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3GPP TSG RAN Rel-18 workshop
Electronic Meeting, June 28 - July 2, 2021
Agenda Item: 4.2

On eMBB Upper Layer Enhancements

Perspectives for Release 18

5G

eMBB - Upper layers

Summary

- Multi-SIM enhancements
  - Dual Active support
    - Coordinated scheduling and capabilities across connections
    - Dynamic UE capability and TDM scheduling
  - Enhancements for same operator scenario
    - There are relevant scenarios with users having two SIMs from the same operator in the same device
    - Allow multiple subscriptions from the same operator to share a single PHY/MAC link
- In Device Coexistence
  - Introduce IDC TDM solution (similar to LTE)
  - Enhance existing FDM solution:
    - Introduce better granularity in UE reporting, e.g., BWP, Sub-band or PRB based reporting
  - Autonomous denial support is not seen as beneficial based on experience from LTE
  - Highest priority is NR SA and NR-DC
- Further UE power savings
  - Further enhancements to DRX groups
  - UE/NW assistance for more power efficient scheduling
- MR-DC enhancements (>2 legs)

Summary

In Device Coexistence

- Introduce IDC TDM solution and enhance FDM solution for NR and MR-DC

Multi-SIM Enhancements

- Dual Active support
  - Dynamic UE capability and TDM scheduling
- Enhancements for same operator scenario

Further UE Power Savings

- Further enhancements to DRX groups
- UE/NW assistance for more power efficient scheduling

MR-DC enhancements

- Extension of multi-connectivity to more than two Cell Groups

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3GPP MUSIM background

- Rel-17 Work Items are in progress in both SA and RAN.
- The scope of Rel-17 work:
  - Paging collision detection and avoidance
  - Switching between two USIM connections
  - Service differentiation in paging.
- Rel-17 WI covers when either one or both USIMs are in RRC Idle/Inactive.
- The case when both USIMs are in RRC Connected (also called DSDA) is outside the scope of Rel-17 work.
- For DSDA, further considerations are needed to address sharing of UE resources/capabilities across the two connections
  - Temporary restriction of UE capabilities, which has been discussed since Rel-15, is a good framework.
  - Time-domain based solutions are also appropriate, especially for uplink.
- If two USIMs belong the same operator, additional enhancements can be introduced:
  - Especially when both USIMs connect to the same CU/DU

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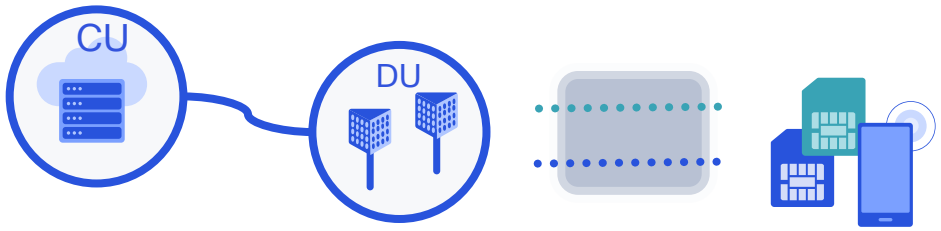
Rel-18 MUSIM Enhancements – Dual Active scenario

High performance dual active connections for the same and across operators

Single link DSDA

Common link for subscriptions in Connected State

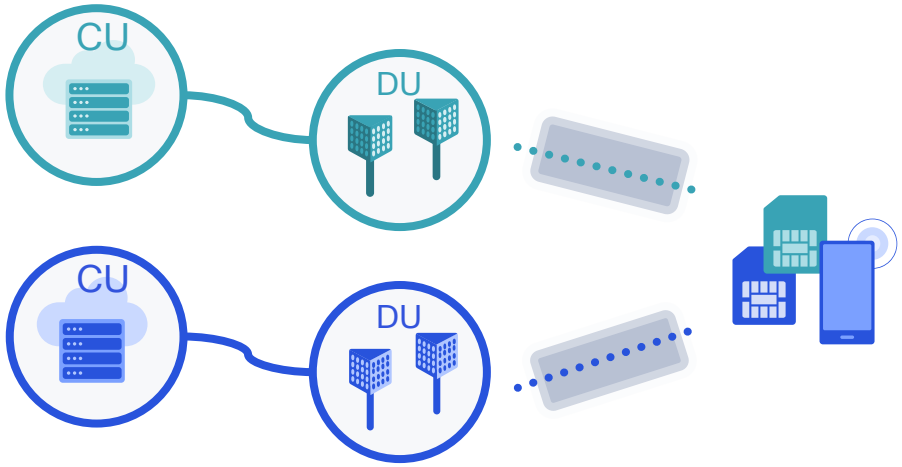


Allow multiple subscriptions from the same operator to share a single PHY/MAC link

