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

NR RRM Further Enh. | RRM Enhancement for larger CC number (1/2)

- Background
  - In NR FR2, multiple serving CCs could be configured to UE for aggregation, it could be e.g., up to 15CCs in FR2 non-contiguous CA (CA_n261(A-7O)).
  - 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.
  - The cell detection and measurement delay is decided by the CSSF significantly,

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.					

Table 9.2.5.2-2: Measurement period for intrafrequency measurements without gaps(Frequency FR2)

DRX cycle	$T_{SSB_measurement_period_intra}$
No DRX	max(400ms, ceil($M_{meas_period_w/o_gaps}$ x K_p x $K_{layer1_measurement}$) x SMTC period)$_{Note\ 1}$ x $CSSF_{intra}$
DRX cycle≤ 320ms	max(400ms, ceil(1.5x $M_{meas_period_w/o_gaps}$ x K_p x $K_{layer1_measurement}$) x max(SMTC period,DRX cycle)) x $CSSF_{intra}$
DRX cycle>320ms	ceil($M_{meas_period_w/o_gaps}$ xK_p x $K_{layer1_measurement}$) 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 no DRX is used, and no MG is configured, and no RLM/beam-management is colliding with SMTC, then the delay is 24*1*1*SMTC*14 = 13.44s for SMTC=40ms case (this example is for PC2/3/4 UE, if PC1 is considered this delay will be even longer).
  - 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 Enhancement for larger CC number (2/2)

- Working scope
  - Discussion on the enhancement for larger CC number (e.g., >8 serving CCs)
    - Study the enhancement solutions for the case of larger CC number
      - 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
      - Other solutions are not precluded

NR RRM Further Enh. | PUCCH SCell activation with/without TA information (1/2)

- Background
  - From release 15 NR, the two PUCCH groups are optionally supported by the UE. As specified in TS38.306, the capability indication of “twoPUCCH-Group” is defined as below,
    - Indicates whether two PUCCH group in CA with a same numerology across CCs for data and control channel [at a given time] is supported by the UE. For NR CA, two PUCCH group is supported with the same numerology across NR carriers for data and control channel at a given time. For EN-DC, two PUCCH group is supported with the same numerology across NR carriers for data and control channel at a given time, wherein an NR PUCCH group is configured in FR1 and another NR PUCCH group is configured in FR2.
- In LTE TS36.133, RAN4 had dedicated PUCCH activation delay requirement considering both valid TA and invalid TA case

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NR RRM Further Enh. | PUCCH SCell activation with/without TA information (2/2)

- Working scope
  - Specify SCell Activation Delay Requirement for Deactivated PUCCH SCell (including valid TA and invalid TA)
  - Specify SCell Activation Delay Requirement for Deactivated PUCCH SCell with Multiple SCells (including valid TA and invalid TA)
  - Specify SCell Deactivation Delay Requirement for Activated PUCCH SCell
  - Specify SCell Deactivation Delay Requirement for Activated PUCCH SCell with Multiple SCells

NR RRM Further Enh. | SRS antenna port switching

- Background
  - In NR system the SRS antenna port switching is supported in the RAN1 and RAN2 specs, and the capability is defined in TS38.306 as below,

srs-TxSwitch

Defines whether UE supports SRS for DL CSI acquisition as defined in clause 6.2.1.2 of TS 38.214 [12]. The capability signalling comprises of the following parameters:

- *supportedSRS-TxPortSwitch* indicates SRS Tx port switching pattern supported by the UE, which is mandatory with capability signaling. The indicated UE antenna switching capability of 'xTyR' corresponds to a UE, capable of SRS transmission on 'x' antenna ports over total of 'y' antennas, where 'y' corresponds to all or subset of UE receive antennas, where 2T4R is two pairs of antennas. *supportedSRS-TxPortSwitch-r16*, which is optional to report, indicates downgrading configuration of SRS Tx port switching pattern. If the UE indicates the support of downgrading configuration of SRS Tx port switching pattern using *supportedSRS-TxPortSwitch-r16*, the UE shall report the values for this as below, based on what is reported in *supportedSRS-TxPortSwitch*.

supportedSRS-TxPortSwitch	***supportedSRS-TxPortSwitch-r16***
t1r2	*t1r1-t1r2*
t1r4	*t1r1-t1r2-t1r4*
t2r4	*t1r1-t1r2-t2r2-t2r4*
t2r2	*t1r1-t2r2*
t4r4	*t1r1-t2r2-t4r4*
t1r4-t2r4	*t1r1-t1r2-t2r2-t1r4-t2r4*

- *txSwitchImpactToRx* indicates the entry number of the first-listed band with UL in the band combination that affects this DL, which is mandatory with capability signaling;

- *txSwitchWithAnotherBand* indicates the entry number of the first-listed band with UL in the band combination that switches together with this UL, which is mandatory with capability signaling.

For *txSwitchImpactToRx* and *txSwitchWithAnotherBand*, value 1 means first entry, value 2 means second entry and so on. All DL and UL that switch together indicate the same entry number.
The UE is restricted not to include fallback band combinations for the purpose of indicating different SRS antenna switching capabilities.

