**3GPP TSG-RAN WG4 Meeting #112 R4-2413959**

Maastricht, Netherlands, 19th – 23rd August, 2024

**Title:** WF on RRM requirements for NR\_ATG\_enh

**Agenda Item:** 8.10.5

**Source:** Moderator (CMCC)

**Document for:** Approval

# <Topic 1> RRM core requirement

## <Sub-topic 1-1> General

**Issue 1-1-1: Scenario**

Agreement:

* Following the WID, only consider FR1 co-located DL intra-band contiguous CA and FR1 co-located DL inter-band CA.
* For other ATG scenario characteristics like UE speed, ISD and so on, the R18 scenario captured in TR 38.876 will be reused as baseline.

**Issue 1-1-2: Co-located definition**

* Option 1: Reuse the legacy definition for MIMO, Tx diversity transmissions, and intra-band contiguous carrier aggregation, as defined in RP-180557.
* Option 2: Antennas at the same physical location, or the distance difference between antennas can be ignored.
* Other Options are not precluded

**Issue 1-1-3: Co-location signaling**

* Proposal 1: FFS whether co-location information in inter-band CA configuration should be provided to UE.

**Issue 1-1-4: Whether to support multiple downlink SCells**

Agreement

* Only consider single SCell for R19 ATG CA

**Issue 1-1-5: UE antenna type**

Agreement:

* For intra-band contiguous CA, same antenna type should be applied on each carrier.
* For inter-band CA, either different or same antenna type can be applied on different carriers.
* For inter-band CA, consider the following cases:
  + 1. ATG UE with omnidirectional antennas on both PCell and SCell.
  + 2. ATG UE with an omnidirectional antenna on PCell and an antenna array on SCell.
  + 3. ATG UE with an antenna array on PCC and an omnidirectional antenna on SCell.
  + [4. ATG UE with an antenna array on both PCell and SCell with only one antenna panel.]
  + 5. ATG UE with an antenna array on both PCell and SCell with separate antenna panels.
  + Note: If some of the cases will be precluded in RF discussion, they will be removed for RRM requirement discussion.

**Issue 1-1-6: Specification structure**

* Option 1: The CA related requirements can be directly added in the sections defined for R18 ATG UE
* Other Options are not precluded.

## <Sub-topic 1-2> RRC\_IDLE/ RRC\_INACTIVE state mobility

**Issue 1-2-1: Cell re-selection Idle/Inactive mode CA measurements**

* Proposal 1: RAN4 to reuse NR cell re-selection as a baseline for ATG cell re-selection to support CA.
* Proposal 2: For cell re-selection, define the exceptions of side conditions for UE supporting CA in FR1. The legacy methodology exception applicability defined in Clause 4.2 and Clause B.3.2.1 can be reused with update of the reference clause of ΔRIB,c.

**Issue 1-2-2: Idle/Inactive mode CA measurements (R16)**

* Option 1: Introduce idle/inactive mode CA measurements requirements for ATG UE in Rel-19
* Option 2: No need to introduce idle/inactive mode CA measurements requirements in ATG CA.

**Issue 1-2-3: Measurement report for fast CA/DC setup (R18)**

* Option 1: RAN4 to define EMR for ATG DL CA by using the Rel-18 NR CA EMR as a baseline
* Option 2: No need to introduce Rel-18 NR CA EMR in ATG CA.
* Option 3: Consider whether to define the requirements of measurement report for fast CA setup in idle/inactive mode for R19 ATG UE

## <Sub-topic 1-3> Timing

**Issue 1-3-1: MTTD**

* Option 1: FFS whether MTTD requirement is needed or not

**Issue 1-3-2: MRTD**

Agreement:

* For ATG intra-band contiguous CA, not define MRTD requirement.
* For ATG inter-band CA, MRTD requirement is:
  + Option 1: A little larger than 3us, i.e., 3.545 µs
  + Option 2: 33us
  + Option 3: 3us
  + Option 4: further discuss

