3GPP TSG-RAN4 Meeting #106R4-2303176

**Athens, Greece, February 27 – March 3, 2023**

**Agenda item:** 9.23.7

**Source:** Apple

**Title:** WF on NR Mobility Enhancements RRM requirements (part 2)

**Document for:** Approval

# Topic #1: NR-DC with selective activation of cell groups via L3 enhancements

## Sub-topic 1-1 Scope of RRM requirements for NR-DC with selective activation of cell groups via L3 enhancements

**Issue 1-1-1: scope of RRM requirements for NR-DC with selective activation of cell groups via L3 enhancements**

* Candidate solutions:
  + Option 1: define requirements for subsequent CPC delay. (Apple, MTK, vivo, HW)
  + Option 2: not define requirements for subsequent CPC delay. (HW)
  + Option 3: The main scenario needs to be specified are (E///)
    - Scenario 1 UE keep the configuration after the 1st activation
    - Scenario 2 UE release the configuration after the 1st activation.
  + Option 3: RAN4 waits for RAN2 progress on Selective Activation. (Nokia)
* Agreement
  + Define requirements for subsequent CPC delay

## Sub-topic 1-2 RRM requirements for subsequent CPC

**Issue 1-2-1: starting point of subsequent CPC in RRM requirements**

* Candidate solutions:
  + Option 1: RAN4 shall discuss how to define the starting point in subsequent CPC. The following two alternatives can be used as a starting point: (Apple, vivo, HW)
    - Alt 1: starting point is the time when UE receives RRC command which triggers subsequent CPC, i.e., same as legacy
    - Alt 2: starting point is the time when UE completes the previous CPC/CPA, e.g. completing random access towards the target PSCell.
  + Option 2: After transmitting SN RRCReconfigurationcomplete message for the previous PSCell addition or change in slot *n* (MTK)
* Recommended WF
  + Continue discuss the following two options:
    - Option 1: starting point is the time when UE receives RRC command which triggers subsequent CPC, i.e., same as legacy
    - Option 2: starting point is the time when UE completes the previous CPC/CPA, e.g. completing random access towards the target PSCell.

**Issue 1-2-2: subsequent CPC delay requirements**

* Candidate solutions:
  + Option 1: Tconfig\_PSCell\_Subsequent\_Change\_Conditional = TEvent\_DU + Tmeasure + TUE\_preparation + Tprocessing + T∆ + TPSCell\_ DU + 2 ms and the definition of each component is the same as 8.11B.2 in TS38.133. (MTK)
  + Option 2: if starting point is the time when UE completes the previous CPC/CPA, existing Tconfig\_PSCell\_Conditional can be reused except that TEvent\_DU needs to be updated. (vivo)
  + Option 3: consider potential measurement delay enhancement due to the fact that the candidates (E///)
    - Have fulfilled the condition during the 1st execution
    - Have a valid L3 measurements of the candidate cell within x seconds
* Recommended WF
  + Continue discussion.

# Topic #2: Improvement on SCell/SCG setup delay

## Sub-topic 2-1 Scope and overall solution

**Issue 2-1-1: scope of improvement on SCell/SCG setup delay**

* Candidate solutions:
  + Option 1: For faster setup of CA/DC, both FR1 and FR2, intra-band or inter-band CA/DC are target scenarios. (Intel)
  + Option 1a: The target cell in FR1 needs to be considered. (LG, E///)
  + Option 2: FR2 intra-band CA is not the target scenario of improved measurement. The normative work should focus on FR1 + FR2 CA/DC scenario (vivo, ZTE, QC)
  + Option 2a: RAN4 to focus first on enhancements with target cell in FR2 within the scope of the Rel-18 WI. After FR2 solution is clear, FR1 can be evaluated (Nokia)
* Tentative agreement:
  + RAN4 shall focus on inter-band target cell in FR2. If final solution to be agreed can cover intra-band and FR1 without extra standardization effort, it is unnecessary to exclude these two scenarios.

**Issue 2-1-2: solutions to improve SCell/SCG setup delay**

* Candidate solutions:
  + Solution 1: Reuse existing measurement, including legacy measurement for cell re-selection and EMR
  + Solution 2: introduce new measurement starting from RRC setup/resume
  + Solution 3: Reuse existing measurement and introduce new measurement starting from RRC setup/resume.
* Tentative agreement:
  + Solution 1 is to be supported in this work item.
  + Solution 2 and 3 are not excluded. RAN4 can continue discuss the feasibility.
    - Note: conclusion of solution 2 and 3 shall be made no later than RAN4#106-bis-e.

