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5G NR 프로토콜 소개




표준연구실 권기범 실장
2018. 1. 4 (목)

innovative technology lab

Agenda

I. RAN discussions on RAN2

II. Major RAN2 issues

1. Deployment Scenarios
2. User Plane

   MAC / RLC / SDAP / QoS / URLLC
3. Control Plane

   RRC inactive / System information / EN-DC
4. Mobility

   Measurement / Handover

01 RAN discussion for RAN2 (1/2)

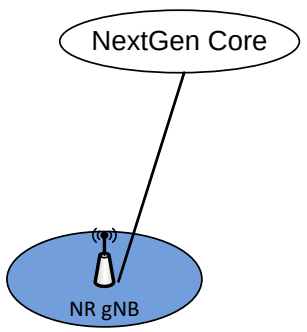
- ✓ At RAN #78, work plan for NR was discussed.
  - ✓ For RAN2
    - RAN2 shall focus on closing the open issues for Option-3 (EN-DC), and on commencing specification work for the essential components of Option-2 (SA)
    - For LTE: The March/2018 ASN.1 freeze contains functions essential for **NR NSA Option-3 family only**, and does not contain any other Rel-15 LTE feature
    - No TU allocation for NR SI

01 RAN discussion for RAN2 (2/2)

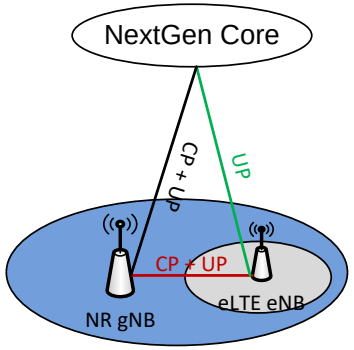
- ✓ Plan to address 0ms handover interruption requirement
  - ✓ RAN#78 to task RAN2 to investigate how the IMT-2020 requirement on 0ms handover interruption requirement can be addressed for LTE and NR within the Rel-15 time frame
    - RAN2 to report to RAN#79
    - First step is to study if the IMT-2020 requirement can be achieved with existing LTE specs, and with developing NR specs.
    - If conclusion of first step is 'no', then consider what can be done in Rel-15 in order to meet it.
  - ✓ Plan within RAN2
    - Kick off email discussion to progress this topic up to RAN2#101 (ZTE to lead)
    - Joint LTE/NR agenda item at RAN2#101 to handle outcome of email discussion and conclude what to report to RAN#79.

02-1 Deployment Scenarios - options

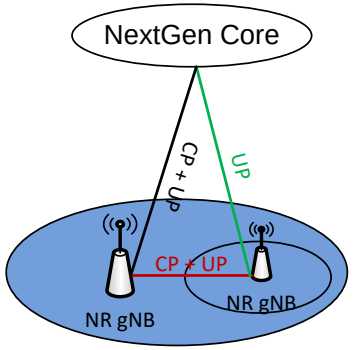
- ✓ CN-RAN connection
  - ✓ NR gNB is a master node. (option 2)



1) NR gNB connected to NextGen Core

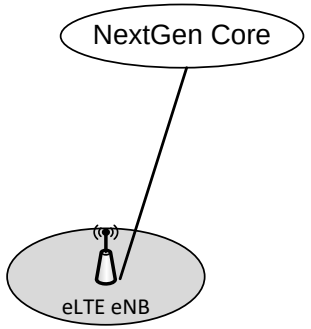


2) Data flow aggregation across NR gNB and eLTE eNB via NextGen Core

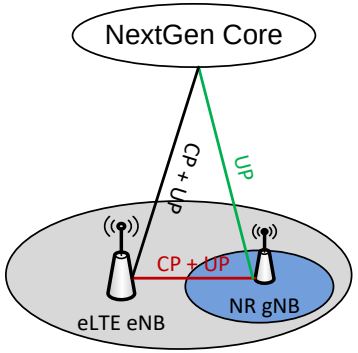


3) Data flow aggregation across NR gNBs via NextGen Core

  - ✓ eNB connected to NextGen Core is a master node. (option 7)

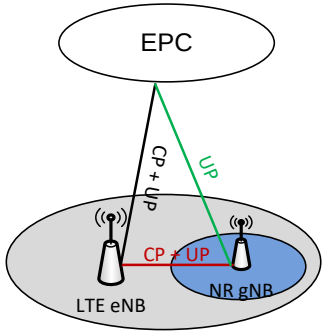


1) eLTE eNB connected to NextGen Core



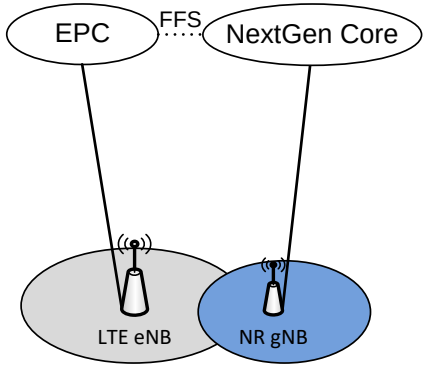
2) Data flow aggregation across eLTE eNB and NR gNB via NextGen Core

- ✓ LTE eNB is a master node. (option3)

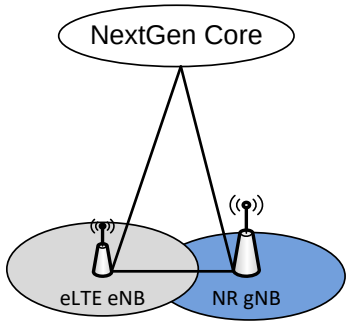


1) Data flow aggregation across LTE eNB and NR gNB via EPC

- ✓ Inter-RAT mobility between NR gNB and (e)LTE eNB.



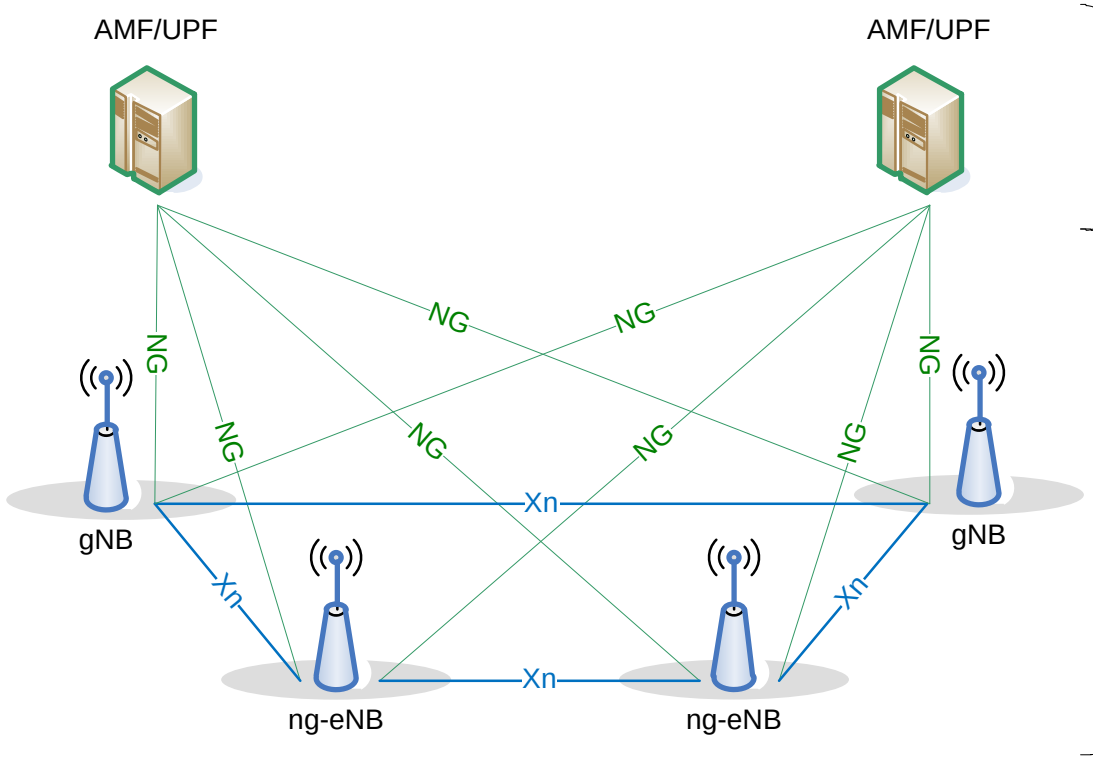
1) LTE eNB is connected to EPC and NR gNB is connected to NextGen Core;



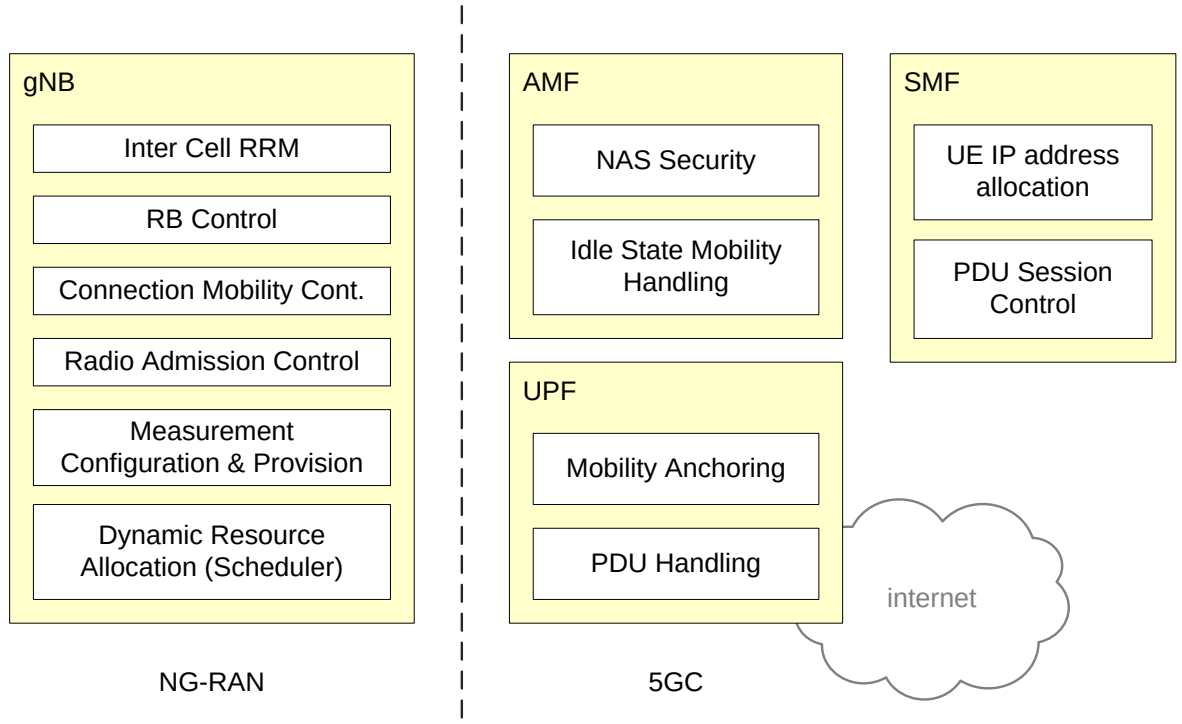
2) eLTE eNB and NR gNB are connected to NextGen Core

02-1 Deployment Scenarios – 5GC perspective

- ✓ NG-RAN architecture

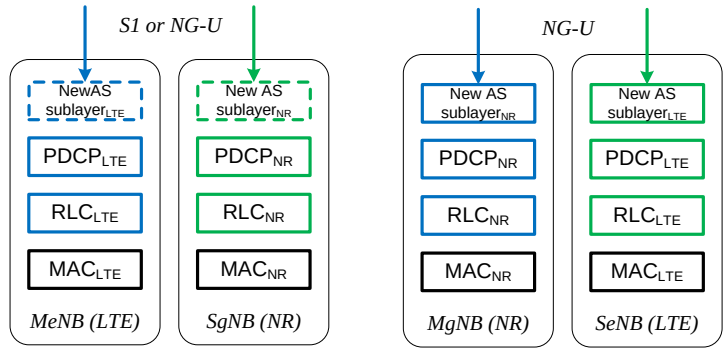


- ✓ Functional split
  - ✓ AMF (Access and Mobility Management Function)
  - ✓ UPF (User Plane Function)
  - ✓ SMF (Session Management function)

