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Online, 20th - 30th Apr 2020

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Motivation paper on Rel-17 further RRM enhancement (FeRRM)

NR RRM Further Enhancement for Rel-17

Scope summary

1. Measurement Sharing and Scheduling Restriction Enhancement
2. RRM Searcher Enhancement
3. Measurement Gap Enhancement
4. Untreated topics from Rel-16 WI

NR RRM Further Enh.| Measurement sharing and Scheduling Restriction (1/3)

- Background - Scheduling restriction on FR1 TDD and different Rx beams
  - In Rel-15 and Rel-16, the scheduling restriction requirement for inter-band CA case is missing due to the progress on the UE capability discussion of supporting different Rx beams and simultaneous Rx&Tx.
  - Scheduling restriction for simultaneous Rx and Tx (e.g., in current spec TS38.133 section 9.2.5.3.1)

> When the UE performs intra-frequency measurements in a TDD band, the following restrictions apply due to SS-RSRP or SS-SINR measurement
>
> - The UE is not expected to transmit PUCCH/PUSCH/SRS on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be measured within SMTC window duration.
>
> When TDD intra-band carrier aggregation is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.

  - Scheduling restriction for FR2 Rx beam sweeping (e.g., in current spec TS38.133 section 9.2.5.3.3)

> The following scheduling restriction applies due to SS-RSRP or SS-SINR measurement on an FR2 intra-frequency cell
>
> - The UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be measured within SMTC window duration (The signaling deriveSSB_IndexFromCell is always enabled for FR2) .
>
> When TDD intra-band carrier aggregation is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.

NR RRM Further Enh.| Measurement sharing and Scheduling Restriction (2/3)

- Working scope
  - Simultaneous Rx and Tx in inter-band CA
    - UE capability of simultaneous Rx&Tx for TDD-TDD and TDD-FDD needs to be taken into account for the requirement when UE has mobility measurement and UL Tx simultaneously (TS38.306)

Definitions for parameters	**Per**	**M**	**FDD-TDD DIFF**	**FR1-FR2 DIFF**
simultaneousRxTxInterBandCA Indicates whether the UE supports simultaneous transmission and reception in TDD-TDD and TDD-FDD inter-band NR CA. It is mandatory for certain TDD-FDD and TDD-TDD band combinations defined in TS 38.101-1 [2], TS 38.101-2 [3] and TS 38.101-3 [4].	BC	CY	No	No
simultaneousRxTxSUL Indicates whether the UE supports simultaneous reception and transmission for a NR band combination including SUL. Mandatory/Optional support depends on band combination and captured in TS 38.101-1 [2].	BC	CY	No	No

  - Simultaneous Rx with different Rx beams in inter-band CA (R4-1916024, up to the R16 eRRM progress)
    - UE is assumed to be feasible to have independent beam management for the bands that are part of supported band configuration in inter-band CA for 28 GHz + 39 GHz combinations.
      - “28GHz” stands for a band group includes n257, n258, n261
      - “39GHz” stands for a band group includes n259, n260

NR RRM Further Enh.| Measurement sharing and Scheduling Restriction (3/3)

- Background - measurement sharing and restriction between BM or RLM and L3 mobility measurement
  - In Rel-15 and Rel-16, the following measurement sharing and restriction is defined in TS38.133, (following table is in generic, details could be found in corresponding sections of TS38.133)

Measurement restriction or measurement sharing	**SSB based BM/RLM**	**CSI-RS based BM/RLM**	**SSB based L3 measurement**	**CSI-RS based L3 measurement**
SSB based BM/RLM	NA	Measurement restriction (e.g. section 8.5.2.3 in TS38.133)	Measurement sharing (sharing factor P in TS38.133)	Not defined yet
CSI-RS based BM/RLM	Measurement restriction (e.g. section 8.5.2.3 in TS38.133)	Measurement restriction (e.g. section 8.5.3.3 in TS38.133)	Measurement sharing (sharing factor P in TS38.133)	Not defined yet
SSB based L3 measurement	Measurement sharing (sharing factor P in TS38.133)	Measurement sharing (sharing factor P in TS38.133)	NA	Not defined yet
CSI-RS based L3 measurement	Not defined yet	Not defined yet	Not defined yet	Not defined yet (e.g. CSI-RS of serving cell is QCL typeD with a known beam RS)