## <Sub-topic 1-4> Signalling characteristics

**Issue 1-4-1: Interruption requirements**

* Proposal 1: Interruption requirements should be introduced for ATG UE
  + Proposal 1-1: Interruption requirements should be defined for following features, legacy requirement can be reused by focusing on the applicable part for ATG by considering the same corresponding scenario
    - Requirement applicability, some adaptation is needed depending on the supported feature by ATG UE
    - Interruption at Scell addition/release
    - Interruptions at SCell activation/deactivation
    - Interruptions during measurements on deactivated SCC
    - Interruptions at UL carrier RRC reconfiguration
    - Interruptions due to Active BWP switching Requirement
    - Interruptions at inter-frequency SFTD measurement
    - Interruptions due to UE-specific CBW change
    - Interruptions at NR SRS carrier based switching
    - Interruptions at direct SCell activation
    - Interruptions due to SCell dormancy
    - Interruptions at NR SRS antenna port switching
    - Interruptions at fast SCell activation
    - Interruptions due to PUCCH SCell activation/deactivation
    - Interruptions due to measurements without gap carried out by UE supporting [NeedForInterruptionInfoNR-R18]
    - FFS:
      * DL Interruptions at UE switching between two uplink carriers
      * DL Interruptions at UE switching between two uplink carriers with two transmit antenna connectors
      * DL Interruptions at UE switching between two uplink bands with two transmit antenna connectors
      * DL Interruptions at UE switching across three or four uplink bands
      * Interruptions when identifying CGI of an NR cell with autonomous gaps
  + Proposal 1-2: Reuse the principle from existing interruption requirements as baseline for ATG for:
    - Interruptions at SCell activation/deactivation
    - Interruptions during measurement on deactivated SCell
  + Proposal 1-3: Introduce the following interruption requirement, the legacy requirement can be reused.
    - Interruptions at SCell addition/release
    - Interruptions at SCell activation/deactivation
    - Interruptions at direct SCell activation
    - Interruptions at fast SCell activation
    - Interruptions during measurements on deactivated SCC
    - Interruptions due to SCell dormancy
    - Interruptions due to Active BWP switching Requirement
    - Interruptions due to UE-specific CBW change
    - Interruptions when identifying CGI of an NR cell with autonomous gaps
    - Interruptions at NR SRS antenna port switching
  + Proposal 1-4: Existing interruption requirements can also apply to ATG supporting CA. RAN4 could discuss whether to introduce new interruption requirements if there are ATG new procedures which are not covered in current interruption requirements.
  + Proposal 1-5: For both omni-directional antenna and antenna array assumption, reuse existing interruption requirements of SCell addition/release.

**Issue 1-4-2: SCell Activation and Deactivation Delay**

* Proposal 1: SCell Activation and Deactivation Delay requirements should be introduced for ATG
  + Proposal 1-1: SCell activation requirements shall be further investigated for potential impact, taking into account the band combinations stated in the WID and the antenna types agreed in RF
  + Proposal 1-2: Reuse the principle from existing SCell activation / deactivation delay requirements as baseline for ATG, and scellWithoutSSB capability can be considered.
  + Proposal 1-3: Introduce following features for ATG, reuse the current FR1 requirements as the starting point, and further study whether further improvement is needed or not due to co-located deployment:
    - SCell Activation Delay Requirement for Deactivated SCell
    - SCell Deactivation Delay Requirement for Activated SCell
    - Direct SCell Activation at SCell addition
    - Direct SCell Activation at Handover
    - Direct SCell Activation at RRC Resume
    - Fast SCell Activation Delay Requirement for Deactivated SCell
    - SCell Activation Delay Requirement for Deactivated SCell with the L3 reporting during activation.
  + Proposal 1-4: RAN4 to define SCell activation for single-SCell for at least:
    - SCell activation
    - Direct SCell activation at SCell addition
    - Direct SCell activation at Handover
  + Proposal 1-5: Due to co-located deployment, similar beam coverage shared between multiple serving cells, the component of cell search can be ignored, whether L1 meas&report can be ignored, which can be discussed.

**Issue 1-4-3: Active BWP switch delay on multiple CCs**

* Proposal 1: For Active BWP switch delay on multiple CCs, introduce following requirements, which can reuse the legacy:
  + Simultaneous DCI based BWP switch delay on multiple CCs
  + Simultaneous RRC based BWP switch delay on multiple CCs
  + Simultaneous and non-simultaneous Timer based BWP switch delay on multiple CCs

**Issue 1-4-4: Beam failure recovery in SCell**

* Proposal 1: Introduce Beam failure recovery in SCell for ATG CA, the legacy procedure and requirement can be reused.

**Issue 1-4-5: Pre-configured measurement gap activation/deactivation delay upon SCell activation/deactivation**

* Proposal 1: Introduce Pre-configured measurement gap activation/deactivation delay requirement upon SCell activation/deactivation, the legacy requirement can be reused.

## <Sub-topic 1-5> Measurement procedure

**Issue 1-5-1: Measurement gap**

* Proposal 1: RAN4 to reuse NR carrier aggregation measurement gap as the baseline for ATG DL CA
* Proposal 2: The measurement gap applicability rule and scheduling applicability for SA single carrier shall be also applied for NR CA configuration.
* Proposal 3: When define the SCC interruption time, only consider aligned frame boundaries scenario, the interruption requirement in single carrier case can be reused for CA configuration.

**Issue 1-5-2: CSSF**

* Proposal 1: Study and accommodate CSSF requirements for ATG DL CA
* Proposal 2: Reuse the legacy scheme when defining the CSSFoutside\_gap for ATG FR1 only CA, that PCC occupy one measurement searcher resource, SCC and other inter-frequency MO with no measurement gap share another measurement searcher resource.