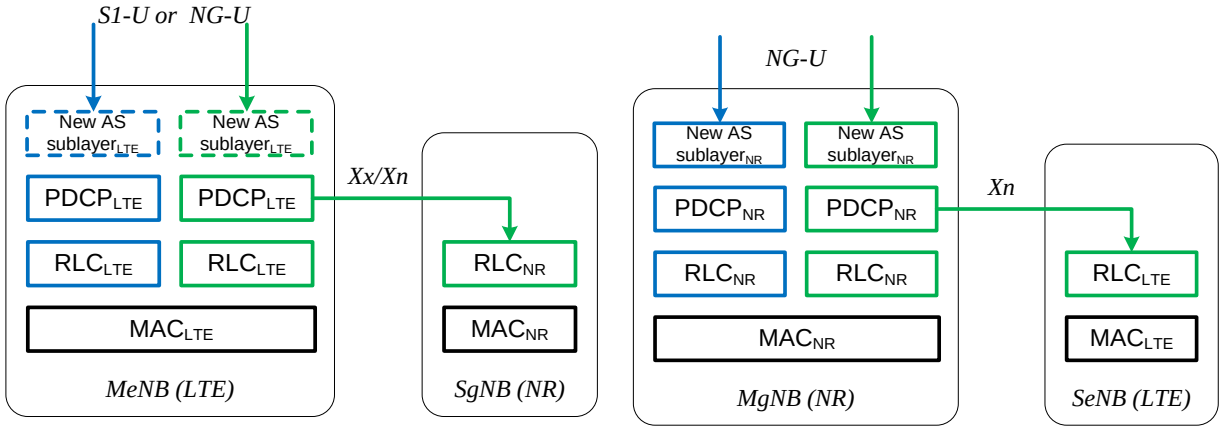


02-1 Deployment Scenarios – Bearer Type

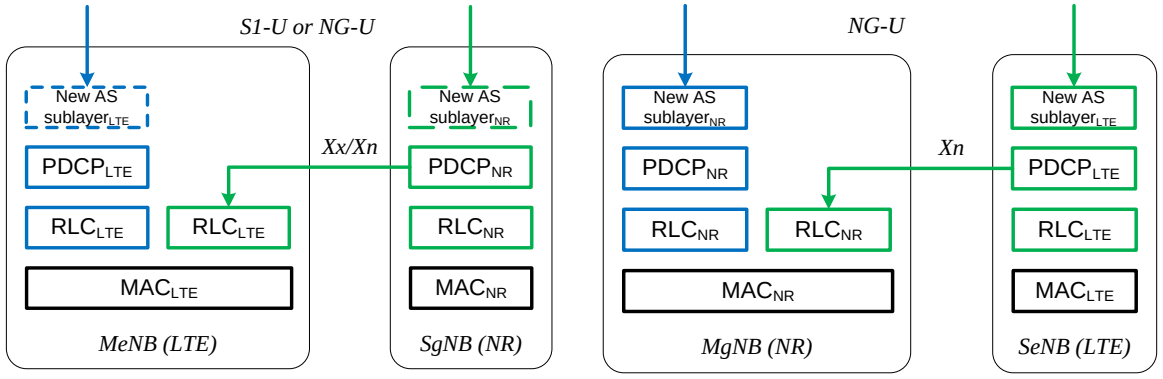
- ✓ Overall structure (Bearer Type)
  - ✓ MCG bearer: in MR-DC, a bearer with RLC bearer only in the MCG.
  - ✓ SCG bearer: in MR-DC, a bearer with RLC bearer only in the SCG.
  - ✓ Split bearer: in MR-DC, a bearer with RLC bearers in both SCG and MCG.
  - ✓ MN terminated bearer: in MR-DC, a bearer for which PDCP is located in the MN.
  - ✓ SN terminated bearer: in MR-DC, a bearer for which PDCP is located in the SN.



MCG / SCG Bearer

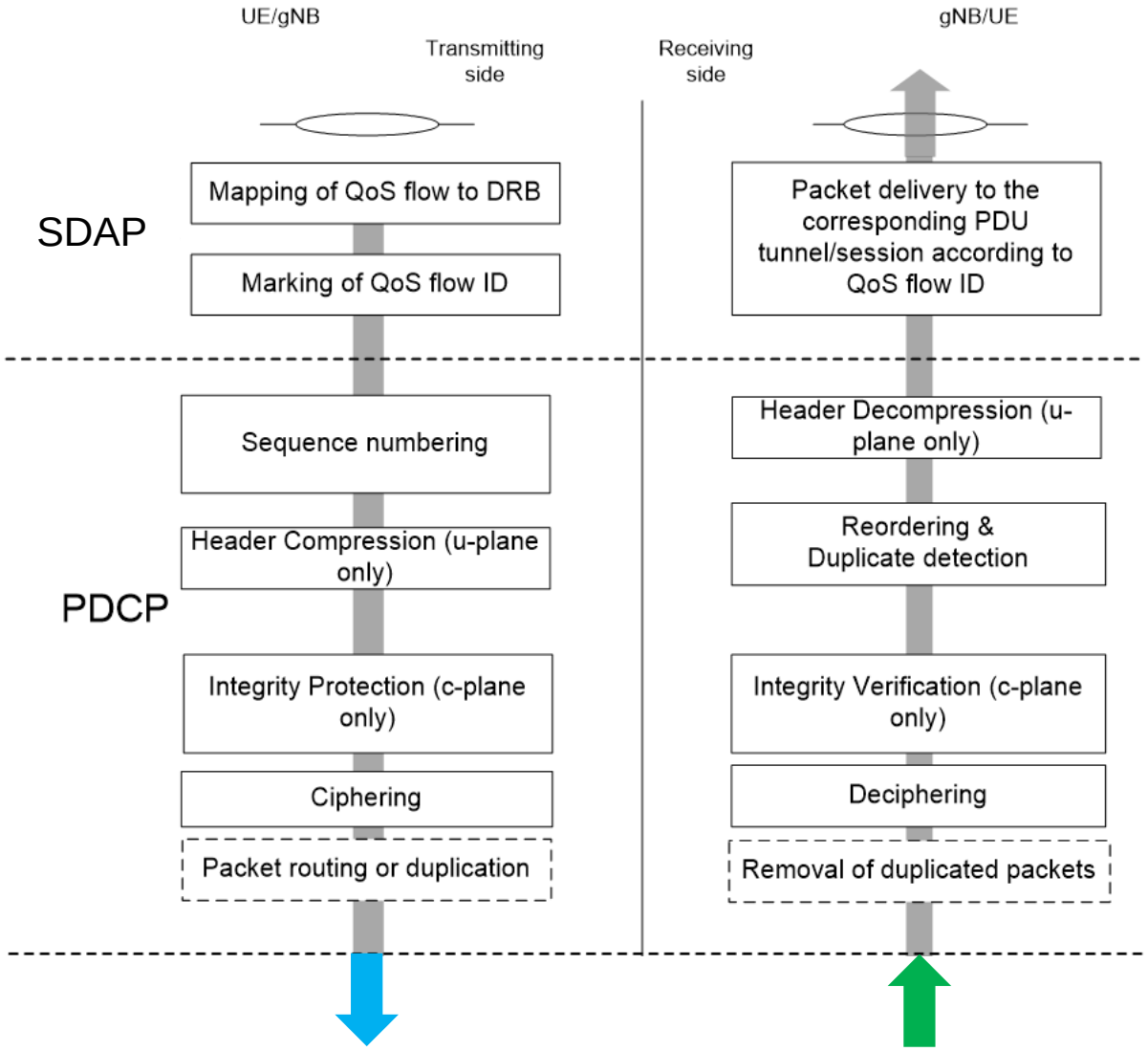


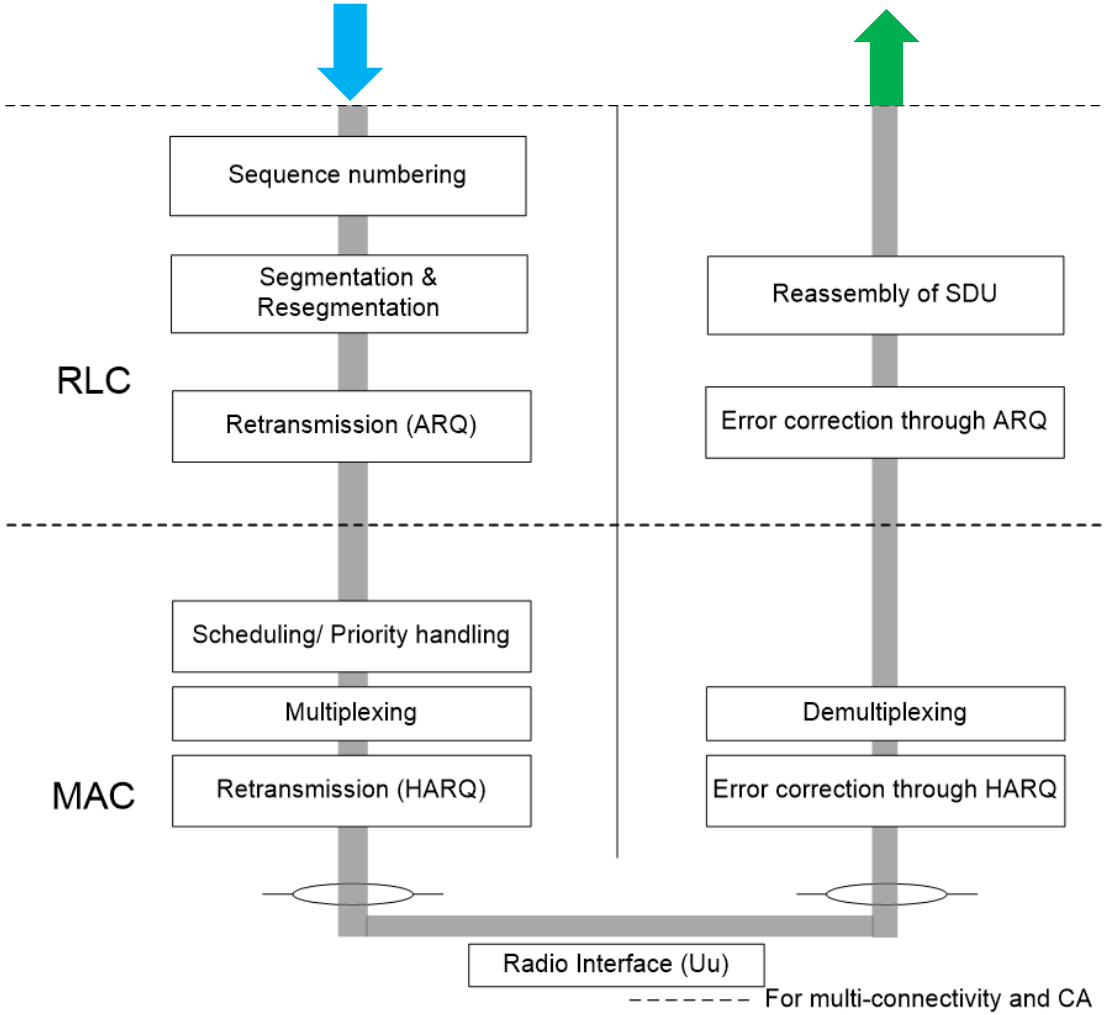
Split bearer (MN terminated bearer)



Split bearer (SN terminated bearer)