**Issue 2-1-3: others**

* Proposals:
  + Proposal 1: Rel-18 enhancements to SCell/SCG setup delay should be independent of UE support of Rel-16 EMR feature. (Nokia)
* Recommended WF
  + Continue discussion.

**Issue 2-1-4: Scell delay improvement target**

* Proposals:
  + RAN4 system-level simulation results show that low SCell setup delays have significant, positive, impact on UEs with different radio link conditions and network load. RAN4 shall specify scenarios where the delay is less than 100 ms, even close to 20 ms (RRC setup/resume delay). (Nokia)
  + When the UE performs validation of earlier measurements, allowed validation delay should be as short as possible for each available measurement. (Nokia)
  + Even with security establishment it is feasible to establish SCell connection in less than 100ms. RAN4 shall consider scenarios for IDLE and INACTIVE mode where setup delays are less than 100ms. (Nokia)
* Recommended WF
  + Continue discussion.

## Sub-topic 2-2 solutions based on existing measurement

**Issue 2-2-1: overall solution**

* Candidate solutions:
  + Option 1: (Apple)
    - For EMR capable UE, introduce a new indication in existing EMR report to allow UE to indicate network whether and which EMR measurement results are valid upon UE returning connected mode.
    - For non-EMR capable UE, allow UE to report valid measurement results obtained during idle/inactive mode upon UE returning connected mode.
    - How to validate measurement results obtained in idle/inactive mode is up to UE implementation.
  + Option 2: (Intel)
    - RSRP/RSRQ variation of severing cell can be used to check the validity of stored measurement result for carrier/cells in intra-band CA since they are co-located.
    - RSRP/RSRQ variation of severing cell or cells configured for cell re-selection can be used to check the validity of stored measurement result for carrier/cells in inter-band CA.
    - RAN4 to further discuss whether NW or UE check the validity of measurement results.
  + Option 3: (CMCC, Xiaomi, MTK, Huawei)
    - Result is considered valid if the measurement are performed within the last [X] seconds before it is reported.
  + Option 4: (Nokia)
    - Early measurements can be considered at RRC connection setup regardless of whether they originate from IDLE/INACTIVE mode or CONNECTED mode before the UE entered IDLE/INACTIVE mode.
    - UE shall send detailed availability and validity status at RRCSetupComplete or RRCResumeComplete.
    - Validation of available measurements may continue in connected mode after RRC setup/resume.
    - Similarly, as for EMR UEs, cells detected in IDLE mode remain detected when transitioning to CONNECTED mode.
* Tentative agreement:
  + Continue discussion on the following two options:
    - Option 1: Result is considered valid if RSRP/RSRQ variation of serving cell after measurements are performed until it is report is no larger than [Y] dB.
    - Option 2: Result is considered valid if the measurements are performed within the last [X] seconds before it is reported.

**Issue 2-2-2: definition of ‘valid’ in solution based on existing measurement**

* Proposals:
  + Option 1: (OPPO)
    - ‘Valid’ should be considered from both UE and network side. Network can assume the reported results are ‘valid’ based on UE assisted information or UE satisfied some predefined conditions.
  + Option 2: (Intel)
    - For validity of measurement results, the key point is that whether quality of measurement carriers/cells vary a lot in terms of RSRP/RSRQ when reported.
  + Option 3: (CMCC)
    - Result is considered valid if the measurement are performed within the last [X] seconds before it is reported.
  + Option 3a: (Xiaomi)
    - The EMR results are considered as valid if the time span from when the EMR timer expires to the time of Msg4 is less than [5]s
  + Option 3b: (MTK)
    - The measurement results are valid if the last measurement occasion is during the last 5 seconds before the evaluation occasion.
  + Option 3c: (Huawei)
    - EMR measurement results are regarded as valid if the UE has acquired the EMR measurement result during the last 5 seconds before transmission of the EMR measurement results or transmission of a measurement indication.
  + Option 4: (E///)
    - Accuracy validity requirement can reuse measurement accuracy from TS 38.133 10.1.2B, 10.1.3B, 10.1.7B and 10.1.8B
    - Time validity is defined as last L3 sample that fulfill accuracy validity plus X seconds
* Recommended WF
  + Merged into issue 2-2-1.

