3GPP TSG-RAN WG4 Meeting #116bis R4-25xxxxx

Prague, Czech Republic, October 13 – 17, 2025

Agenda item: 8.1

Source: Feature lead (Apple)

Title: WF on 6G RRM

Document for: Approval

# Topic #1: 6G RRM (8.7)

### Issue 1: Summary of the support status for the main features

Issue 1: RRM features prioritization for 6G SI

[Way forward]

* FFS:
  + Which RRM topics can be prioritized for 6G SI scope based on the following criteria, and further discuss the detailed scopes for the prioritized topics
    - Topics that can be initiated directly in RAN4
    - Topics with clear commercial demand for RRM
    - Topics for fundamental feature in RRM (not incremental enhancement from 5G)
    - Topics with the strongest support from companies
    - Topics whose study can address the most critical pain points in 5G RRM

### Issue 2: RRM requirement design principle

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* FL note: This issue 2 has been moved to [116bis][111] 6G operation efficiency.

### Issue 3: General RRM scope

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FL note: this general RRM scope is not for a specific feature or functionality, but it’s the basic/common part for RRM requirement design.

[Way forward]

* + FFS:
    - Whether discuss such general RRM scope in 6G SI?
    - If yes, which part shall be prioritized? E.g., select/delete/add based on followings:
      * Intra and inter-frequency definition
      * RF retuning time, baseband processing time for typical use cases
      * UE reference architecture for 6G spectrums
      * Baseline assumptions of RRM requirements for different UE device types

### Issue 4: Measurement gap(MG) and interruption

Issue 4-1: MG related scope

Agreement in main session (Tue):

Measurement gap, including gap-less measurement, is considered as part of RAN4 RRM 6G study. The detailed scope will be further decided.

* Interruption enhancement due to gap-less measurement will be part of the MG discussion.

[Way forward]

* + FFS followings in RAN4#117 (other sub-topics are not precluded)
    - based on the majority views from companies, RAN4 RRM to discuss which MG related sub-topics can be prioritized from the following candidate list, and then discuss the solutions for the selected topics in 6G SI:
      * MG pattern reduction from 5G (10 companies: Apple, MTK, QC, OPPO, Sony, Xiaomi, vivo, Ericsson, Samsung, Nokia)
      * Gap-less measurement and its side conditions (10 companies: MTK, Samsung, CMCC, ZTE, NTT DCM, HW, Ericsson, Nokia, QC, Xiaomi)
        + In scenarios with and without an available RF chain.
      * Unified MG (7 companies: Apple, OPPO, LGE, Xiaomi, ZTE, Ericsson, QC), e.g.,
        + Unified MG configuration
        + Unified MG and scheduling restriction
        + Unified MG for different feature related measurements
      * Adapative MG operation, e.g., activation/deactivation/cancellation/skipping (7 companies: Apple, OPPO, CMCC, Xiaomi, ZTE, Ericsson, LGE)
      * Using which 5G MG enhancement features to 6G day 1 (OPPO, CMCC, Xiaomi, vivo)
        + E.g., needforGap, NCSG, concurrent MG, preconfigured MG and etc.
      * MG sharing(Apple, OPPO, vivo), e.g.,
        + among intra-frequency, inter-frequency, and inter-RAT measurement (including L3 and L1 measurement)
      * UE assisted MG configuration (Apple, QC)
        + e.g., MG requesting by UE (Apple, QC)
      * Multi-CC measurements in MG (Apple, CMCC, ZTE(searcher related))
      * Optimization on MGL and RF tuning/retuning (Apple, MTK, QC)
      * MG applicability for per-UE, per-FR, per-CC, or per-CC group (OPPO, Xiaomi, ZTE(granularity))

Issue 4-2: interruption related scope

[Way forward]

* + FFS followings in RAN4#117 (other sub-topics are not precluded)
* Proposal 1(QC):
  + RAN4 should identify and evaluate mechanisms that enable interruption-free measurements, with a focus on deployability from the beginning of 6GR.
  + RAN4 should study all existing interruption scenarios in 5G NR whether they are still applicable to 6GR, whether the existing requirements should be refined and whether interruptions are needed in certain scenarios not yet covered in 5G NR.
  + RAN4 should study for the case of 15 kHz subcarrier spacing whether the unused half slot (0.5 ms) in the duration of a measurement gap can be used efficiently, e.g., for data transmission.
* Proposal 2(ZTE):
  + Finer granularity of interruption such as symbol level is foreseen in 6G to benefit the throughput via avoid the vital symbols within a slot used for DCI or UCI. Awareness of the location of interruption by NW could lesson the impact on throughput.
* Proposal 3(Ericsson):
  + RAN4 shall strive for reducing the amount of interruptions in UEs.
  + The interruptions can be specified at a symbol level.
  + The existing interruption requirements may need to be revisited for 6G, if the 6G UEs can achieve a better performance.
* Proposal 4(Nokia):
  + RAN4 to aim at removing all UE autonomous interruptions in 6G.
* Proposal 5(MTK):
  + RAN4 (RRM/RF) to further study the possibility of reducing the interruption time including the RF retuning time for different UE procedures.