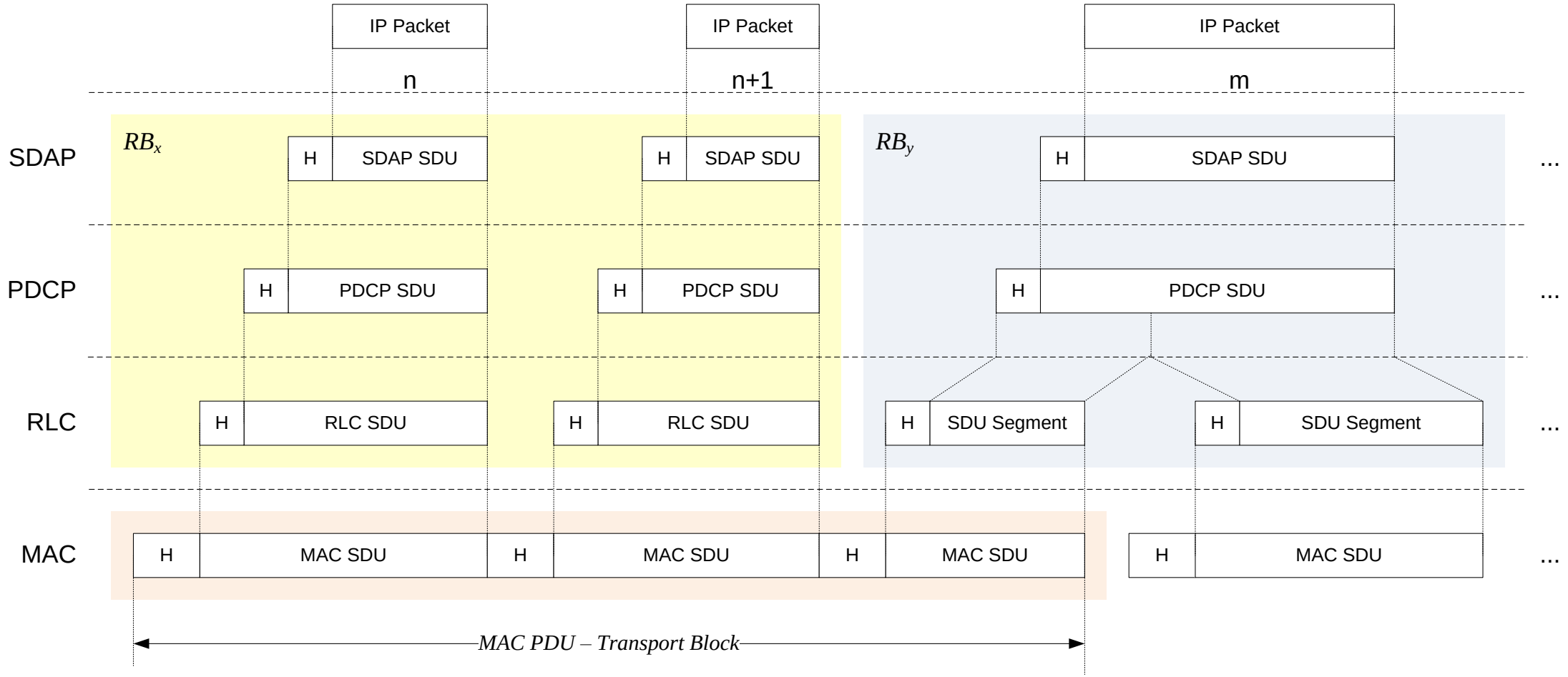
- ✓ Overview of Layer 2 functions





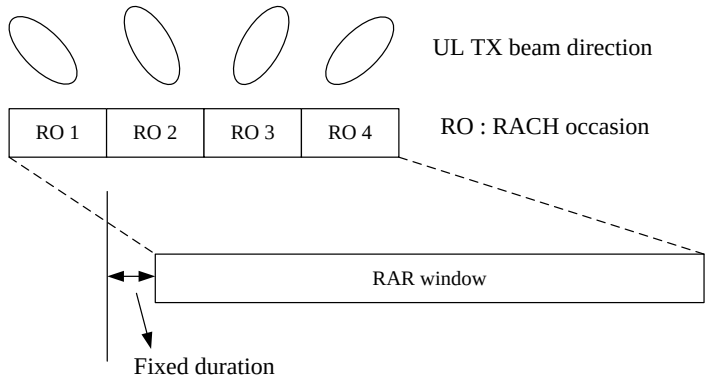
02-2 User Plane – Overview

- ✓ Overall layer 2 data flow

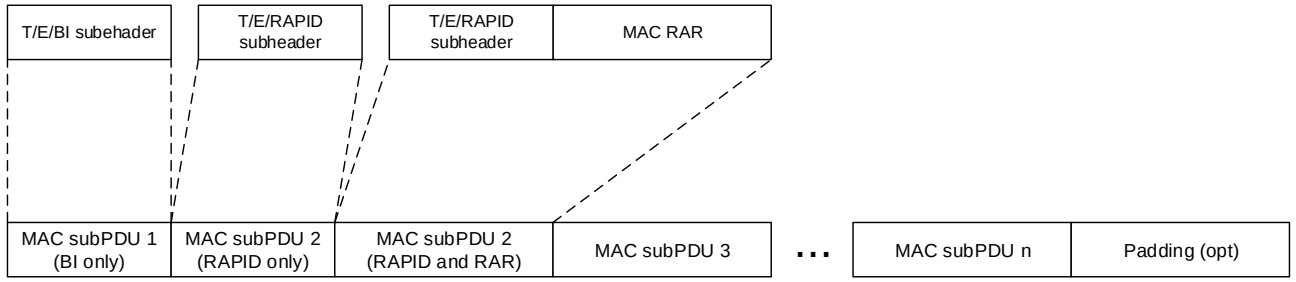


Random Access

- ✓ A single RAR window is applied for multiple msg1 transmission.
- ✓ The UE monitors multiple RA-RNTIs. The RA-RNTI is associated to the RACH transmission occasion in which the preamble was transmitted.
- ✓ Differentiation of backoff parameter and/or power ramping will be supported.
  - ✓ Preamble Power Ramping
    - ✓ Two counters “PREAMBLE_TRANSMISSION_COUNTER and PREAMBLE_POWER_RAMPING_COUNTER” are defined and set.
    - ✓ A new notification “power ramping counter suspension notification” is defined.
  - ✓ PRACH Resource Configuration
    - ✓ Whether the MAC needs to know the selected SS block (and CSI-RS if an association is agreed).
      (in order to select from the associated PRACH resource and/or associated preamble sequences)
- ✓ MAC RAR PDU Design
  - ✓ MAC PDU of RAR shall follow the MAC PDU format for NR (interleaved MAC sub-headers)

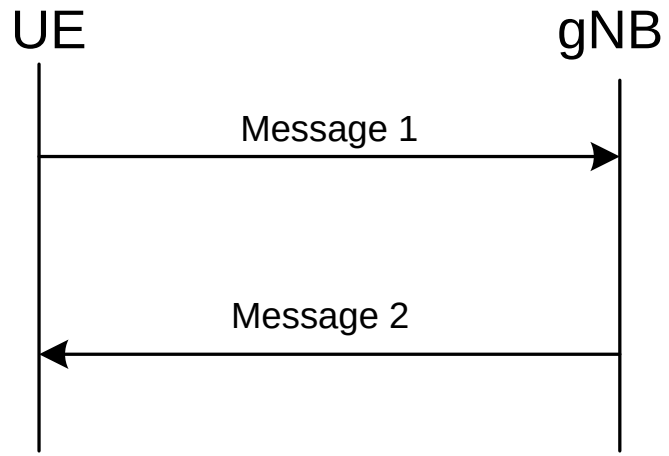


R2-1708049 RAR design supporting multiple preamble transmission, MediaTek Inc.

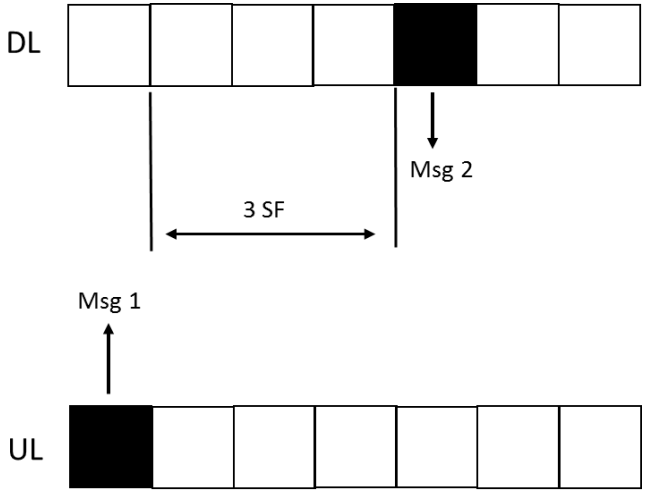


Example of MAC PDU consisting of MAC RARs

- ✓ Two Step RA procedure
  - ✓ Support of the two-step Random Access procedure has not been agreed. (Captured in Annex E of TR 38.804)
  - ✓ Due to the reduced message exchange, the latency of the two-step procedure is expected to be reduced compared to the four step procedure assuming the same success rate for both procedures.



Two-step Random Access procedure



Latency for two-step RA procedure

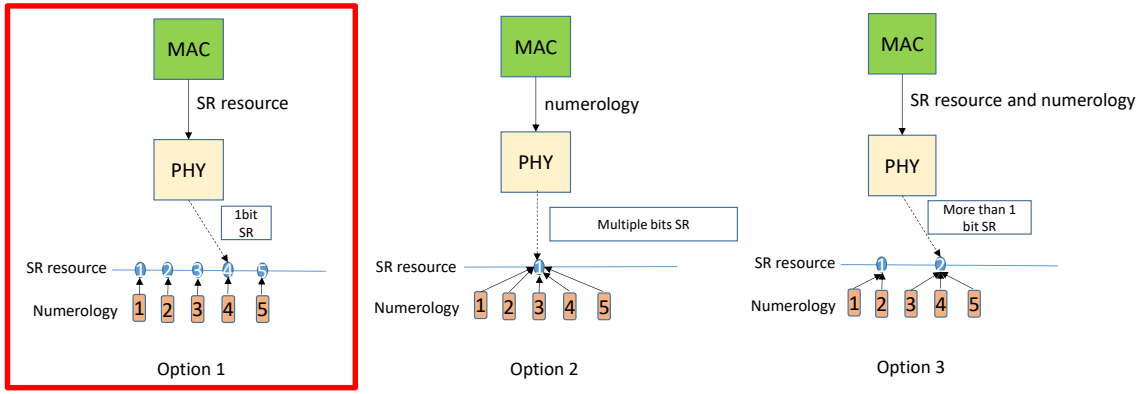
02-2 User Plane – MAC

SR (Scheduling Request)

- ✓ Multiple SR configuration will be support
  - ✓ To support multiple numerology
- ✓ One or multiple logical channel(s) are mapped to SR configuration (e.g. not LCG)
- ✓ RAN2 understanding is that numerology of the SR transmission need not be the same as the numerology of the LCH which triggered the SR.

BSR

- ✓ Flexible Long BSR format will be supported.
- ✓ BSR type will be selected by amount of data in buffer
  - ✓ Length of BS in Short BSR: 5bits
  - ✓ Length of BS in Long BSR: 8bits



R2-1705625 SR enhancements with multiple numerologies, Huawei, HiSilicon

SPS/Grant free

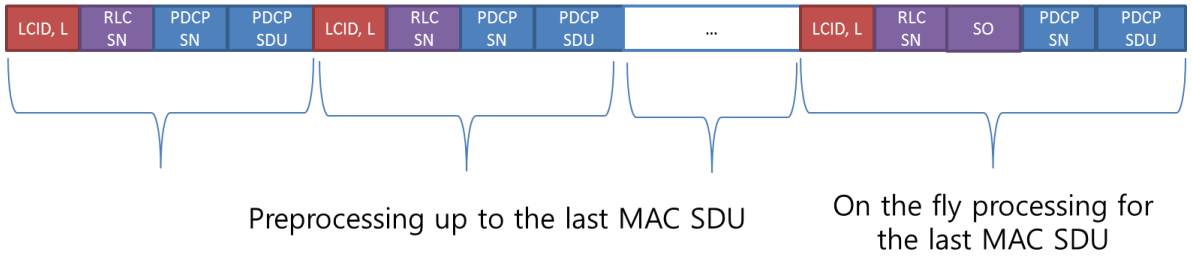
- ✓ DL SPS operation will be based on LTE
- ✓ Multiple SPS will be supported but not for the same cell

Impact of BWP

- ✓ New timer “BWP inactivity timer” is introduced

02-2 User Plane - RLC

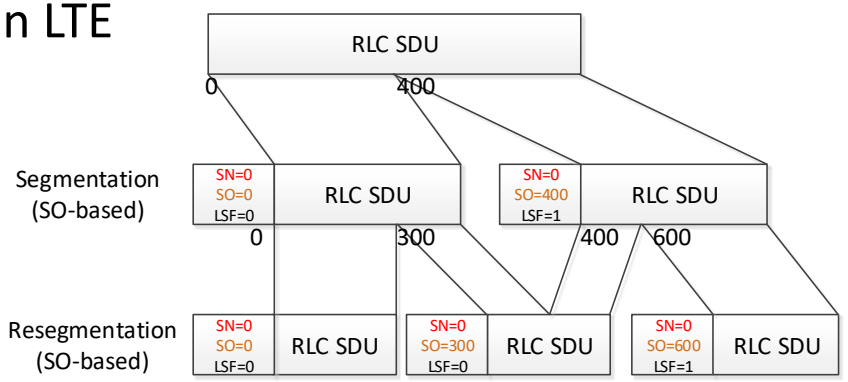
- ✓ RLC (to support Real-time Processing)
  - ✓ Removing Concatenation



R2-169092, NO RLC Concatenation, Samsung

- ✓ SO-based segmentation
  - ✓ Only in RLC layer
  - ✓ The SO field should be included in the last SDU segment as well as the middle SDU segment.
  - ✓ Name of FI field is changed to SI but reused as same in LTE

Benefit of removing concatenation and SO-based segmentation
- UE: Pre-processing for reducing latency, High-speed L2 processing by hardware accelerator
- NW: Flexibility of CU-DU split