- Working scope
  - Specify RRM requirement for SRS antenna port switching

NR RRM Further Enh. | IDLE/Inactive mode requirement for SMTC2-LP

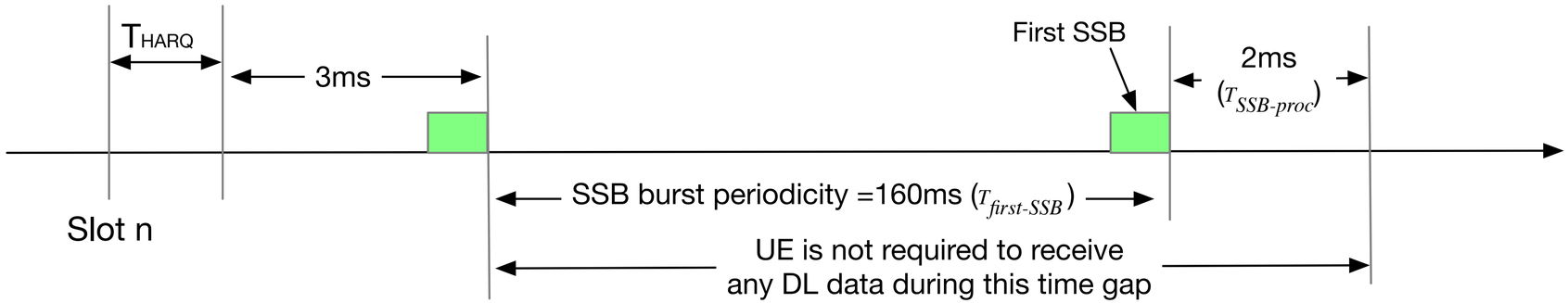
- Background
  - From Rel-16, the smtc2-LP has been introduced from RAN2, it was specified in TS38.331 that,
    - If smtc2-LP is present, for cells indicated in the pci-List parameter in smtc2-LP in the same frequency (for intra frequency cell reselection) or different frequency (for inter frequency cell reselecion), the UE shall setup an additional SS/PBCH block measurement timing configuration (SMTC) in accordance with the received periodicity parameter in the smtc2-LP configuration and use the Offset (derived from parameter periodicityAndOffset) and duration parameter from the smtc configuration for that frequency. The first subframe of each SMTC occasion occurs at an SFN and subframe of the NR SpCell or serving cell (for cell reselection) meeting the above condition.
  - This smtc2-LP can be configured to an intra-frequency and/or an inter-frequency. The smtc2-LP IE consists of two parts: (1)PCI list; and (2) periodicity of this smtc2-LP

```
SSB-MTC2-LP-r16 ::=                SEQUENCE {
   pci-List                         SEQUENCE (SIZE (1..maxNrofPCIsPerSMTC)) OF PhysCellId                OPTIONAL,   -- Need R
   periodicity                       ENUMERATED {sf10, sf20, sf40, sf80, sf160, spare3, spare2, spare1}
}
```

- Working scope
  - The corresponding RRM requirement in IDLE/Inactive mode needs to be updated to accommodate the smtc2-LP.

NR RRM Further Enh. | TCI switching enhancement

- Background
  - In Rel-16 TCI switching requirement, there was a time gap from "*slot n+ T_{HARQ} +(3 ms) / NR slot length*" to "*slot n+ T_{HARQ} +(3 ms +TO_k*($T_{first\text{-}SSB}$ + $T_{SSB\text{-}proc}$)) / NR slot length*". Since UE is not required to receive DL data during this time gap, it will probably impact the throughput performance in case the first SSB arrives 160ms later (analyzed in R4-2006616). RAN4 to further discuss if UE behavior can be enhanced to receive DL data during the time gap of $T_{first\text{-}SSB}$ in Rel-17.



- Working scope
  - Work on the feasibility of enhancement to maintain the UE reception and transmission during the period (or part of period) of MAC CE based TCI switching
  - Work on the feasibility of enhancement to maintain the UE reception and transmission during the period (or part of period) of RRC based TCI switching

NR RRM Further Enh. | CGI reading enhancements

- Background
  - In release 16, CGI decoding requirements have not been introduced for unlicenced target cells where listen before talk may be used. It would be beneficial to introduce CGI reading requirements to enable SON automatic neighbour relations establishment with NR-U target cells
  - UE assistance information indicating potential SI occasions would avoid the need for UE to always check PDCCH for SI-RNTI when performing SI reading procedures including CGI reading. This could reduce the number of autonomous interruptions for CGI reading and may also be used for power saving purposes in other cases such as reselection where the UE needs to decode SIB1.
- Working scope
  - Specify requirements for reporting the CGI of a cell using CCA in the downlink
  - Investigate enhancements to minimize interruptions in SIB1 decoding based on providing UE with assistance information on potential occasions when SIB1 will and will not be scheduled using the SI-RNTI
    - The investigation should assume that all cells on a frequency layer will use the same occasions for potential SIB1 transmission
    - According to implementation, the assistance information may also be used by the UE for other procedures involving SIB1 decoding such as reducing power consumption during reselection, however this does not impact specification requirements.

NR RRM Further Enh. | Measurement gap enhancements for NR-U

- Background
  - As unlicensed bands >=5GHz are relatively far from licenced bands <=3.5GHz, some UEs may be capable of independent RF operation (i.e. without interruptions) between licenced and unlicensed bands. This would allow analogous requirements to the per FR measurement gap capability between FR1 and FR2 to be specified.
- Working scope
  - Specify requirements for UEs capable of independent RF operation (i.e. without interruptions) between licenced and unlicensed bands. This capability between licenced FR1 bands and NR-U bands above 5GHz would be analogous to the per FR measurement gap capability between FR1 and FR2.

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