**Issue 2-2-3: indication of valid measurement results**

* Proposals:
  + Option 1: (Apple)
    - For EMR capable UE, introduce a new indication in existing EMR report to allow UE to indicate network whether and which EMR measurement results are valid upon UE returning connected mode.
    - For non-EMR capable UE, allow UE to report valid measurement results obtained during idle/inactive mode upon UE returning connected mode.
  + Option 1a: (Intel)
    - RAN4 to further discuss whether NW or UE check the validity of measurement results.
    - RAN4 to further discuss whether to add new signaling for “validity” or re-use idleMeasAvailable.
    - If UE didn’t support EMR feature, UE can report measurement results for carrier/cell configured for cell re-selection for CA/DC setup.
  + Option 1c: (E///)
    - For UE capable of supporting Rel-16 Idle/Inactive measurement for CA/DC setup how to report can re-use the existing framework.
    - For Cell selection /reselection inter-frequency measurements, RAN4 need to trigger RAN2 discussion to obtain their feedback.
  + Option 1d (Nokia)
    - UE shall send detailed availability and validity status at RRCSetupComplete or RRCResumeComplete.
  + Option 2: (CMCC)
    - For improvement on SCell/SCG setup delay, the idle/inactive measurement results can be reported in followinng two ways:
      * in RRCResumeComplete (or RRCSetupComplete) message
      * after UE in connected mode (i.e. in UEInformationResponse message)
* Tentative agreement:
  + For measurement on EMR candidate frequencies/cells according to EMR configuration, re-use the existing EMR framework for reporting. FFS on whether new indication of validity status needs to be introduced.
  + For legacy measurement for cell (re-)selection, study how to report valid results.
  + Whether NW or UE check the validity of measurement results
    - Option 1: UE reports variation of serving cell’s RSRP/RSRQ. NW checks the validity.
    - Option 2: UE checks the validity before reporting.

**Issue 2-2-4: others**

* Proposals:
  + Proposal 1: Measurement results are invalid when UE performs cell re-selection. (Intel)
  + Proposal 2: If the EMR results are invalid, RAN4 to study whether and how to report the invalid EMR results. The following alternatives are considered for further study (Xiaomi)
    - Alternative 1: The UE does not report the EMR results to NW;
    - Alternative 2: The UE reports invalid indication to NW;
* Recommended WF
  + Continue discussion.

## Sub-topic 2-3 solutions based on enhanced measurement

**Issue 2-3-1: overall solution**

* Proposals:
  + Option 1: (QC)
    - NW can explicitly provide the measurement information for candidate frequencies which can be used for FR2 CA/DC setup. It can be overlapped with given information of EMR or cell re-selection configurations.
    - NW/UE can initiate to perform the enhanced measurement starting from RRC setup/resume under certain conditions such as MT/MO data volume, cell conditions.
    - Performing measurement for selected frequencies starting from RRC setup/resume and measurement can be completed during RRC CONNECTED state. UE report the measurement results in RRC CONNECTED.
  + Option 1b (Nokia):
    - Early measurements can be considered at RRC connection setup regardless of whether they originate from IDLE/INACTIVE mode or CONNECTED mode before the UE entered IDLE/INACTIVE mode.
    - UE shall send detailed availability and validity status at RRCSetupComplete or RRCResumeComplete.
    - Validation of available measurements may continue in connected mode after RRC setup/resume.
    - Similarly, as for EMR UEs, cells detected in IDLE mode remain detected when transitioning to CONNECTED mode.
* Recommended WF
  + Continue discussion.

**Issue 2-3-2: definition of ‘valid’ for solutions based on enhanced measurement**

* Proposals:
  + Option 1: ‘Available’ means that there have results stored in the memory after UE finished early measurement. And the ‘valid’ early measurement result can be assessed by determining whether the measurement was taken during the last [X] seconds before the enhanced measurements perform. (ZTE)
  + Option 2: If the time span from the ending point of EMR measurement T1 to starting point of improved measurement T2 is less than [Tvalid] seconds, the measurement result obtained during IDLE/INACTIVE mode can be regarded as valid and useful result. (vivo)
* Recommended WF
  + Continue discussion.