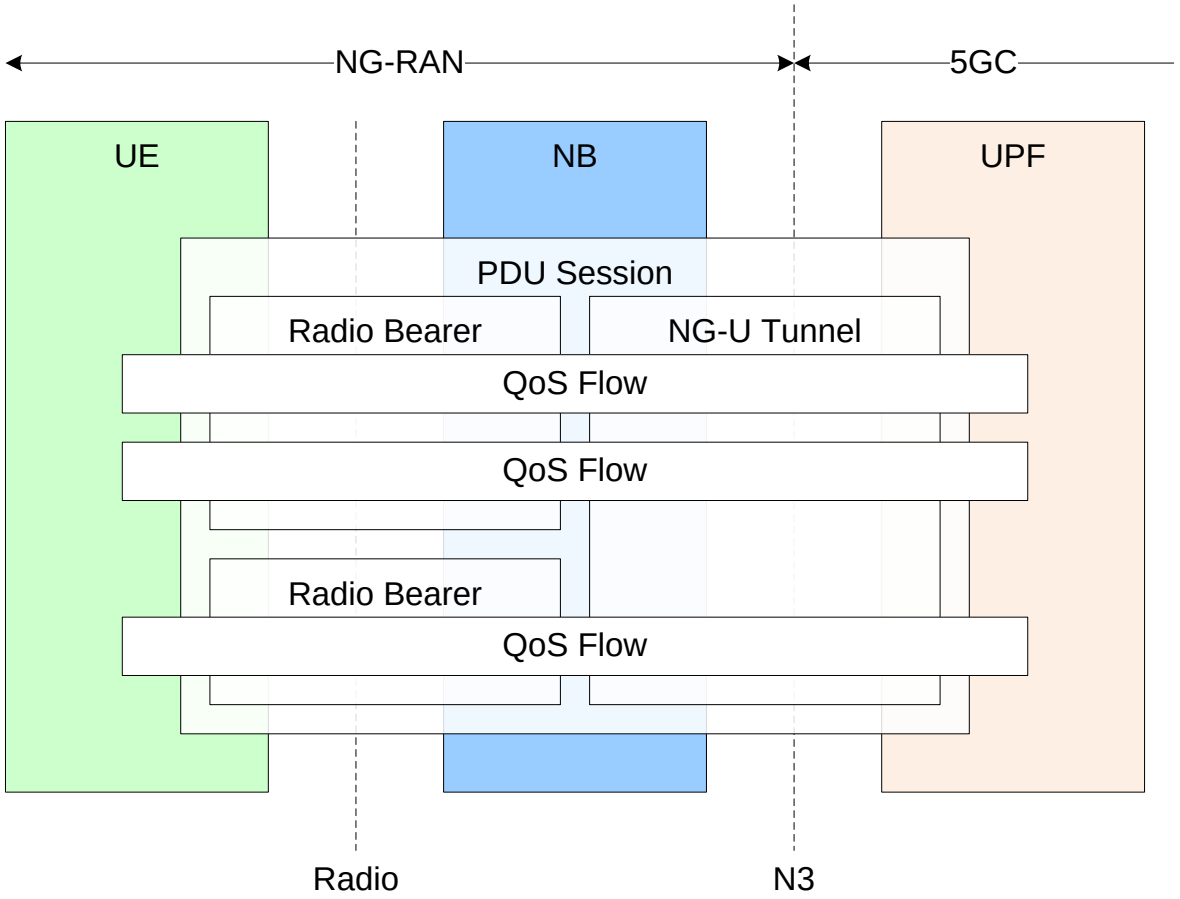
R2-166511 SO-based Segmentation, Samsung

02-2 User Plane –RLC/PDCP

- ✓ NACK range field introduced
  - ✓ indicating the number of consecutively lost RLC SNs starting from and including NACK_SN
  - ✓ E3 indicates the presence of NACK range
- ✓ ARQ
  - ✓ RLC AM supports T-reordering like functionality for the purposes of determining the content of the RLC status report.
- ✓ Single Reordering
  - ✓ PDCP reordering is always enabled.
  - ✓ Out-of-sequence delivery from RLC to PDCP
  - ✓ Out-of-order deciphering of PDCP PDUs
  - ✓ RLC reassembles RLC SDU and delivers them to upper layers in the order they are received

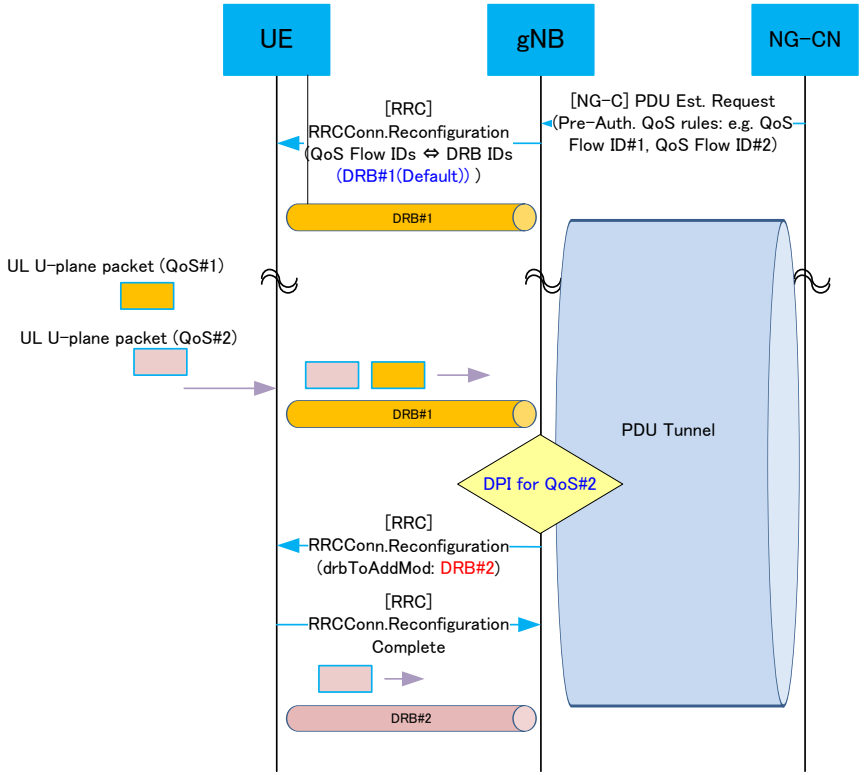
02-2 User Plane - QoS

- ✓ QoS (general)
  - ✓ For each UE, the NG-RAN establishes one or more Data Radio Bearers (DRB) per PDU Session.
  - ✓ 2-step mapping
    - ✓ NAS level packet filters in the UE and in the 5GC associate UL and DL packets with QoS Flows
    - ✓ AS-level mapping rules in the UE and in the NG-RAN associate UL and DL QoS Flows with DRBs.



02-2 User Plane - QoS

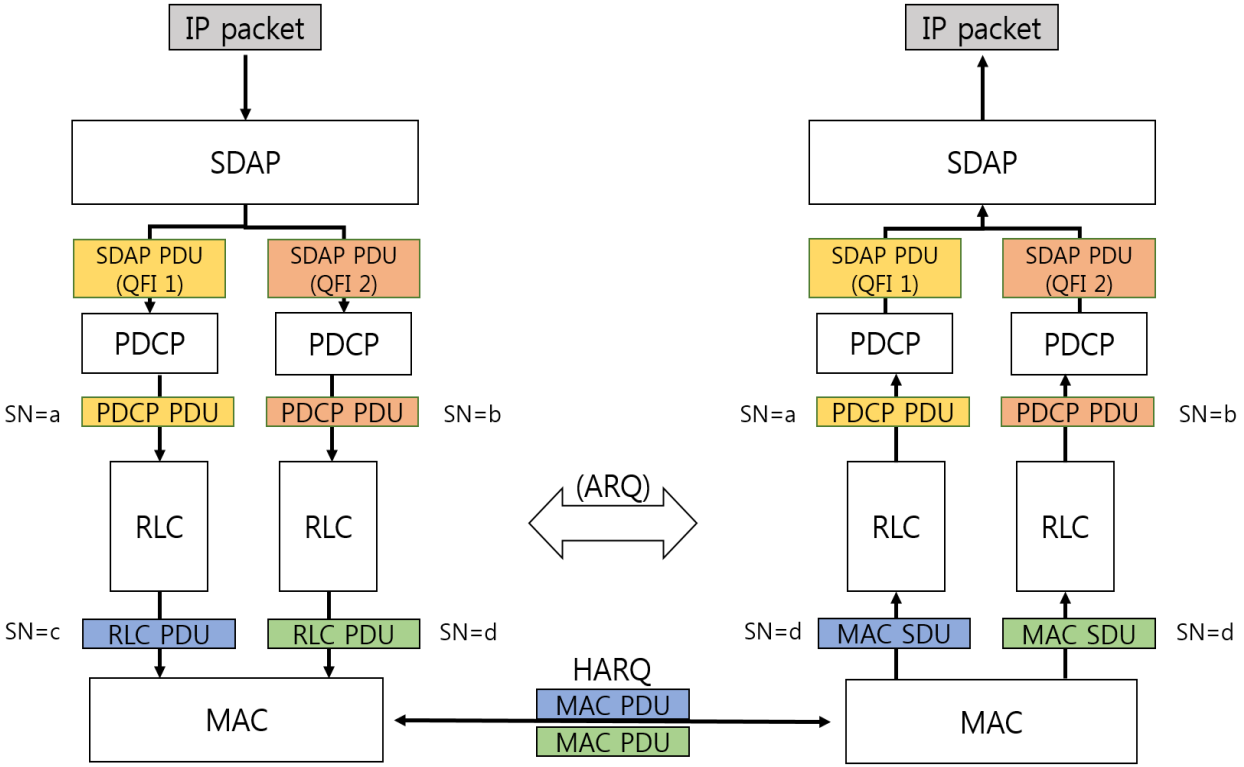
- ✓ QoS (default bearer)
  - ✓ The NG-RAN establishes at least one default DRB for each PDU Session.
  - ✓ Reflective QoS Attribute (RQA): the RQA, when included, indicates that some (not necessarily all) traffic carried on this QoS flow is subject to reflective quality of service (RQoS) at NAS.
  - ✓ If an incoming UL packet matches neither an RRC configured nor a reflective "QoS Flow ID to DRB mapping", the UE shall map that packet to the default DRB of the PDU session.

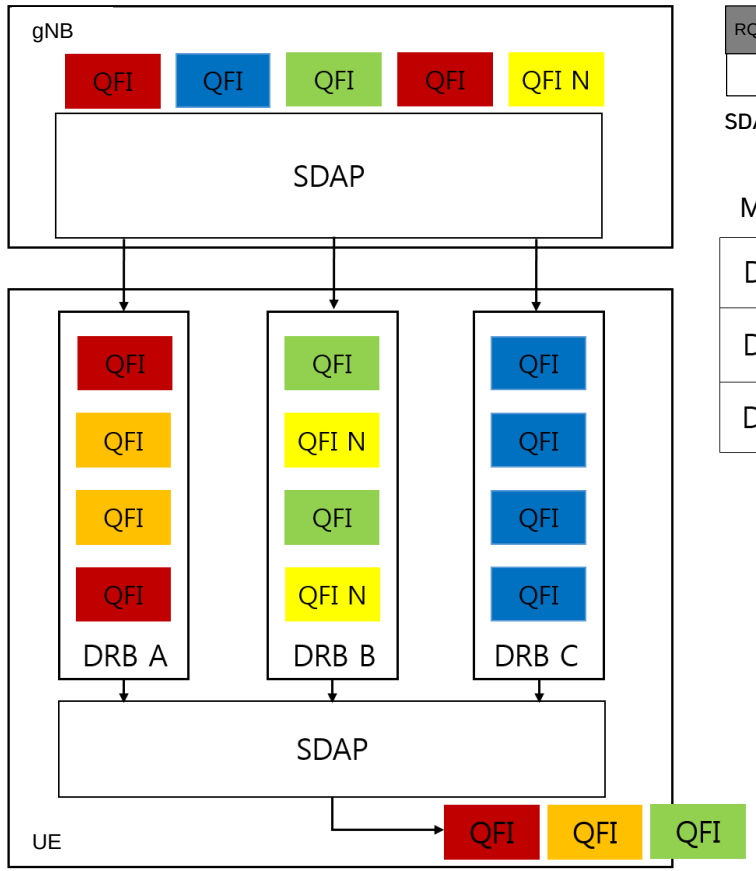


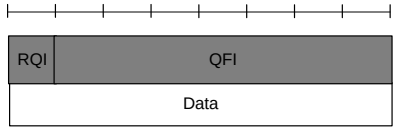
R2-1701991 On first UL packet without QoS mapping configuration, NTT DOCOMO INC