**Issue 1-5-3: Capabilities for Support of Event Triggering and Reporting Criteria**

* Proposal 1: For UE capability of supporting NR reporting criteria of category intra-frequency, the SCell serving frequency shall be counted in the number of configured NR serving frequencies carrier frequency.

**Issue 1-5-4: Pre-configured measurement gap requirement**

* Proposal 1: Introduce the SCell related triggering conditions as an event for triggering pre-configured measurement gap, and the legacy procedure and requirement can be reused.

**Issue 1-5-5: SCell activation triggered measurement reporting requirement**

* Proposal 1: If SCell Activation for Deactivated SCell with the L3 reporting during activation is supported for ATG, then the measurement reporting requirement shall also be introduced, legacy requirement can be reused.

**Issue 1-5-6: Beam sweeping factor N**

* Proposal 1: The extension of co-located CA has no impact on the beam sweeping factor N defined in R18 ATG.

**Issue 1-5-7: Deactivated SCell measurement**

* Proposal 1: Define intra-frequency measurement requirements for deactivated SCell
  + Option 1-1: Reuse the principle from the existing cell identification and measurement requirements with measCycleScell as baseline for ATG, for example

|  |  |
| --- | --- |
| DRX cycle | T SSB\_measurement\_period\_intra |
| No DRX | ceil( 5 x Kp x N1 Note 1 x Klayer1\_measurement) x measCycleSCell x CSSFintra |
| DRX cycle≤ 320ms | ceil(5 x Kp x N1 Note 1 x Klayer1\_measurement) x max(measCycleSCell, 1.5 x DRX cycle)) x CSSFintra |
| DRX cycle>320ms | ceil( 5 x Kp x N1 Note 2 x Klayer1\_measurement) x max(measCycleSCell, DRX cycle) x CSSFintra |
| NOTE 1: For ATG UE with the antenna array, N1 = 3 when network assistance on ATG cells reference locations is provided, otherwise N1 = 4. Otherwise, N1 = 1. | |

* + Option 1-2: Introduce Time period for PSS/SSS detection, Time period for time index detection, Measurement period for intra-frequency measurements without gaps for FR1 deactivated SCell. The legacy requirement can be reused, for ATG UE with one or more omni-directional antenna and ATG UE with antenna array on SCC.
  + Option 1-3: For the deactivated SCell measurement, whether need to introduce smaller candidate of measCycleSCell to facilitate the small ISD ATG deployment, which can be considered.

**Issue 1-5-8: Scheduling Availability/Restrictions**

* Proposal 1: the scheduling restriction extension to intra-band/inter-band CA, further study the impact of antenna pattern on scheduling availability ATG CA
* Proposal 2: For scheduling availability of UE performing measurement with a different subcarrier spacing than PDSCH/PDCCH for RLM, BFD, CBD, intra/inter-frequency measurement without MG, L1-RSRP measurement, and L1-SINR measurement
  + When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions on FR1 serving PCell should apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.
  + When inter-band carrier aggregation within FR1 is configured, there are no scheduling restrictions on FR1 serving cell(s) configured in other bands than the bands in which PCell is configured.
* Proposal 3: For scheduling availability of UE performing measurements on FR1 TDD band for intra/inter-frequency measurement without MG and CSI-RS based intra-frequency measurements
  + When TDD intra-band carrier aggregation is performed, the scheduling restrictions due to a given serving cell also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.
  + When TDD inter-band carrier aggregation is performed, the scheduling restrictions due to a given serving cell should also apply to another serving cell in a different band on the symbols that fully or partially overlap with the aforementioned restricted symbols, if UE does not have the capability of supporting simultaneousRxTxInterBandCA for this band pair.
* Proposal 4: For scheduling availability of UE with the antenna array performing measurements on FR1 for intra/inter-frequency measurement without MG and CSI-RS based intra-frequency measurements:
  + When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions due to a given serving cell also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.
  + When inter-band carrier aggregation is performed:
    - For ATG UE with the antenna array on PCC and one or more omni-directional antenna on SCC, the scheduling restrictions due to PCell will not apply to another serving cell in a different band.
    - For ATG UE with the one or more omni-directional antenna on PCC and antenna array on SCC, the scheduling restrictions due to SCell will not apply to another serving cell in a different band.
    - For ATG UE with the antenna array on both PCC and SCC, and only one Rx beam can be formed, the scheduling restrictions due to a given serving cell should also apply to another serving cell in a different band on the symbols that fully or partially overlap with the aforementioned restricted symbols.
    - For ATG UE with the antenna array on both PCC and SCC, and two Rx beams can be formed simultaneously, he scheduling restrictions due to a given serving cell will not apply to another serving cell in a different band.