- Working scope
  - Depending on the progress in R16 CSI-RS L3 measurement WI, the following enhancements can be considered for single carrier, intra-band CA and inter-band CA scenarios,
    - Between SSB/CSI-RS based BM/RLM and L3 CSI-RS measurement with/without MG
    - Between L3 SSB measurement and L3 CSI-RS measurement with/without MG

NR RRM Further Enh. | RRM Searcher Enhancement (1/2)

- Background
  - In Rel-15 and Rel-16, the searcher number limitation is fixed to 2 in all the RRM requirements and in some cases this limitation results into huge long measurement/detection delay to mobility performance, e.g. CSSF factor in the following table,

Table 9.1.5.1.2-1: $CSSF_{outside_gap,i}$ scaling factor for SA mode

Scenario	$CSSF_{outside_gap,i}$ for FR1 PCC	$CSSF_{outside_gap,i}$ for FR1 SCC	$CSSF_{outside_gap,i}$ for FR2 PCC	$CSSF_{outside_gap,i}$ for FR2 SCC where neighbour cell measurement is required	$CSSF_{outside_gap,i}$ for FR2 SCC where neighbour cell measurement is not required
FR1 only CA	1	Number of configured FR1 SCell(s)	N/A	N/A	N/A
FR2 only intra band CA	N/A	N/A	1	N/A	Number of configured FR2 SCell(s)
FR1 +FR2 CA (FR1 PCell) Note 1	1	2×(Number of configured SCell(s)-1)	N/A	2	2×(Number of configured SCell(s)-1)
Note 1: Only one FR1 operating band and one FR2 operating band are included for FR1+FR2 inter-band CA. Note 2: Selection of FR2 SCC where neighbour cell measurement is required follows clause 9.2.3.2.					

  - The cell detection and measurement delay is decided by the CSSF significantly,

Table 9.2.5.1-1: Time period for PSS/SSS detection, (Frequency range FR1)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	max(600ms, ceil(5 x K_p) x SMTC period)Note 1 x $CSSF_{intra}$
DRX cycle⩽ 320ms	max(600ms, ceil(1.5x 5 x K_p) x max(SMTC period,DRX cycle)) x $CSSF_{intra}$
DRX cycle>320ms	ceil(5] x K_p) x DRX cycle x $CSSF_{intra}$
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

  - If the number of searcher is increased, SMTC periodicity can be potentially increased while maintaining the same cell identification/ measurement requirements

NR RRM Further Enh. | RRM Searcher Enhancement (2/2)

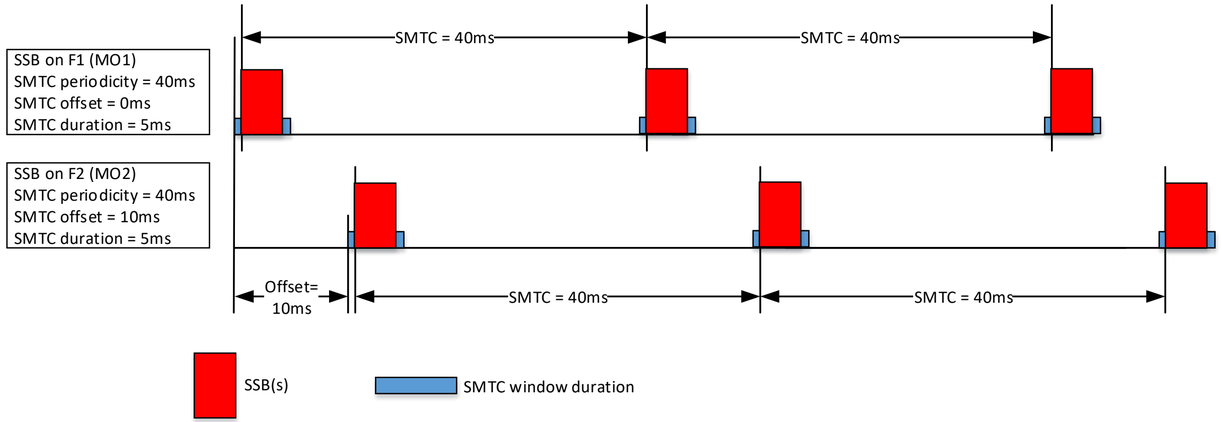
- Working scope
  - Discussion on the enhancement for the searcher number limitation
    - Work on feasibility and necessity of introducing UE capability of searcher number greater than 2
    - If the searcher number is increased for certain UE capability, the corresponding new RRM requirements would be introduced, e.g. additional CSSF might be defined as,