02-2 User Plane - SDAP

- ✓ SDAP (will be discussed for Rel-15)
  - ✓ A single protocol entity of SDAP is configured for each individual PDU session, except for DC where two entities can be configured (one for MCG and another one for SCG)
  - ✓ No SN will be introduced in SDAP





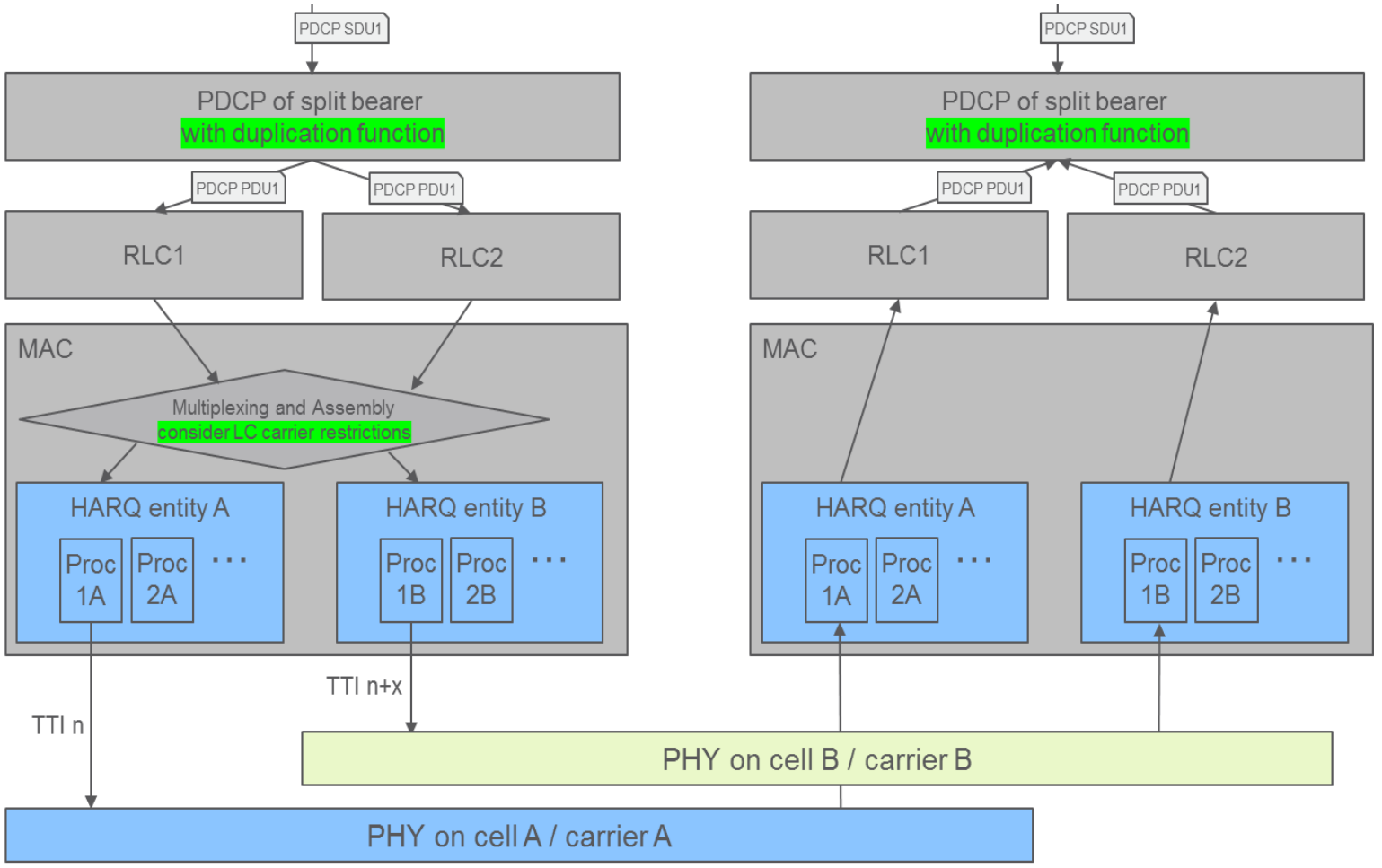


SDAP Data PDU format with SDAP header

Mapping table

DRB A	QFI QFI
DRB B	QFI N QFI
DRB C	QFI

- ✓ Duplication for URLLC (discussion will be restarted for Rel-15)
  - ✓ For DL and UL, duplication solution for CA case uses PDCP duplication to more than 1 logical channel so that the duplicated PDCP PDUs are sent over different carriers.

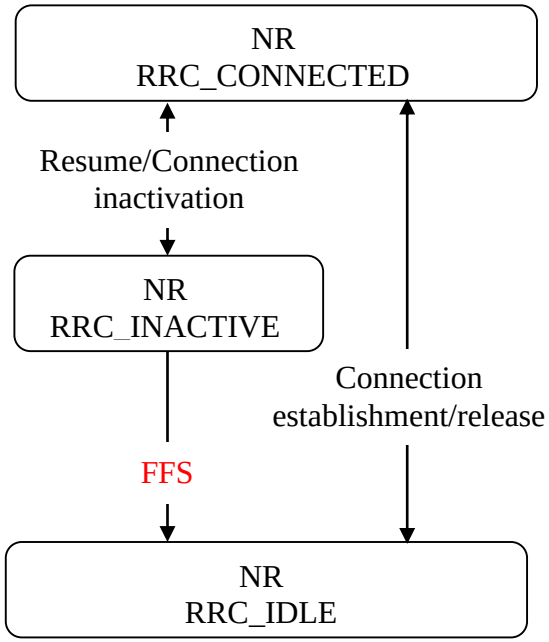


R2-1702032 Data duplication in lower layers (HARQ), Ericsson

02-3 Control Plane – RRC inactive

- ✓ RRC inactive
  - ✓ Broadcast of system information;
  - ✓ Cell re-selection mobility;
  - ✓ Paging is initiated by NG-RAN (RAN paging);
  - ✓ RAN-based notification area (RNA) is managed by NG-RAN;
  - ✓ DRX for RAN paging configured by NG-RAN;
  - ✓ 5GC - NG-RAN connection (both C/U-planes) is established for UE;
  - ✓ The UE AS context is stored in NG-RAN and the UE;
  - ✓ NG-RAN knows the RNA which the UE belongs to.

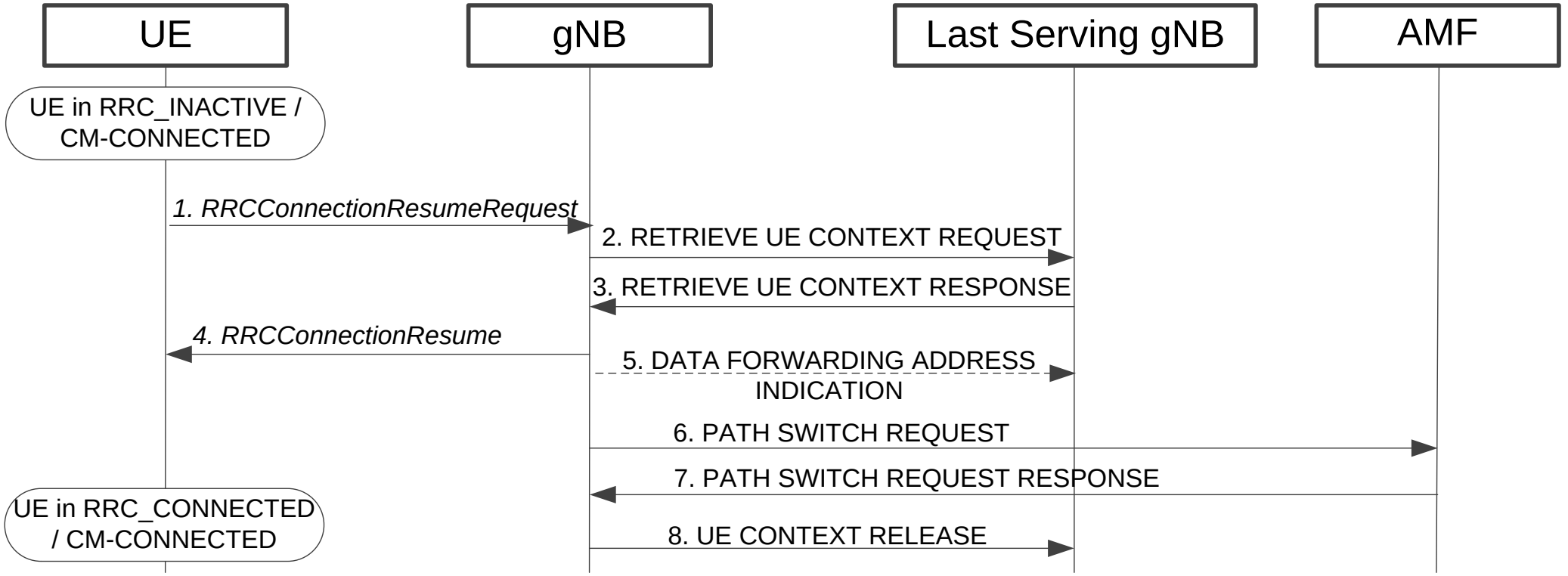
  - ✓ For NR connected to 5GC, the following UE identities are used at NG-RAN level:
    - ✓ I-RNTI: unique identification used to identify the UE context for RRC_INACTIVE.