**Issue 2-3-3:** **starting point of the enhanced measurement**

* Proposals:
  + Option 1: (QC)
    - UE is not expected to start enhanced measurement before msg1 transmission.
  + Option 2: (Nokia)
    - Early measurements can be considered at RRC connection setup regardless of whether they originate from IDLE/INACTIVE mode or CONNECTED mode before the UE entered IDLE/INACTIVE mode
* Recommended WF
  + Continue discussion.

**Issue 2-3-4: ending point of the enhanced measurement**

* Proposals:
  + Option 1: Enhanced measurement can be completed during RRC CONNECTED state (QC)
  + Option 1a: Validation of available measurements may continue in connected mode after RRC setup/resume (Nokia)
* Recommended WF
  + Continue discussion.

**Issue 2-3-5: network assistant information**

* Proposals:
  + Option 1: NW shall provide explicit information such as target frequency and/or Cell ID, and/or target SSB info for enhanced measurement on FR2. Signaling details are up to RAN2 (QC)
  + Option 2: NW can provide information to initiate the enhanced measurement. (QC)
    - In case of MT-call, NW can initiate UE to perform FR2 enhanced measurement. The triggering command can be included in paging. (Note: signaling details up to RAN2).
    - In case of MO-call, UE can initiate FR2 enhanced measurement when volume of MO-data exceeds certain threshold and NW can provide the threshold information. (Note: signaling details up to RAN2).
* Recommended WF
  + Continue discussion.

**Issue 2-3-6: measurement period**

* Proposals:
  + Option 1: (QC)
    - Enhanced measurement period can be based on SSB period instead of SMTC for the frequency. SSB period can be provided by NW or default SSB period (20ms) can be applied.
    - Enhanced measurement requires at least 8 SSB samples and additional [X] samples of SSB burst. (FFS on X, e.g 2)\
  + Option 2: (MTK)
    - Measurement accuracy still cannot be guaranteed by the one or two shot measurement during RRC connection setup/resume procedure.How to reduce measurement delay is not in the scope.
  + Option 3: (vivo)
    - FFS: how to select the frequency layers for improved measurement, how many frequency layers to measure and which scenario that is applicable
    - FFS: How to reduce number of samples without measurement accuracy degradation.
    - FFS: Reduced scaling factor of Rx beam sweeping
  + Option 4: (OPPO)
    - As baseline, RAN4 shall not reduce the scaling factor of Rx beam sweeping when defining requirements for the new measurement during RRC connection setup/resume.
  + Option 5: (Nokia)
    - When the UE performs validation of earlier measurements, allowed validation delay should be as short as possible for each available measurement. UE should be able to make the results available to the network as soon as the validation has been completed regardless of the maximum validation delay.
* Recommended WF
  + Continue discussion.

**Issue 2-3-7: applicability rules to perform enhanced measurement**

* Proposals:
  + Option 1: (QC)
    - The enhanced measurement is not applied when PCell is FR2.
    - The enhanced measurement is applied when target cell SNR > [Y] dB (e.g Y = 6 dB).
    - UE is allowed to stop enhanced measurement upon RA procedure problem (e.g msg2 reception failure).
* Recommended WF
  + Continue discussion.

**Issue 2-3-8: others**

* Proposals:
  + Proposal 1: UE is not expected to perform enhanced measurement on FR2 more than one carrier per band. FFS on the selection of carriers if multiple carriers are configured per band in FR2. (QC)
  + Proposal 2: The condition of triggering FR2 enhanced measurement shall be defined. (QC)
  + Proposal 3: It is hard to define the measurement requirements if the overall measurement starts from IDLE/INACTIVE mode and ends in Connected mode. (MTK)
  + Proposal 4: UE shall send detailed availability and validity status at *RRCSetupComplete* or *RRCResumeComplete.* (Nokia)
  + Proposal 5: Even with security establishment it is feasible to establish SCell connection in less than 100ms. RAN4 shall consider scenarios for IDLE and INACTIVE mode where setup delays are less than 100ms. (Nokia)
* Recommended WF
  + Continue discussion.