- @ CU-CP - each RRC instance is associated with a separate AS context and a corresponding NAS context
- @DU - subscriptions share a common MAC/PHY instance

Multi-link DSDA

Independent link for subscriptions in connected state



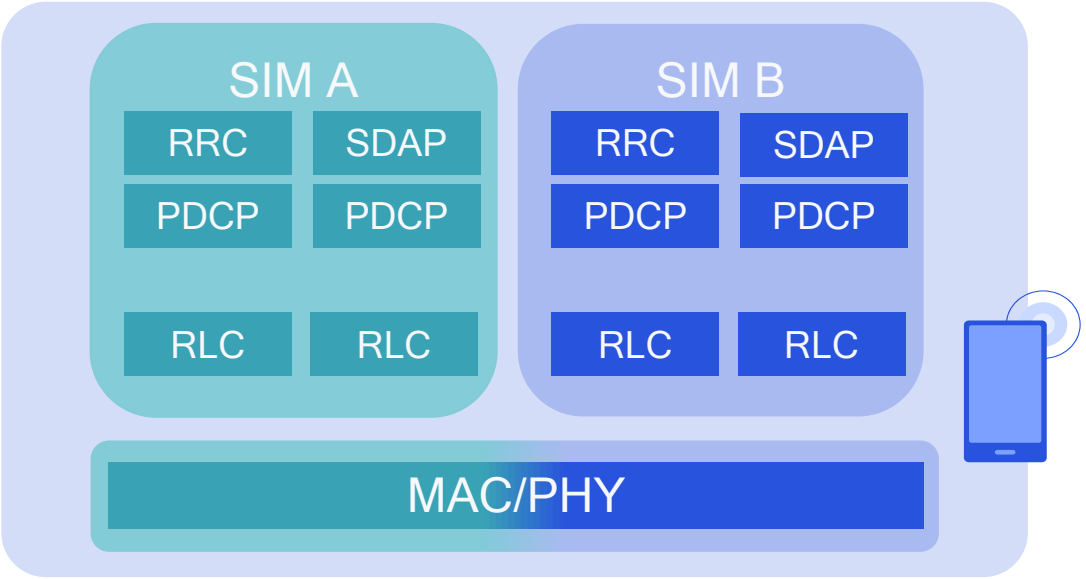
Coordinated scheduling and capabilities across connections

- Flexible gaps to adapt to activity on each USIM
- Temporary capabilities restrictions for simultaneous operation
- Enhancements for same operator case via awareness of the co-location of the subscriptions at the same device