UE state machine and state transitions in NR

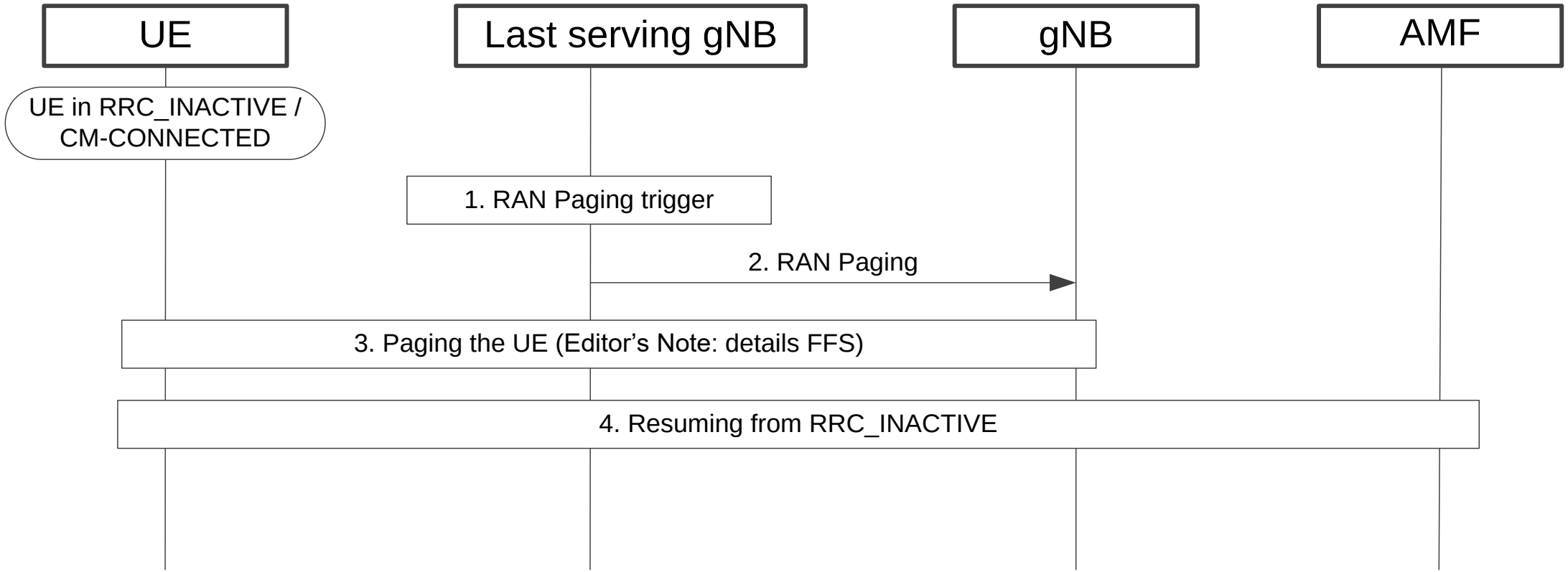
02-3 Control Plane – RRC inactive

- ✓ UE triggered transition from RRC_INACTIVE to RRC_CONNECTED



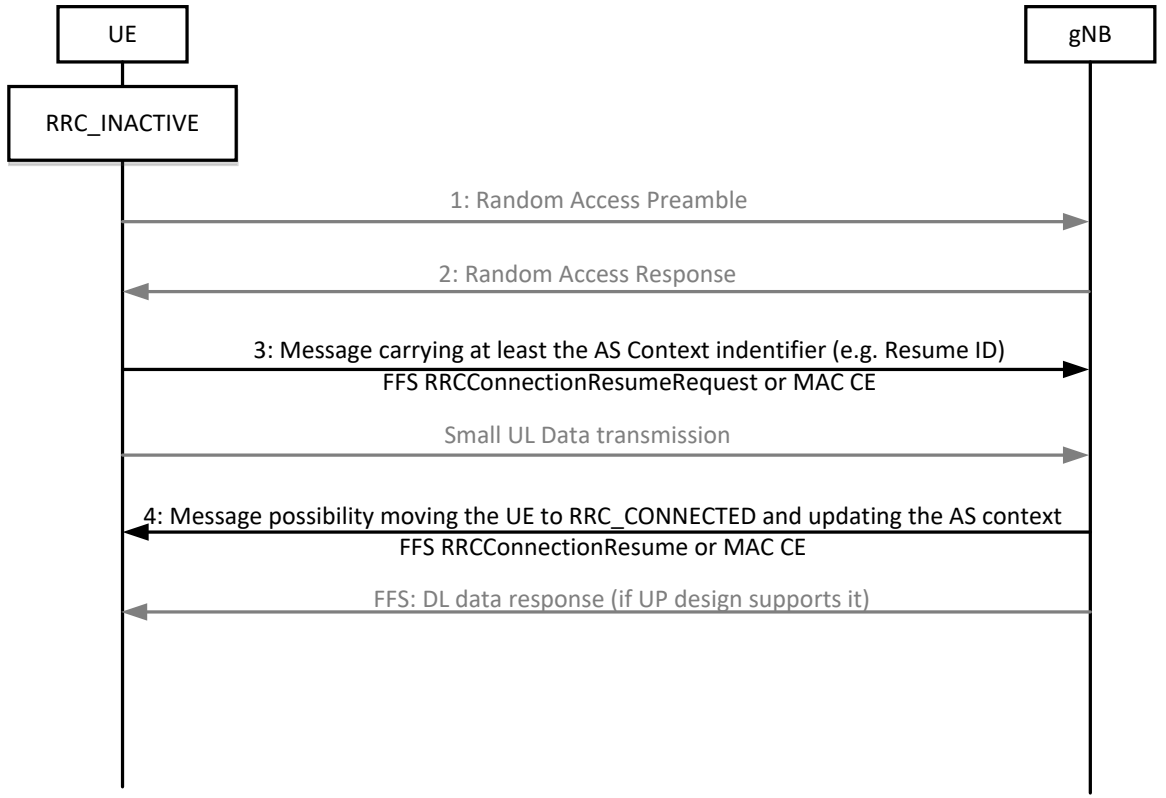
02-3 Control Plane – RRC inactive

- ✓ NW triggered transition from RRC_INACTIVE to RRC_CONNECTED



1. A RAN paging trigger event occurs (incoming DL user plane, DL signalling from 5GC, etc.)
2. RAN paging is triggered; either only in the cells controlled by the last serving gNB or also by means of Xn RAN Paging, in other gNBs, being member of the RAN Paging area the UE is registered with.

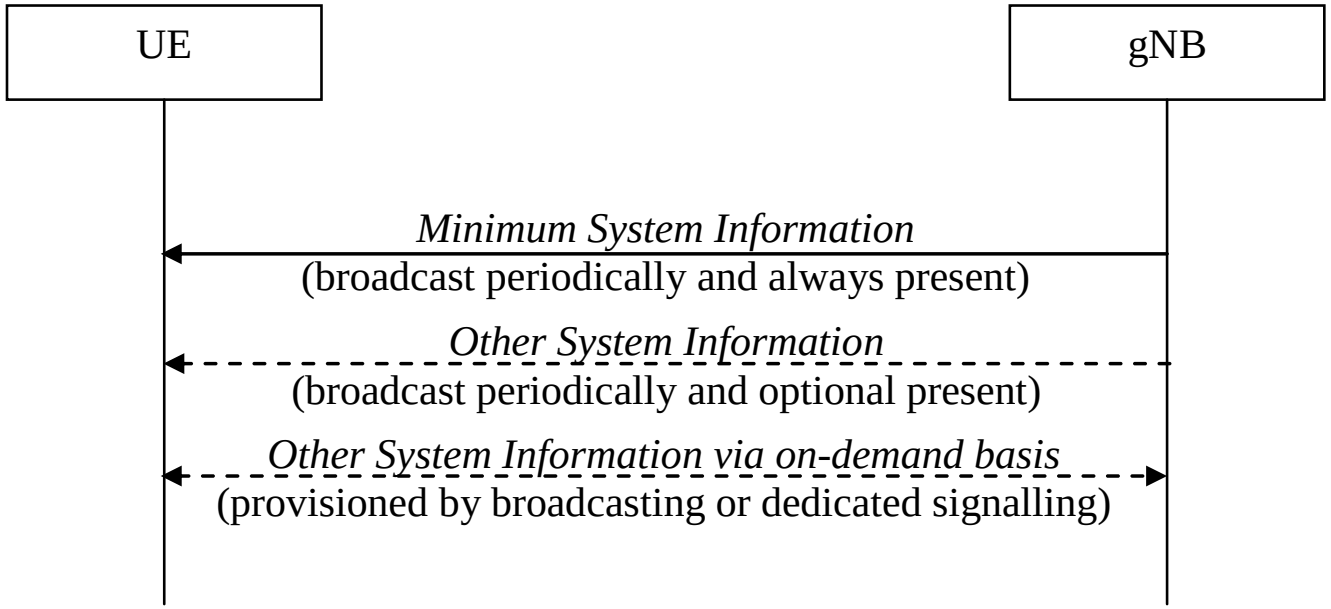
- ✓ RRC inactive (remaining issues)
  - ✓ Small UL data transmission in RRC_INACTIVE refers to a feature where a UE in RRC_INACTIVE can transmit small UL data without necessarily performing a full state transition to RRC_CONNECTED. (not agreed yet)
    - ✓ If supported, the feature should be service-agnostic, catering different service requirements. The feature should work either with 4-step or 2-step RACH



Example of a message flow for the small UL data transmission in RRC_INACTIVE

02-3 Control Plane - SI

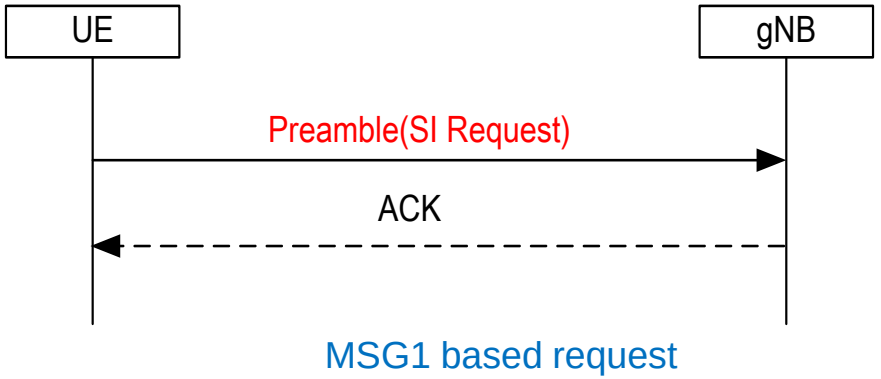
- ✓ System information (general)
  - ✓ Minimum SI (MIB, SIB1)
    - ✓ Periodically broadcast
    - ✓ Basic information required for initial access to a cell
    - ✓ Information for acquiring any other SI broadcast periodically or provisioned via on-demand basis (i.e. scheduling information)
  - ✓ Other SI (SIB2, …)
    - ✓ The other SI encompasses everything not broadcast in the minimum SI.
    - ✓ may either be broadcast, or provisioned in a dedicated manner, either triggered by the network or upon request from the UE



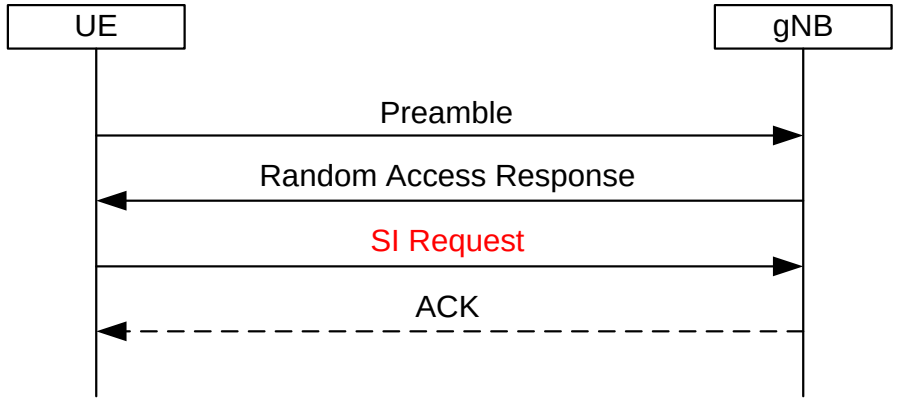
High level concept of on-demand SI provisioning

02-3 Control Plane - SI

- ✓ System information (on-demand SI)
  - ✓ RRC_CONNECTED
    - ✓ dedicated RRC signalling is used for the request and delivery of the Other SI.
  - ✓ RRC_IDLE and RRC_INACTIVE,
    - ✓ The request triggers a random access procedure and is carried over MSG3 unless the requested SI is associated to a subset of the PRACH resources, in which case MSG1 can be used.
    - ✓ When MSG1 is used, the minimum granularity of the request is one SI message (i.e. a set of SIBs), one RACH preamble can be used to request multiple SI messages and the gNB acknowledges the request in MSG2. When MSG 3 is used, the gNB acknowledges the request in MSG4.



