

3GPP TSG RAN Meeting #93-e

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Further RRM requirements enhancement in Rel-18

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RRM requirements enhancement for NR-U (1/5)

- Background

- The Rel-16 WI on NR-based Access to Unlicensed Spectrum (RP-192926) has introduced NR operation in unlicensed spectrum for all supported scenarios.
 - RRM requirements for NR-U have been specified with baseline requirements for Rel-15 NR operations.
 - New features were introduced in Rel-16 for NR operation in licensed spectrum. Many of the new Rel-16 features can also be used for NR operation in unlicensed spectrum. However, no corresponding RRM requirements for the new features is specified for NR-U.
 - Improved system and mobility performance for NR-U can be achieved and guaranteed by specifying RRM requirements for the Rel-16 features for NR operation in unlicensed spectrum.
 - There are some Rel-15 NR requirements not being specified for Rel-16 NR-U, e.g., CSI-RS based radio link monitoring, CSI-RS based link recovery and CSI-RS based L1-RSRP reporting. These features are also beneficial for NR-U operation.
 - Scenario E was deprioritized in Rel-16 NR-U and no RRM requirements has been specified for this scenario. It is also beneficial to define requirements for Scenario E to meet future use cases.
 - The scope of enhanced RRM requirements for NR-U could be large. A dedicated WI from further RRM enhancements in Rel-18 is necessary.
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- Proposal 1: Specify enhanced RRM requirements for selected Rel-16 features for NR-U.
 - Proposal 2: A dedicated WI is assigned for enhanced RRM requirements for NR-U in Rel-18.

RRM requirements enhancement for NR-U (2/5)

- Proposal 3: Following Rel-16 features can initially be considered for defining enhanced RRM requirements for NR-U.
 - Idle/Inactive Mode CA/DC Measurements (EMR)
 - Direct SCell activation
 - DAPS handover
 - Conditional handover
 - Conditional PSCell Change
 - Multiple SCell activation
 - BWP switching on multiple CCs
 - Uplink spatial relation switch delay
 - CSI-RS based L3 measurement
 - L1-SINR measurement
 - Pathloss reference signal switching delay
 - CGI reading
 - [HO with PSCell]
- Proposal 4: RRM requirements for following Rel-15 features are also specified as part of RRM enhancements for NR-U.
 - CSI-RS based RLM for NR-U
 - CSI-RS based link recovery for NR-U
 - CSI-RS based L1-RSRP measurements and reporting
- Proposal 5: RRM requirements for Scenario E are also specified as part of RRM enhancements for NR-U.

RRM requirements enhancement for NR-U (3/5)

- Candidate scope (1/3)
 - Specify enhanced RRM requirements for NR-U operation [RAN4]
 - 1) Idle/Inactive Mode CA/DC Measurements (EMR)
 - Requirements for Idle Mode CA/DC measurements on carriers with CCA
 - Requirements for Inactive Mode CA/DC measurements on carriers with CCA
 - 2) Direct SCell activation
 - Delay and interruption requirements for direct SCell activation at SCell addition on carrier with CCA
 - Delay and interruption requirements direct SCell activation at handover on carrier with CCA
 - Delay and interruption requirements direct SCell activation of multiple downlink SCells with CCA
 - 3) DAPS handover
 - Requirements for NR DAPS handover to target cell using CCA
 - 4) Conditional handover
 - Requirements for conditional handover to target cell using CCA
 - 5) Conditional PSCell Change
 - Requirements for conditional PSCell change to target PSCell using CCA
 - 6) Multiple SCell activation
 - Delay and interruption requirements for multiple SCell activation on carriers with CCA

RRM requirements enhancement for NR-U (4/5)

- Candidate scope (2/3)

- 7) BWP switching on multiple CCs

- Delay and interruption requirements for BWP switching on multiple CCs with CCA

- 8) Uplink spatial relation switch delay

- Delay requirements for uplink spatial relation switch on carriers with CCA

- 9) CSI-RS based L3 measurement

- Requirements for CSI-RS based intra-frequency measurements on carriers with CCA
 - Requirements for CSI-RS based inter-frequency measurements on carriers with CCA

- 10) L1-SINR measurements for reporting

- Requirements for L1-SINR measurements for reporting under CCA

- 11) Pathloss reference signal switching delay

- Delay requirements for Pathloss reference signal switch on serving cell using CCA

- 12) CGI reading

- Delay and interruptions requirements for CGI-reading of NR-U target cell using CCA

- 13) [HO with PSCell]

- Discuss and decide scenarios for HO with PSCell for NR-U
 - Requirements for HO with PSCell with target PCell and/or PSCell using CCA

RRM requirements enhancement for NR-U (5/5)

- Candidate scope (3/3)

- 14) CSI-RS based RLM for NR-U

- Requirements for CSI-RS based radio link monitoring on serving carriers using CCA
 - Scheduling availability for CSI-RS based radio link monitoring on serving carriers using CCA

- 15) CSI-RS based link recovery for NR-U

- Requirements for CSI-RS based beam failure detection on serving carriers using CCA
 - Requirements for CSI-RS based candidate beam detection on serving carriers using CCA
 - Scheduling availability for CSI-RS based beam failure detection on serving carriers using CCA
 - Scheduling availability for CSI-RS based candidate beam detection on serving carriers using CCA

- 16) CSI-RS based L1-RSRP measurements and reporting

- Requirements for CSI-RS based L1-RSRP measurements and reporting under CCA
 - Scheduling availability for CSI-RS based L1-RSRP measurements and reporting under CCA