Scenario	***CSSF*$_{outside_gap,i}$ for FR1 PCC**	***CSSF*$_{outside_gap,i}$ for FR1 SCC**	***CSSF*$_{outside_gap,i}$ for FR2 PCC**	***CSSF*$_{outside_gap,i}$ for FR2 SCC where neighbour cell**	***CSSF*$_{outside_gap,i}$ for FR2 SCC where neighbour cell**
FR1 only CA	1	Ceiling (Number of configured FR1 SCell(s) / (n-1))	N/A	N/A	N/A
FR2 only intra band CA	N/A	N/A	1	N/A	Ceiling (Number of configured FR2 SCell(s) / (n-1))
FR1 +FR2 CA (FR1 PCell) Note 1	1	Ceiling (2×(Number of configured SCell(s)-1) / (n-1))	N/A	Ceiling (2/ (n-1))	Ceiling (2×(Number of configured SCell(s)-1) /

Note 1: Only one FR1 operating band and one FR2 operating band are included for FR1+FR2 inter-band CA.
Note 2: Selection of FR2 SCC where neighbour cell measurement is required follows clause 9.2.3.2.

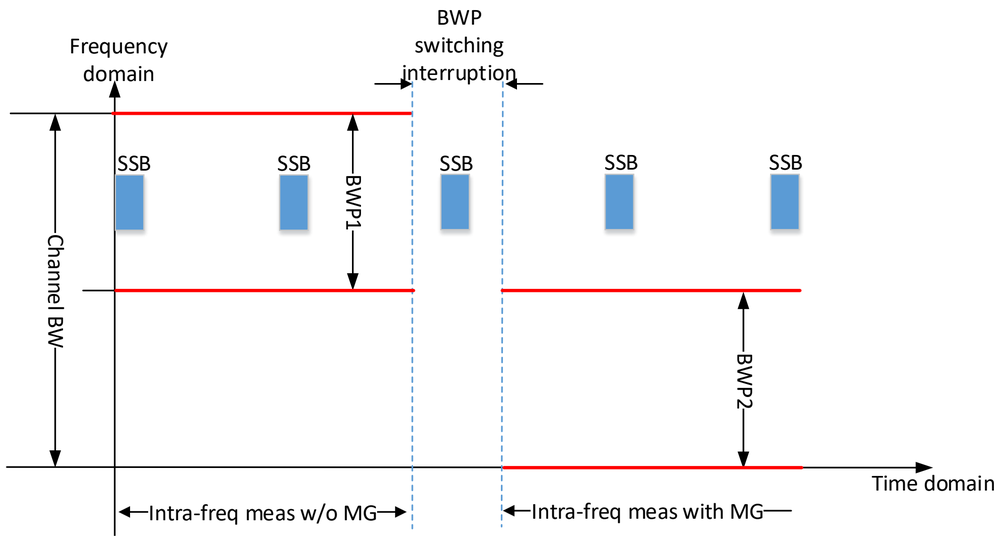
NR RRM Further Enh. | Measurement Gap Enhancement (1/3)