MSG1 based request

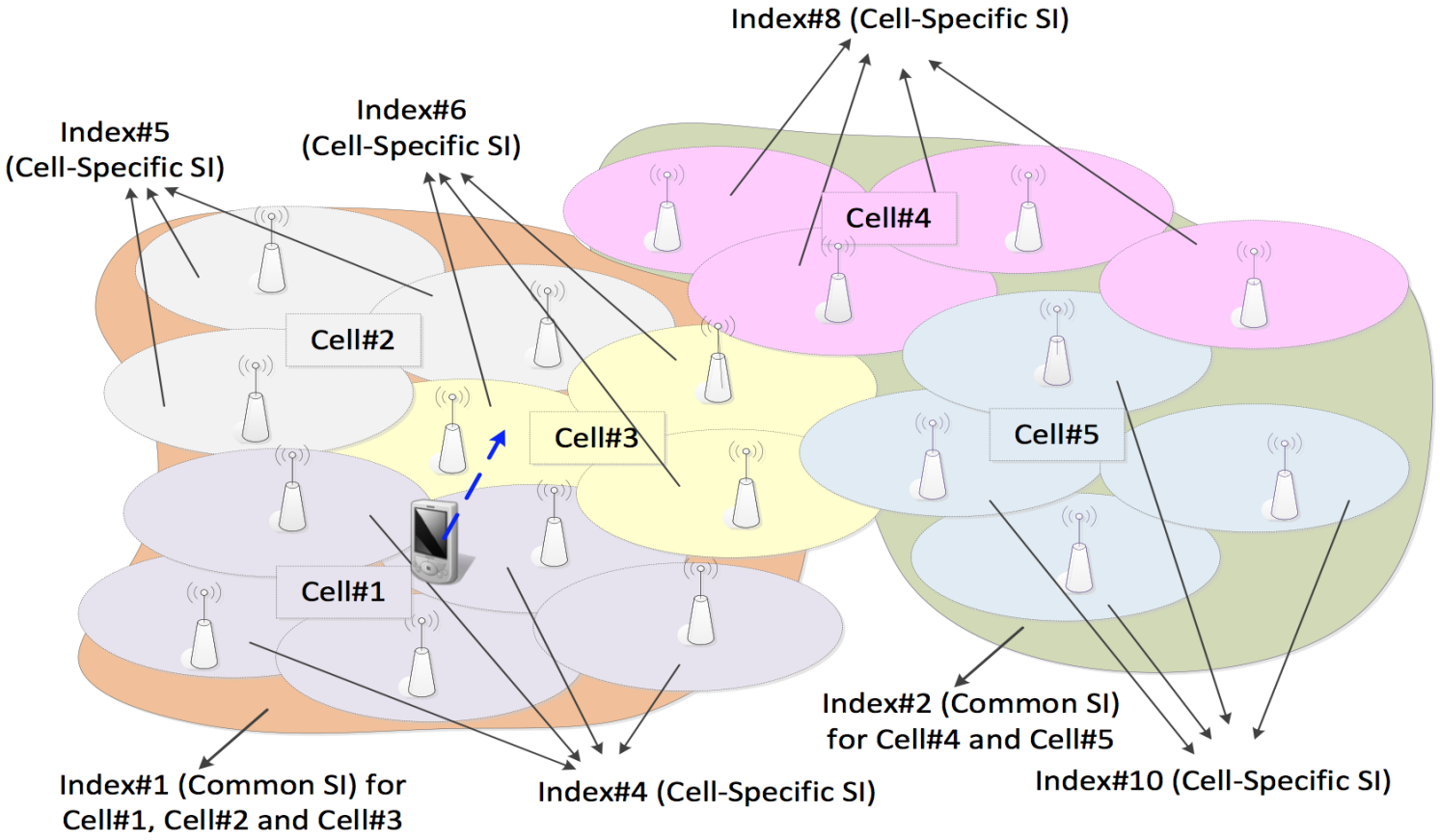


MSG3 based request

R2-1701490 On-demand SI Request Transmission, CATT

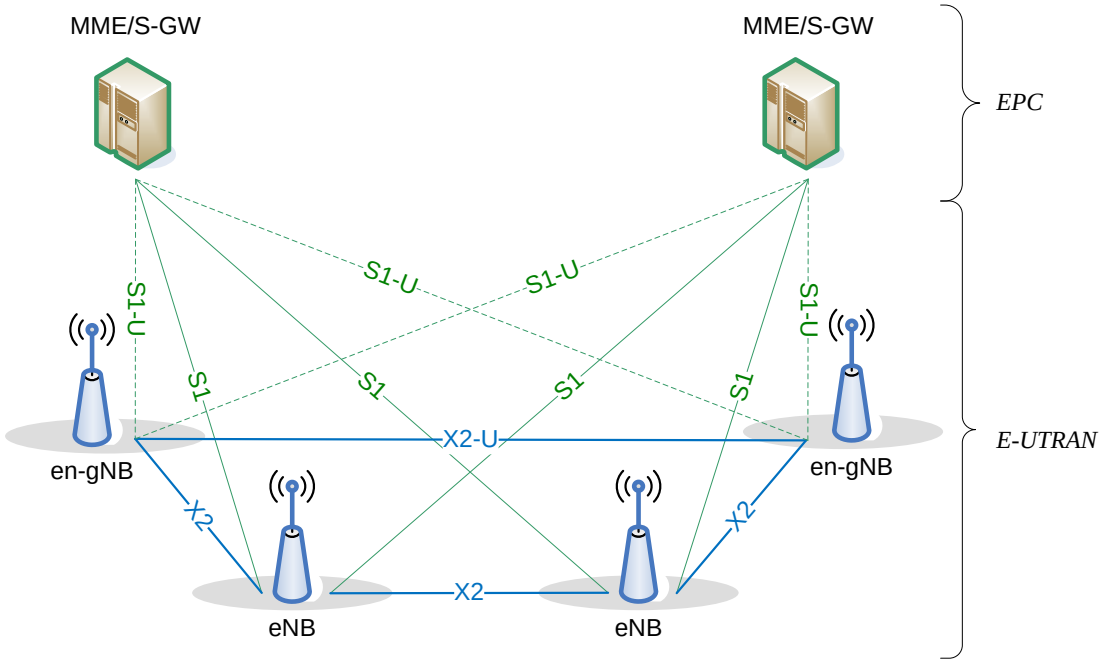
02-3 Control Plane - SI

- ✓ System information (indexed / Stored SI)
  - ✓ Broadcasting some kind of index/identifier in minimum SI to enable the UE to avoid re-acquisition of already stored SI-block(s)/SI message(s).
  - ✓ The index/identifier and associated system information can be applicable in more than one cell.
  - ✓ System information valid in one cell may be valid also in other cells.

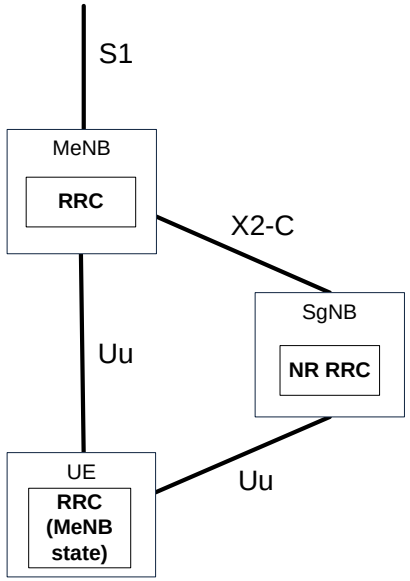


R2-1701569 Way forward on index based approaches, Samsung

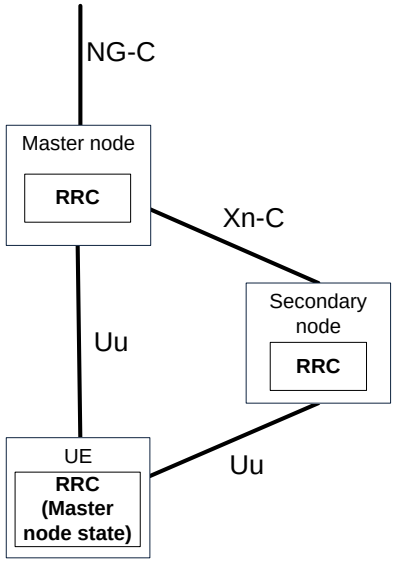
✓ Architectures



Overall Architecture



EN-DC

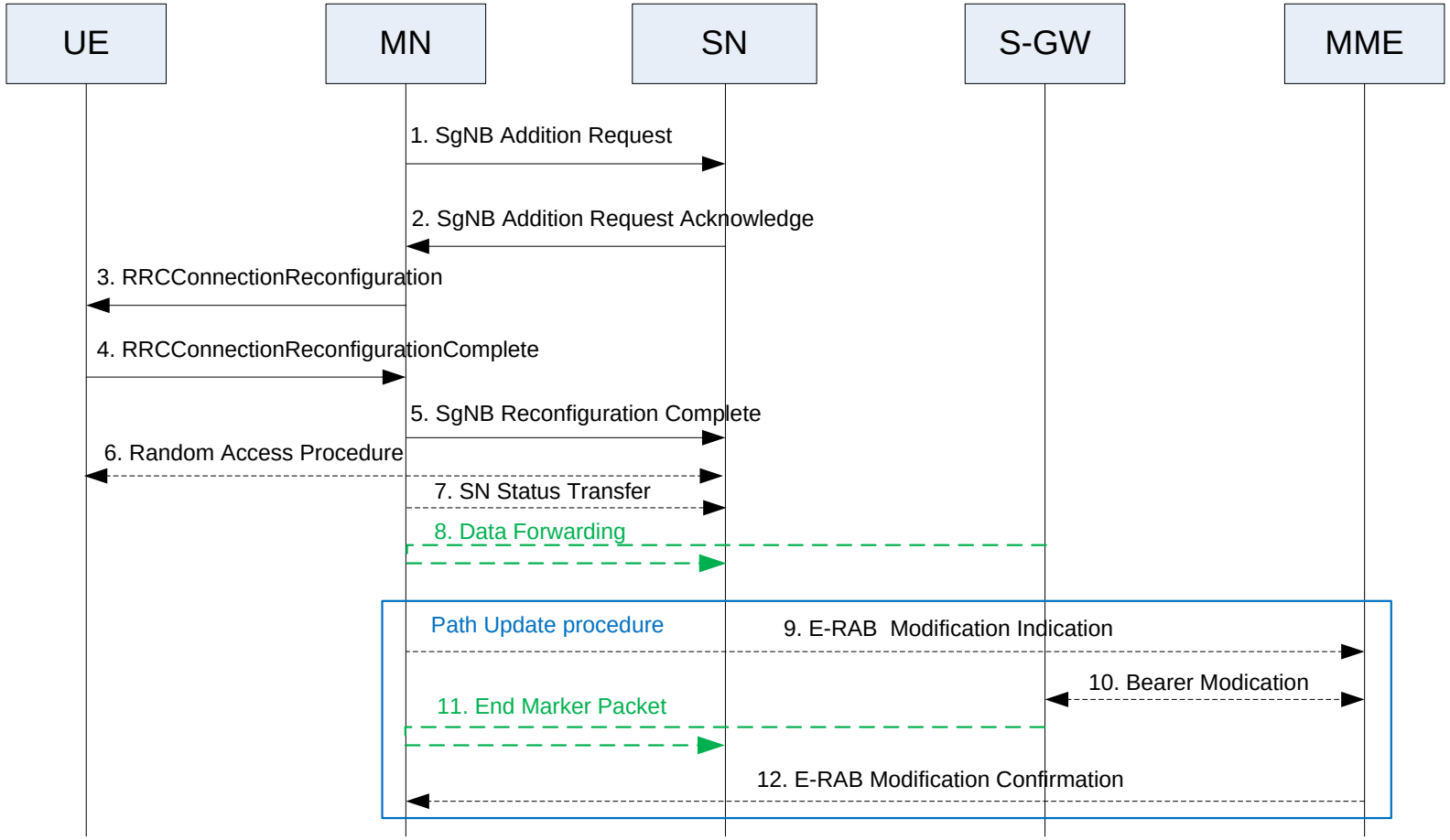


MR-DC with 5GC

c.f. NG-RAN E-UTRA-NR Dual Connectivity (NGEN-DC):
in which a UE is connected to one ng-eNB that acts as a MN and one gNB that acts as a SN

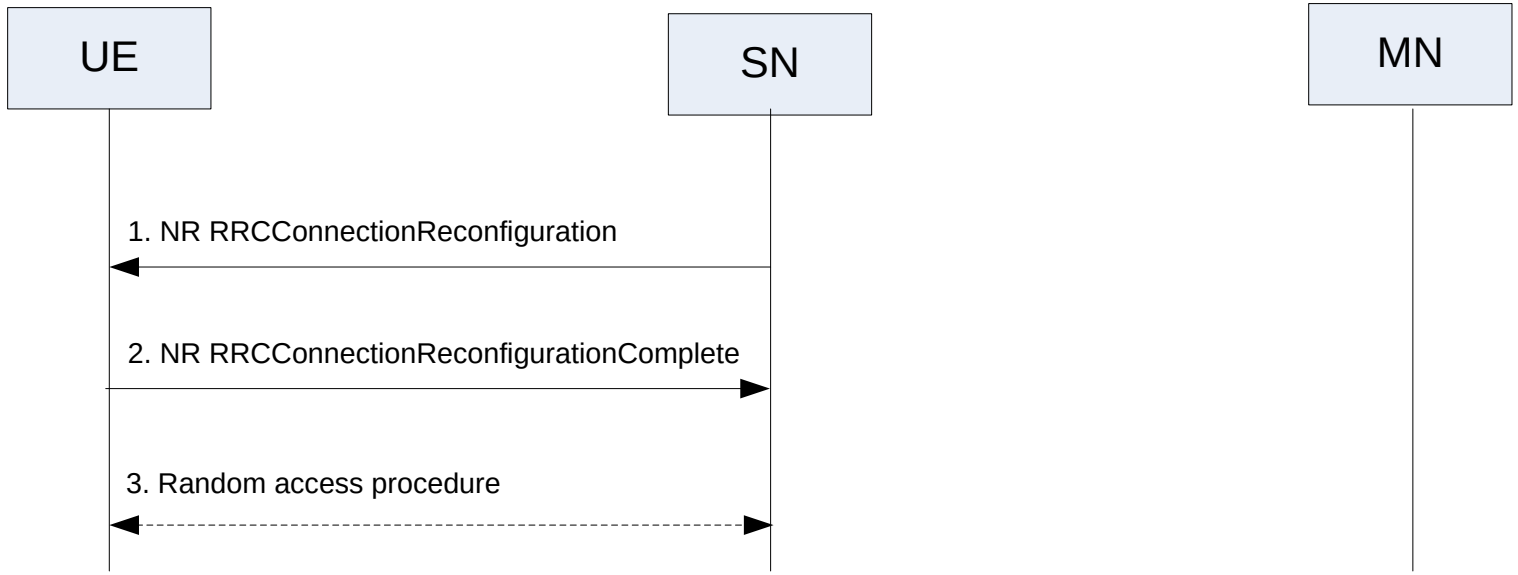
02-3 Control Plane – EN-DC (procedures)

- ✓ The Secondary Node Addition procedure
  - ✓ Initiated by the MN and is used to establish a UE context at the SN to provide radio resources from the SN to the UE.
  - ✓ For bearers requiring SCG radio resources, this procedure is used to add at least the first cell of the SCG. This procedure can also be used to configure an SN terminated MCG bearer (where no SCG configuration is needed).



