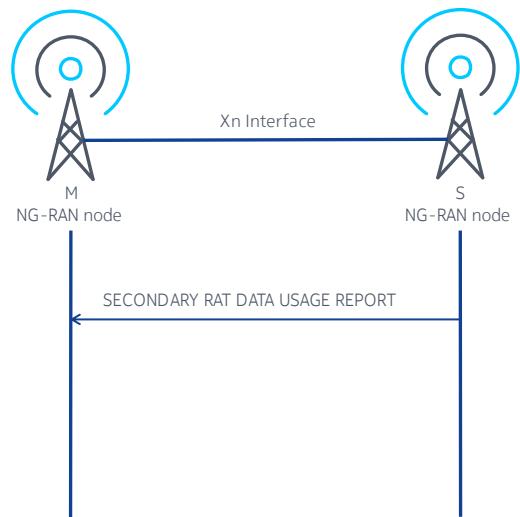
S-NG-RAN node Release

This procedure is used to initiate the release of the resource for a specific UE in the S-NG-RAN node.

Xn Interface

M
NG-RAN node

S
NG-RAN node

S-NODE RELEASE REQUEST

S-NODE RELEASE REQUEST ACKNOWLEDGE

(S-NODE RELEASE REJECT)

M-NG-RAN node initiated S -NG-RAN node Release

Xn Interface

M
NG-RAN node

S
NG-RAN node

S-NODE RELEASE REQUIRED

S-NODE RELEASE N CONFIRM

S-NG-RAN node initiated S -NG-RAN node Release

Nokia Confidential

# Secondary RAT Data Usage Report

This procedure is used to provide information on the used resources of the secondary RAT.

Xn Interface

M
NG-RAN node

S
NG-RAN node

SECONDARY RAT DATA USAGE REPORT
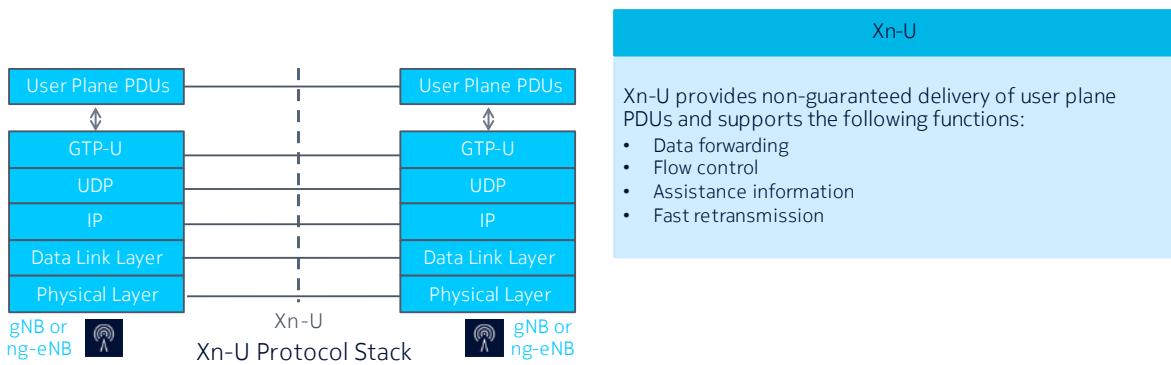
Xn-U Interface

Nokia Confidential

Xn-U Interface Protocols

User Plane PDUs
GTP-U
UDP
IP
Data Link Layer
Physical Layer

gNB or ng-eNB

User Plane PDUs
GTP-U
UDP
IP
Data Link Layer
Physical Layer

gNB or ng-eNB

Xn-U

Xn-U Protocol Stack

Xn-U

Xn-U provides non-guaranteed delivery of user plane PDUs and supports the following functions:
- Data forwarding
- Flow control
- Assistance information
- Fast retransmission

The Xn user plane (Xn-U) interface is defined between two NG-RAN nodes. The Xn-U interface provides non-guaranteed delivery of user plane PDUs between two NG-RAN nodes.

The protocol stack for Xn-U is shown in Figure.

The user plane packets conveyed by GTP-U may be PDCP PDUs (e.g. in case of dual connectivity), PDCP SDUs (e.g. in case of DRB level data forwarding), or SDAP SDUs (e.g. in PDU Session level data forwarding).

User plane protocol messages are carried by container fields in the GTP-U extension header. A single GTP-U packet may carry a user plane packet and/or a user plane protocol message.

Wrap-up
In this module we have covered the following items

Describe Xn-C protocol stack and signaling messages
Describe Xn-U protocol stack and GTPU header

NOKIA

Nokia Confidential