Rel-18 MUSIM: Single Link DSDA Protocol Stack

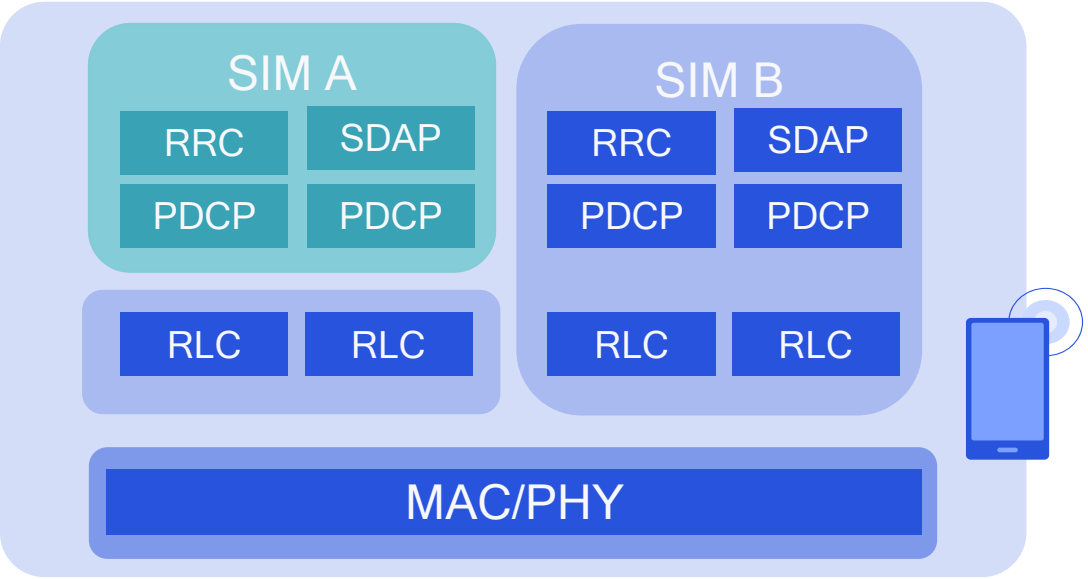
Alternative models

Independent DSDA links



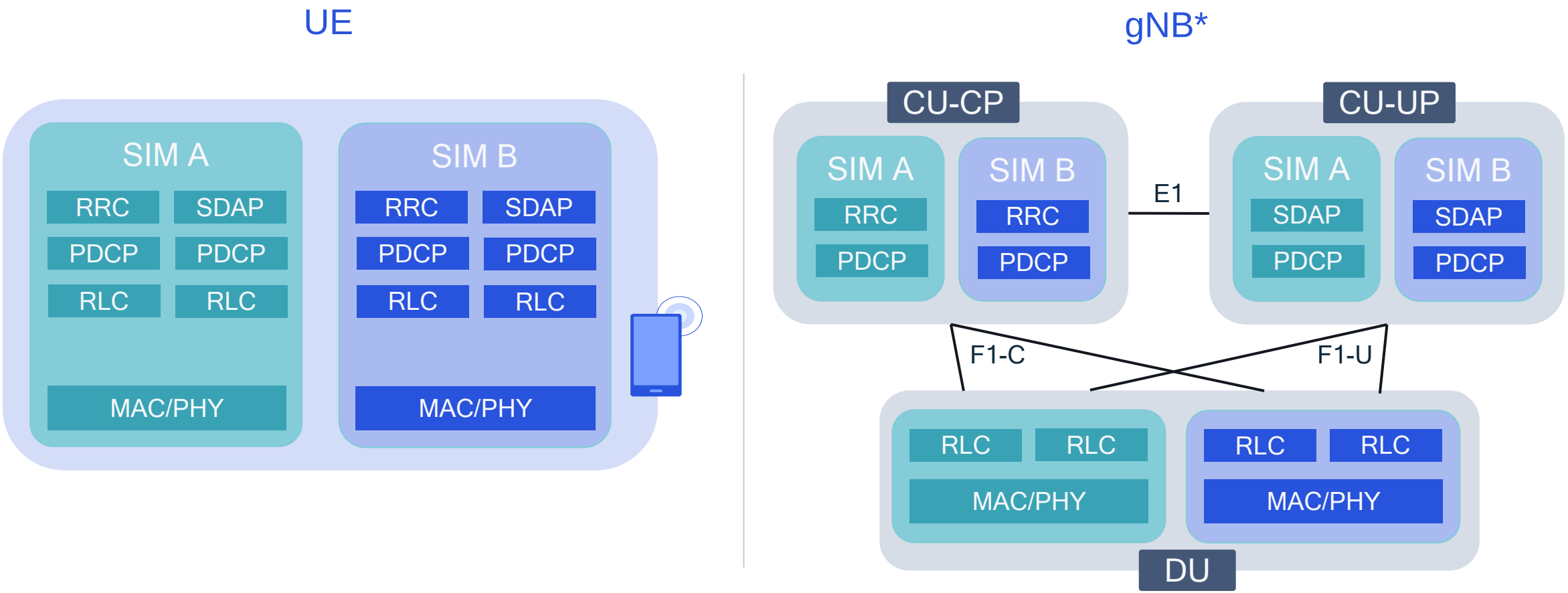
Both links host independent PDCP/RLC and above
Common MAC/PHY configuration shared across SIMs
A primary link is designated to optimize signaling instead of duplicating signaling to both SIMs

Primary/secondary DSDA links



Both links host independent PDCP and above
Common MAC/PHY configuration shared across SIMs
Primary link manages RLC/MAC/PHY for connection with transparently to secondary SIM

Rel-18 MUSIM: Dual Link DSDA Protocol Stack



* For Intra-PLMN (same operator) scenario, same CU can simplify the operation as different CUs will need inter-CU coordination. For different PLMNs, different CU are assumed.