# Topic #3: Enhanced CHO configurations

## Sub-topic 3-1 Scope of RRM requirements for enhanced CHO configurations

**Issue 3-1-1: scope of RRM requirements for enhanced CHO configurations**

* Background: obj #3 and #4 for information:

1. *For CHO including target MCG and target SCG in NR-DC [RAN3]:*

* *to specify data forwarding optimizations; and*
* *to specify, if needed, a solution to avoid unnecessary signaling exchange between source MN and target SN.*

1. *To specify* *CHO including target MCG and candidate SCGs for CPC/CPA in NR-DC [RAN3, RAN2]*

* *CHO including target MCG and target SCG is used as the baseline*
* Proposals:
  + Proposal 1: RAN4 would define requirements for both objective 3 and objective 4. (MTK)
  + Proposal 1a: RAN4 shall discuss and reach consensus of the scenarios for setting delay requirements of both Rel-17 CHO with MR-DC and Rel-18 CHO with CPA/C. (E///, vivo)
  + Proposal 2: Further discuss how to define the related RRM requirements for CHO including target MCG and candidate SCGs for CPC/CPA (objective 4) after RAN2 concluding on whether CHO evaluation and CPC/CPA evaluation is concurrent or sequential (MTK)
  + Proposal 3: Define the requirements for CHO with PSCell (objective 3) in FR1+FR2 NR-DC at first. (MTK)
  + Proposal 4: RAN4 to discuss if CHO needs to be enhanced considering CHO with SCG. (Nokia)
* Recommended WF
  + Continue discussion.

## Sub-topic 3-2 RRM requirements for enhanced CHO configurations

**Issue 3-2-1: RRM requirements for CHO with PSCell in FR1+FR2 NR-DC**

* Proposals:
  + Option 1: (MTK)
    - For CHO with PSCell in FR1+FR2 NR-DC, the delay requirements for PCell DCHOwithPSCell\_PCell is the same as CHO i.e., DCHOwithPSCell\_PCell = TRRC + TEvent\_DU + Tmeasure + Tinterrupt + TCHO\_execution and Tinterrupt = Tprocessing + TIU + T∆ + Tmargin, except that
      * Tprocessing = 30 ms if SMTC of the target unknown PSCell is configured in targetcellSMTC-SCG-r16 but not configured in reconfigurationWithSync. Otherwise, Tprocessing = 25 ms.
      * TIU can be up to the summation of SSB to PRACH occasion association period and 10 ms as UE can transmit RACH on different FR simultaneously in FR1+FR2 NR-DC.
    - ForCHO with PSCell in FR1+FR2 NR-DC, the delay requirements for PSCell DCHOwithPSCell\_PCell = TRRC + TEvent\_DU + Tmeasure + TCHO\_execution + Tprocessing + Tsearch\_PCell\_Conditional + Tsearch\_PSCell + T∆\_PSCell + TPSCell\_ DU + 2 ms, where
      * The definitions of TRRC, TEvent\_DU, Tmeasure, TCHO\_execution, Tprocessing are the same as the definitions in the delay requirements for PCell
      * Tsearch\_PCell\_Conditional is the time for obtaining the timing reference of target PCell. If SMTC of the target unknown PSCell is configured in targetcellSMTC-SCG-r16 but not configured in reconfigurationWithSync, Tsearch\_PCell = TΔ + Tmargin, where TΔ has the same definition in the delay requirements for PCell and Tmargin =2ms. Otherwise, Tsearch\_PCell\_Conditional = 0 ms.
      * TPSCell\_ DU is the delay uncertainty in acquiring the first available PRACH occasion in the PSCell. TPSCell\_ DU is up to the summation of SSB to PRACH occasion association period and 10 ms as UE can transmit RACH on different FR simultaneously in FR1+FR2 NR-DC.
  + Option 2: (E///)
    - For Rel-17 CHO to include a target SCG, the delay can be
      * TRRC + TEvent\_DU + Tmeasure + TCHO\_execution +Tprocessing + TIU + T∆ + Tmargin+ TPscell\_addition/change\_delay.
      * TPscell\_addition/change\_delay = TRRC\_delay + Tprocessing + Tsearch\_PCell + Tsearch\_PSCell + T∆ + TPSCell\_ DU + 2 ms
* Recommended WF
  + Continue discussion.