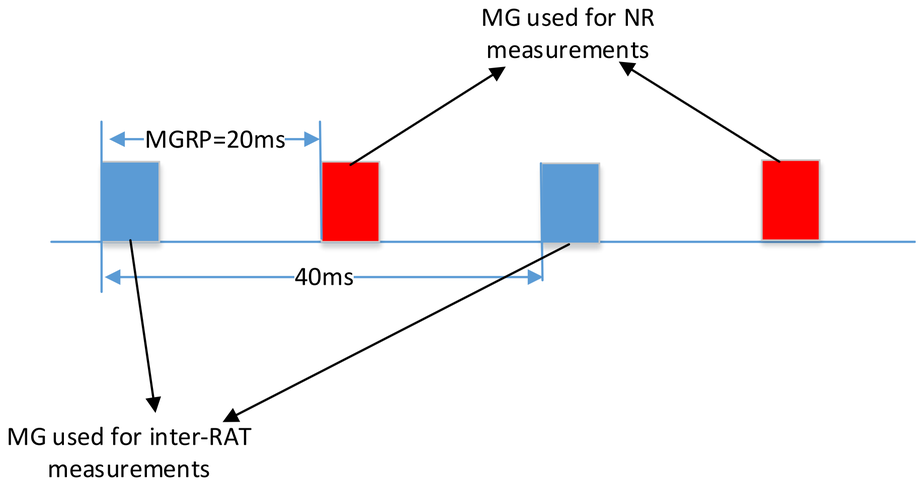
- Background
  - In Rel-15 and Rel-16, some of the restriction conditions were assumed for the measurement gap design, which will also directly or indirectly cause limitations to network and UE implementation. In order to optimize the efficiency of RRM functionalities on both network and UE sides, it's quite desirable and worthwhile to enhance the current measurement gap design in Rel-17 standards.
- Working scope
  - Enh 1: Multiple MGs to cover multiple flexible SMTCs
    - If multiple MOs are configured with different SMTC offsets, it is very likely that those MOs cannot be conducted by UE in a single measurement period since one single gap pattern can be configured in this measurement period.
      - To network, this will limit network flexibility of configuring multiple MOs since network cannot have multiple gap patterns to cover them, and consequentially it will force network either to align the SSBs at gNB sides to make sure single gap pattern can cover SMTC windows on different SSB frequencies or to configure the MOs in serial order (which would delay some candidate neighbor cells measurement reporting).
        - To UE, this will limit the UE to conduct the measurements for multiple MOs in serial order if SMTCs on those MOs cannot covered by single MG pattern.
    - To support multiple MG patterns in the single measurement period and multiple SMTC configuration patterns on the single frequency layer



NR RRM Further Enh. | Measurement Gap Enhancement (2/3)

- Working scope
  - Enh 2: Dynamic MG configuration during BWP switching
    - In Rel-15/16, since it's rather difficult for network to configure and de-configure MG according to BWP switching, network may always configure MG for SSB based measurement, and consequentially it will cause throughput loss to both network and UE side in case some of the MGs are unnecessary for SSB based measurement, e.g. in the right-side figure UE doesn't need MG to conduct the intra-frequency measurement when active BWP is BWP1.
    - To introduce fast MG configuration mechanism to meet the demand from measurement type change for SSB based intra-frequency measurement, e.g. due to BWP switching
  - Enh 3: MG applicability extension
    - According to the current specification, only pattern #0 and #1 could be utilized for 2G and 3G inter-RAT measurement in EN-DC mode, and only MG pattern #0 is supported for RSTD measurement. However, it would be more efficient if UE can use diverse MG pattern to conduct the 2G/3G/RSTD measurements together with other NR measurements; e.g., as shown in the right-side figure, MG pattern #4 has 20ms MGRP and 6ms duration and it can be utilized for both 2G/3G inter-RAT measurements and NR measurements.
    - To extend the MG applicability to allow more MG patterns serving 2G/3G/RSTD MOs, and the applicability of short MGL could also be studied whether it could be controlled by network to support multiple kinds MOs, e.g. LTE/2G/3G.





NR RRM Further Enh. | Measurement Gap Enhancement (3/3)

- Working scope
  - Enh 4: MG sharing enhancement
    - In Rel-15/16, the MG sharing was design to coordinate MG resource allocation between intra-frequency MOs and inter-frequency MOs; and in RAN4 #AH1807 meeting, some operators prefer to further improve the MG sharing mechanism to prioritize some specific RATs, e.g. LTE in EN-DC mode. But the singling bit string is quite limited in Rel-15/16, e.g. 2 bits, to indicate the MG sharing ratio, and therefore it's far from enough to adequately cover all the prioritization preference from network operators. For instance, 2G/3G is an important option to do the fall-back for voice service while LTE also plays key role in EN-DC operation; so depending on different demands from different network operators, it would be much beneficial if the MG sharing mechanism can allow network to prioritize any RAT measurement it wants. The signalling for MG sharing might need to be extended in RAN2 and the corresponding sharing requirement shall be defined in RAN4 RRM specification. On the other hand the UE complexity is also an important aspect to pay attention to during the MG sharing enhancement.
    - Enhance the MG sharing mechanism and signalling to offer network operators more flexibility on prioritize any RAT measurement.

NR RRM Further Enh. | Untreated topics from Rel-16 (RP-200256)

- Background
  - In case some of the requirement standardization cannot be completed in Rel-16 RRM enhancement WI, it would also be included in this further enhancement WI

- Working Scope
  - Leftover topics from Rel-16 RRM enhancement WI.

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