Rel-18 MUSIM: Coordination of UE capabilities

- When the UE is active (Connected) on both USIMs, the capabilities on each link need to be reduced compared to single active USIM baseline.
- UE may need to split RF/baseband resources when both links are active
  - Unless only TDM is used for both downlink and uplink
- General idea for UE requesting reduced or temporary capability restriction was discussed during NR study item in Rel-15.
- Rel-15/16 introduced signaling for the UE to request reduction of number of CCs, BW and MIMO layers.
- Requirement: a more extensive and efficient UE capability signaling
  - Capability change depends on the band combination(s) of both links in use which can change over time
  - Signaling should be fast enough so as not to cause or minimize interruption and inefficiency during transition until capability reconfiguration is complete
- Request for UE capability change should be initiated by the UE.

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Rel-18 MUSIM: Intra-PLMN optimizations

- For the same PLMN, it is beneficial to have “commonality” between two USIM links:
  - Especially for the case when the UE connects to the same gNB
- For IDLE/INACTIVE mode, camping on the same cell/frequency provides power savings:
  - This can also be done as a UE implementation to some degree.
  - Further optimizations, e.g., getting paging for both USIMs on one link is possible with NW side changes.
- For Connected mode, the coordination between two links can be done as a NW side implementation:
  - By making the NW aware of the two links belonging to the same UE
  - Without requiring any changes to the UE side operation at PHY and MAC layers

3GPP IDC background

- IDC was introduced in LTE rel-11 with the intention that in certain bands LTE can interfere with or be interfered by other technologies within the same device
  - Solution includes: FDM, long DRX, short DRX (HARQ based) and autonomous denial
- IDC for EN-DC was also introduced in rel-15
  - Only **FDM solution for EN-DC (option 3)** was specified
- IDC for NR was planned to start from RAN2#106 as an Rel-16 WI but was postponed in RAN#83
  - It was discussed in RAN#85 and given very limited RAN2 time as TEI for Rel-16
- Only FDM solution was introduced in March 2020 for NR SA:
  - Very similar to LTE FDM solution
- RAN plenary has **not** discussed IDC since then.

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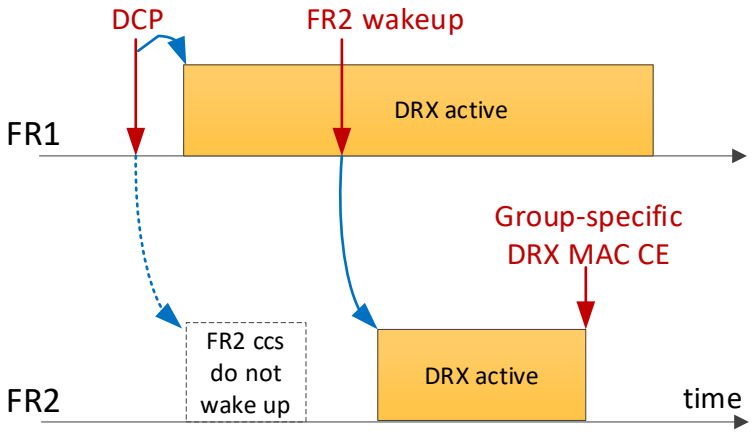
Rel-18 IDC proposals for NR

- TDM option (DRX based):
  - Similar to LTE TDM and use cases,
  - LTE HARQ based solution is not applicable to NR due to different HARQ structures.
- FDM solution enhancements:
  - Introduce better granularity in UE reporting, e.g. BWP, Sub-band or PRB based reporting
- Autonomous denial support is not seen as beneficial based on experience from LTE.
- Highest priority is NR SA and NR-DC.