- Specify baseline RRM requirements for Scenario E for NR-U operation [RAN4]

- PSCell addition delay requirements
 - PSCell release delay requirements
 - CCSF for NR Pcell + NR-U PSCell

Enhancement on TCI state switch

- Background

- For MAC-CE based and RRC based TCI state switch, and active TCI state list update, one SSB is needed under certain conditions which will result in long switch delay.
 - If TCI state is known, the MAC-CE based TCI state switch delay is
 - $T_{\text{HARQ}} + 3N_{\text{slot}}^{\text{subframe},\mu} + \text{TO}_k * (T_{\text{first-SSB}} + T_{\text{SSB-proc}}) / NR \text{ slot length}$
 - $\text{TO}_k = 1$ if target TCI state is not in the active TCI state list for PDSCH, 0 otherwise.
 - If TCI state is unknown, the MAC-CE based TCI state switch delay is
 - $T_{\text{HARQ}} + 3N_{\text{slot}}^{\text{subframe},\mu} + T_{\text{L1-RSRP}} + \text{TO}_{\text{uk}} * (T_{\text{first-SSB}} + T_{\text{SSB-proc}}) / NR \text{ slot length}$
 - $\text{TO}_{\text{uk}} = 1$ for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD
 - $\text{TO}_{\text{uk}} = 1$ when TCI state switching involves other QCL types only
 - Active TCI state list update delay is
 - $T_{\text{HARQ}} + 3N_{\text{slot}}^{\text{subframe},\mu} + \text{TO}_k * (T_{\text{first-SSB}} + T_{\text{SSB-proc}}) / NR \text{ slot length}$
- Temporary RS as for fast SCell activation may be enhanced to reduce TCI state switch delay under certain conditions.
- Other possible solutions can also be studied in RAN4.

- Proposal 1: Study and specify enhanced RRM requirements for fast TCI state switch.

FR1+FR1 NR-DC

- Motivation

- Band combinations for FR1+FR1 NR-DC are already introduced in TS 38.101-1 in Rel-16.
- MRTD/MTTD RRM requirements for both synchronous and asynchronous FR1+FR1 NR-DC are already specified in TS 38.133 in Rel-16.
- For PSCell change, PSCell release, conditional PSCell change and scheduling availability of UE during RLM and BFD, the existing requirements can cover FR1+FR1 NR-DC scenario. There are no further requirements being needed.
 - It can be further studied during WI phase if existing requirements can be reused.
- RRM requirements for Pcell addition and CCSF are missing in TS38.133 in Rel-16, from which the FR1+FR1 NR-DC was introduced.

- Proposal 1: Complete broken RRM requirements for FR1+FR1 NR-DC in Rel-18.

- Candidate scope

- General RRM requirement applicability: number of serving carriers configured under NR-DC
- Delay and/or interruption requirements for PSCell procedures if any
 - PSCell addition and release requirements
- Scheduling availability
- CSSF for NR-DC measurements within gaps
- CSSF for NR-DC measurements outside gaps

NR DC configuration	Uplink NR DC configuration
DC_n2A-n5A	DC_n2A-n5A
DC_n3A-n28A	DC_n3A-n28A
DC_n3A-n77A	DC_n3A-n77A
DC_n3A-n77(2A)	DC_n3A-n77A
DC_n3A-n78A	DC_n3A-n78A
DC_n28A-n77A	DC_n28A-n77A
DC_n28A-n78A	DC_n28A-n78A

Frequency Range		Maximum receive timing difference (μs)
Cell in MCG	Cell in SCG	
FR1	FR1	33
FR2	FR2	8
FR1	FR2	33

Frequency Range		Maximum uplink transmission timing difference (μs)
Cell in MCG	Cell in SCG	
FR1	FR1	34.6
FR2	FR2	8.5
FR1	FR2	34.1

Max {Sub-carrier spacing in PCell (kHz), Sub-carrier spacing in PSCell (kHz)}	Maximum receive timing difference (μs)
15	500
30	250
60	125
120	62.5

Max {Sub-carrier spacing in PCell (kHz), Sub-carrier spacing in PSCell (kHz)}	Maximum uplink transmission timing difference (μs)
15	500
30	250
60	125

SRS carrier based switching for FR2 Inter-band

- Motivation

- No interruption requirements for inter-band SRS carrier switching in FR2
 - In Rel-16, for Intra-band SRS carrier switching in FR1 or FR2, interruption requirements are specified by assuming SRS carrier switching time $\leq 200\mu\text{s}$.
 - In Rel-16, for inter-band SRS carrier switching in FR1, interruptions requirements are specified for different SRS carrier switching time with maximum switching time $\leq 900\mu\text{s}$.
 - RAN4 agreed that interruption requirements for inter-band SRS carrier switching in FR2 will be specified once there is conclusion in RF session during Rel-16 WI.
 - There was no conclusion on maximum applicable SRS carrier switching time for FR2 inter-band. $900\mu\text{s}$ is too large for FR2 inter-band.
- Inter-band combinations are supported in FR2
 - With extension of NR operation to 71GHz in Rel-17, more FR2 inter-band combinations are expected.
- SRS carrier based switching is essential and beneficial for TDD system

- Objectives

- Decide and specify, if necessary, applicable inter-band SRS carrier based switching time in FR2 in RF session.
- Specify interruption requirements for inter-band SRS carrier based switching in FR2 in RRM session.

THANK YOU.

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