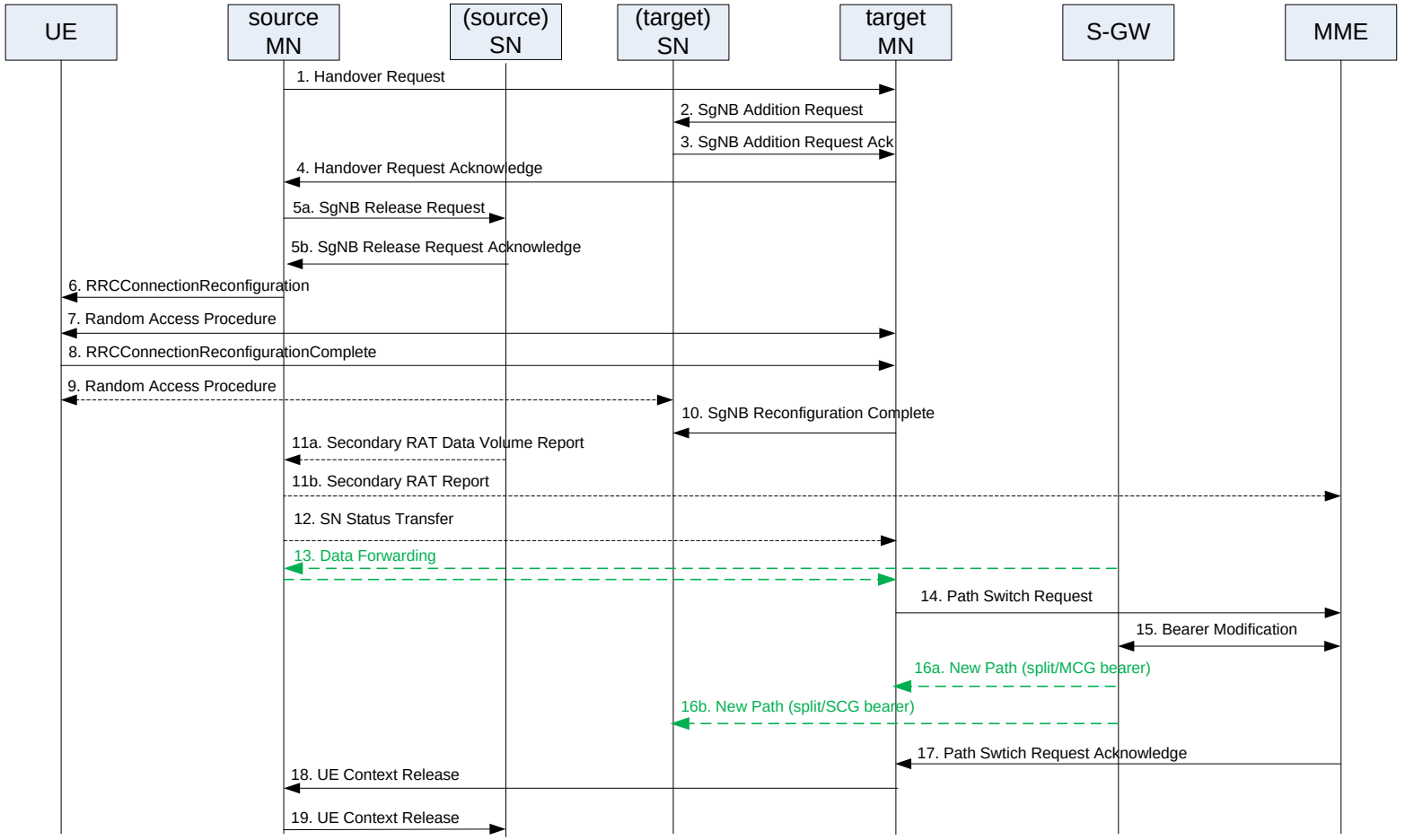
02-3 Control Plane – EN-DC (procedures)

- ✓ SN initiated SN Modification without MN involvement
  - ✓ To modify the configuration within SN in case no coordination with MN is required
    - ✓ NR measurement configuration
    - ✓ NR MAC, RLC and PDCP configuration
    - ✓ NR physical layer reconfiguration. The physical layer reconfiguration includes the modification of physical parameters used by PSCell or SCell(s). It also includes add/release of NR SCell(s).
    - ✓ NR RLF Timer and Constants
    - ✓ PSCell change that doesn't impact MN (e.g. when the security key does not need to be changed and the MN does not need to be involved in PDCP recovery)



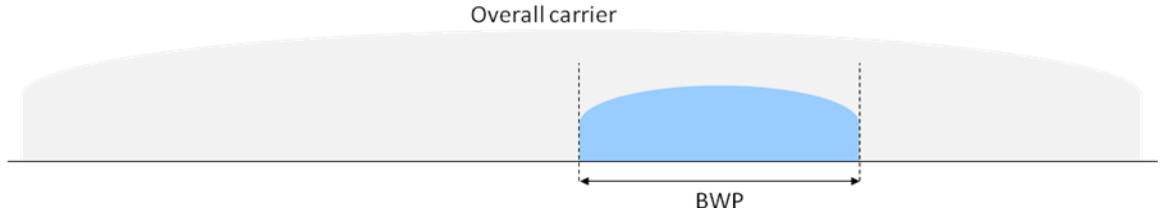
02-3 Control Plane – EN-DC (procedures)

- ✓ Inter-MN handover with/without MN initiated SN change
  - ✓ Used to transfer context data from a source MN to a target MN while the context at the SN is kept or moved to another SN.
  - ✓ During an Inter-Master Node handover, the target MN decides whether to keep or change the SN

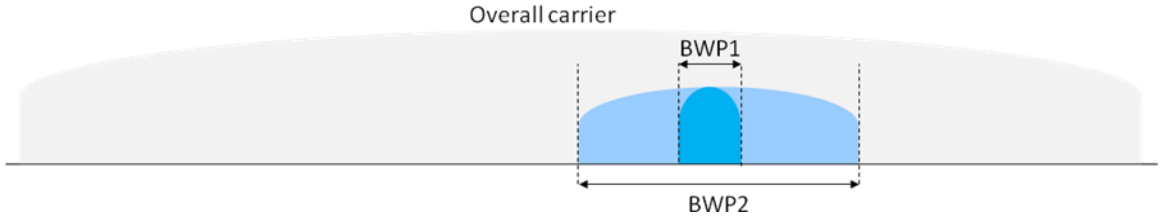


Impact of bandwidth parts

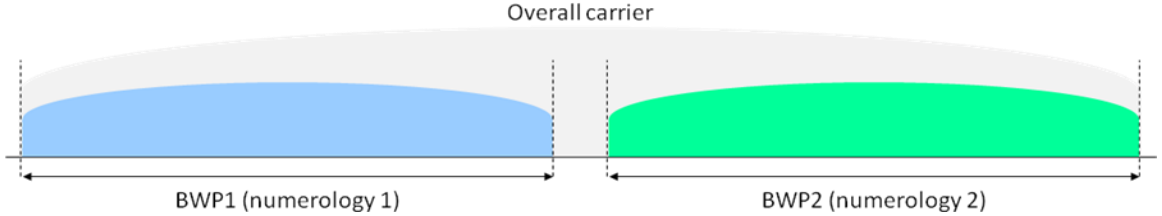
- ✓ BWP impacts on the CONNECTED mode will be progressed by Dec 17.
- ✓ The cell defining SS block is considered as the time reference of the serving cell, and for RRM serving cell measurements based on SSB (irrespective of which BWP is activated)
- ✓ RRC timers and counters related to RLM are not reset when the active BWP is changed



For a wideband capable UE operating at low data rate or a narrow band UE, only a single BWP with smaller bandwidth can be configured to the UE



For a wideband capable UE initially operating on a single BWP with smaller bandwidth, with the increase of data rate, the bandwidth of the BWP can be reconfigured (e.g. enlarged)

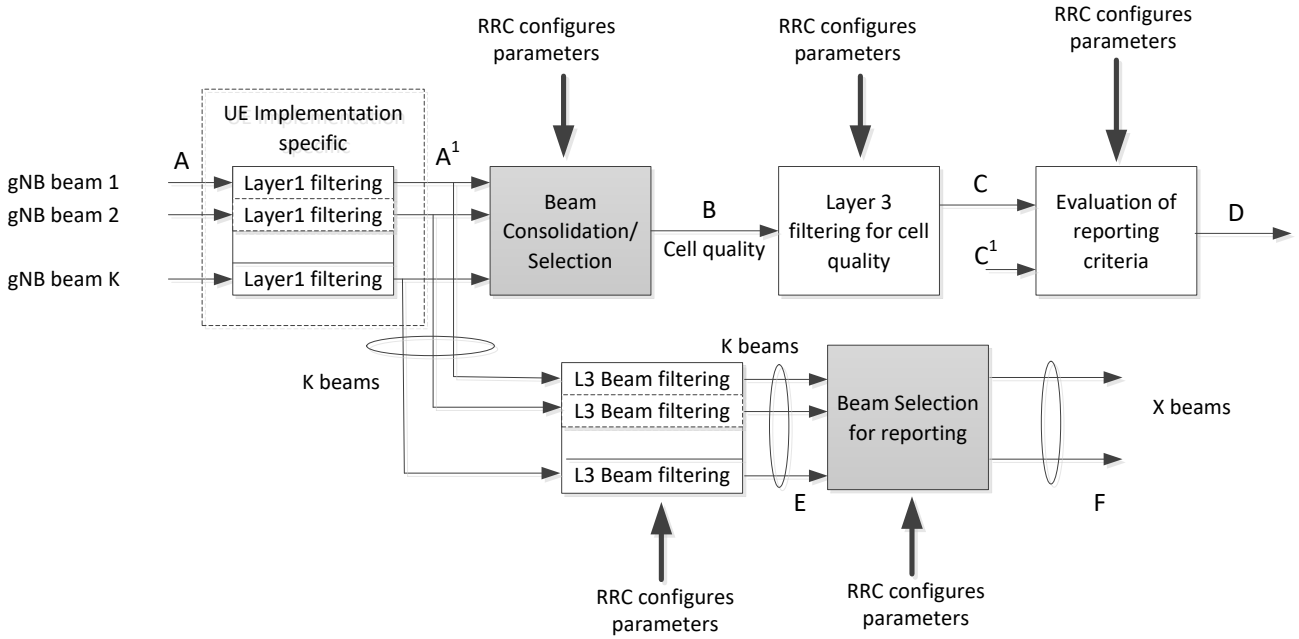


For a wideband capable UE operating at high data rate or for a CA capable UE, multiple BWPs can be configured for the UE

R2-1711640 Initial discussion on the impacts of BWP on RAN2, ZTE

02-4 Mobility - Measurement

- ✓ Mobility (RRM measurement – RRC connected)
  - ✓ Perform RRM measurements on always on IDLE RS (e.g. synchronization signal) and additional RS (e.g. CSI-RS, MRS, etc.).
  - ✓ Cell quality can be derived from N best beams where value of N can be configured to 1 or more than 1.
    - ✓ Best beam: above absolute configured threshold
    - ✓ Cell quality: Averaging the best beam (up to N-1 best beams)
    - ✓ Independent N and independent threshold should be configured per carrier frequency in the MeasObject for NR-SS based and CSI-RS based L3 mobility. (FFS: per cell)
  - ✓ Support reporting of individual beam measurement
    - ✓ Actual beam result may be reported (as in LTE)



Measurement Model

02-4 Mobility - Handover

- Mobility (Handover – RRC connected)
  - Access information (e.g. RACH configuration) for the target cell is provided in the HO command to enable the UE to access the cell without reading system information. Access information may include beam specific information (if any).
  - Whether to support HO without RLC re-establishment will be discussed in the WI when the RLC design is more clear.
  - 'Conditional' handover can continue to be discussed within the WI phase
  - We will aim to define HO for NR with an interruption as close to zero as possible while only having single Tx/Rx in the UE, and 0ms interruption at least for the case that the UE supports simultaneous Tx/Rx with source cell and target cell during HO
  - RAN2 protocols for NR should be flexible to allow the possibility of intra-freq DC/multi connectivity

04 Reference

- ✓ 3GPP TR 38.804 V14.0.0
- ✓ 3GPP TS 38.300 V2.0.0
- ✓ 3GPP TS 38.321 V2.0.0
- ✓ 3GPP TS 37.340 V2.0.0