IDC sub-feature	LTE	EN-DC	NR, NR-DC, NE-DC, NGEN-DC
FDM: Cell level	Supported	Rel-15 (March 2020)	NR: Rel-15 (March 2020)
TDM solution	Supported	Supported for LTE; NR: Rel-18	Rel-18
HARQ Solution	Supported	Supported for LTE, NR: N/A	N/A
Autonomous denial	Supported	Supported for LTE; No interest	No interest
NR enhancement: Better granularity	N/A	No	Rel-18

Rel-18 Further UE Power Savings

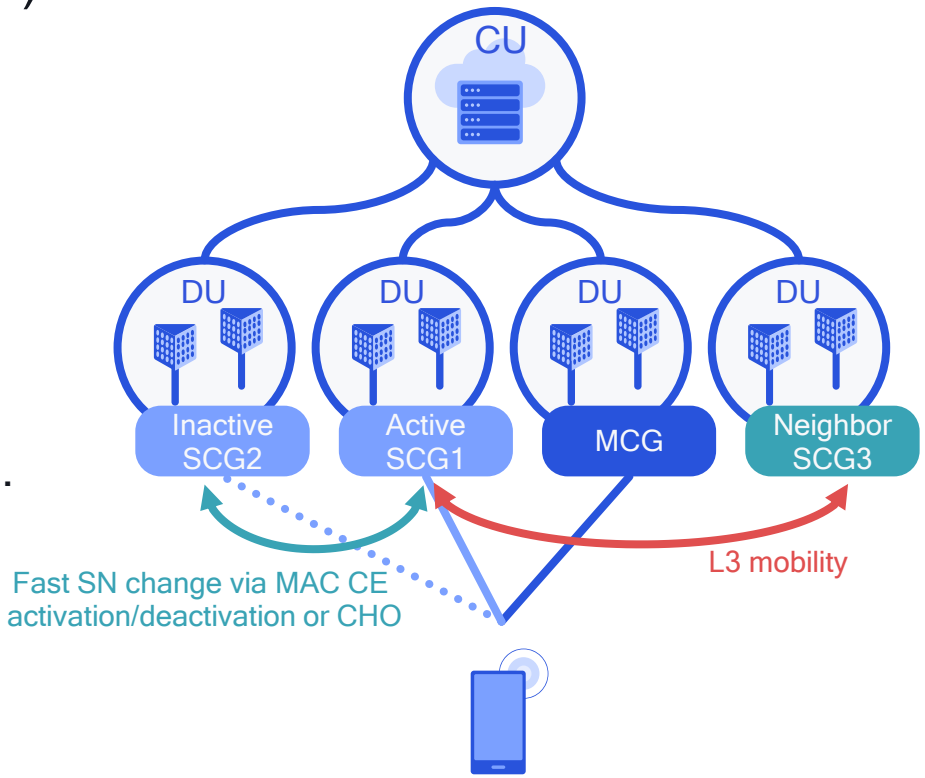
- Further enhancements to DRX groups
  - Joint configuration between DCP and DRX groups
    - Including selective wakeup of DRX groups (wakeup only one group vs both groups)
  - Cross-group wakeup within DRX active time
    - Network sends a L2 indication to start DRX active time of an inactive DRX group
  - Group-specific DRX MAC CE
    - DRX MAC CE can be for either a specific DRX group or both
  - UAI for group-specific DRX configuration



- UE/NW assistance for more power efficient scheduling:
  - UE indicates a threshold for delayed scheduling of buffered data
    - Applied only to flows with elastic traffic and insensitive to scheduling delay
    - Can be used jointly with PDCCH skipping within DRX active time, or with DCP outside DRX active time
  - Early indication of expected data
    - Uplink: UE indicates end of burst to terminate DRX active time or new data arriving soon to prompt network to increase UE's radio configuration(e.g. activation of more CC's and SCG)
    - Downlink: network indicates total size of buffered data, to assist UE to better allocate its radio resources (e.g. number of Rx antennas)

Rel-18 MR-DC enhancements

- Extension of multi-connectivity beyond two Cell Groups (CGs):
  - Example use cases: further duplication for URLLC, enhanced mobility between CGs, improved reliability especially for FR2
  - One MCG and one or more SCGs are configured
    - Active # of CGs can be limited to two
  - Can be restricted to intra-NR and a single gNB-CU to simplify coordination of UE capabilities.
  - PDCP aggregation/duplication/switching across CGs
  - Mobility (add, change) between CGs by regular or conditional HO.
  - Simultaneous CA and multi-connectivity allowed as in DC.
- Further multi-connectivity optimizations for consideration:
  - RAN configures multiple candidate MCGs
  - Support for deactivated SCG and Inactive states
  - RLF enhancements to minimize re-establishment, e.g. MN-SN role switching
  - Early measurements and other RRM aspects
  - L1/L2 signaling for activating/switching CGs, leveraging Rel-17 feMIMO work



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