### Issue 5: RRM framework:

Issue 5: RRM framework: Measurement capability/delay/overhead/accuracy

Agreement:

RRM framework: measurement capability/delay/overhead/accuracy/quantities/unified measurement, is considered as part of RAN4 RRM 6G study. The detailed scope will be further decided.

Note: the title of the main topic can be revised after selection of the sub-topics.

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded):
  + Measurement capability
    - measurement capability for number of cells, beams and frequency layers (MTK, OPPO, Ericsson)
    - Virtual RRM UE group (Apple, ZTE)
    - Measurement requirements depending on purpose of the configured measurement: mobility or data (CA) (Nokia)
  + Measurement delay/overhead
    - Searcher number for enhanced simultaneous measurements (OPPO, HW, Samsung, ZTE, vivo, Ericsson)
    - Rx beam sweeping factor reduction (QC, Ericsson)
    - Identification/measurement/tracking/reporting delay reduction (QC)
    - RRM with NW aided measurement priority (Ericsson)
    - Virtual RRM UE group (Apple, ZTE)
    - Measurement requirements depending on purpose of the configured measurement: mobility or data (CA) (Nokia)
    - Unified UE measurement requirements, including cell detection status and measurements, across state transitions and cell changes. (Nokia)
    - SSB evaluation (Samsung)
  + Unified measurements
    - United/integrated cross-layers measurement and/or report between L1 and L3 (Samsung, OPPO, CMCC, LGE, Xiaomi)
    - United/integrated cross-functions measurement and/or report for L1 (e.g., integration of MIMO and LTM, or integration of RLM/BFD/CBD)(OPPO, CMCC, Xiaomi)
    - RAN4 to study the flexible and adaptive measurement behaviour for L1 measurement. Unification in terms of reusing L3 measurements for L1 before certain point (e.g., before TCI state activation) (Ericsson)
* FFS:
  + For other WG driven topics which have RRM impacts:
    - Option 1: RAN4 to set check points to check whether or not starting discussion on other RRM framework related RRM topics if there are sufficient conclusions from other WGs
      * FFS: Check point timeline
      * If the topic is driven by RAN4, RAN4 can take into account the agreements from other WGs as early as possible.
    - Option 2: RAN4 to check whether or not starting discussion on other RRM framework related RRM topics once there are sufficient conclusions from other WGs.

### Issue 6: Mobility related RRM

Issue 6: Mobility related RRM

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded):
  + RAN4 to start from mobility related RRM solutions with less RAN1/2-dependency.
  + RAN4 to identify which of the following topics can be starts directly in RAN4:
    - Latency and/or interruption reduction for mobility through RAN4-defined components (Apple, MTK(interruption only), QC, LGE, ZTE, HW, vivo, Ericsson, Nokia, CMCC, Samsung)
      * discuss RRM part reduction during mobility, e.g., L1/L3 measurement, beam sweeping and etc.
      * discuss the scenarios/conditions for such reduction (known, unknown, or other status)
      * discuss NW controlled and UE initiated L1/L3 measurement report
    - Solutions for longer SSB periodicity in mobility (MTK, Samsung, Ericsson)
    - Early RRC decoding, and/or, DL/UL sync, and/or, early T/F tracking for mobility (MTK, Nokia)
    - Virtual RRM UE group (Apple, ZTE)
    - Unified measurement and mobility framework (QC)
      * E.g., based on 5G LTM
    - End-to-end handover latency target (QC)
      * RAN4 to study the practically achievable end-to-end handover latency target, taking into account user-plane data forwarding latency, to better align handover requirements with practical effectiveness.
    - Unified UE measurement requirements across cell changes (Nokia)
  + To be discussed:
    - Option 1: RAN4 to set check points to check whether or not starting discussion on other mobility related RRM topics if there are sufficient conclusions from other WGs
      * FFS: Check point timeline
    - Option 2: RAN4 to check whether or not starting discussion on other mobility related RRM topics once there are sufficient conclusions from other WGs.

### Issue 7: RRM related energy efficiency

Issue 7: RRM related energy efficiency

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded):
  + RAN4 to identify candidate topics can be studied in RAN4 directly:
    - Network energy saving:
      * RRM for new SSB design(e.g., SSB periodicity extension, OD-SSB/OD-SIB1) (vivo, Ericsson, Nokia, ZTE)
      * SSB-less based RRM (Ericsson, Nokia, ZTE)
    - UE power saving:
      * UE type/state based RRM relaxation (Apple, CMCC, Ericsson(scalable set of measurement requirement), Nokia)
      * LR based solutions for UE power saving (Sony, vivo, Ericsson)
      * DRX/eDRX based measurement (Ericsson)
      * Energy sensing based RRM strategy (CATT)
  + To be discussed:
    - Option 1: RAN4 to set check points to check whether or not starting discussion on other energy efficiency related RRM topics if there are sufficient conclusions from other WGs
      * FFS: Check point timeline
    - Option 2: RAN4 to check whether or not starting discussion on other energy efficiency related RRM topics once there are sufficient conclusions from other WGs.

### Issue 8: Spectrum aggregation and CA related RRM

Issue 8: Spectrum aggregation and CA related RRM

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded):
  + RAN4 to identify which of the following topics can be starts directly in RAN4 RRM with less RAN1/2 and RAN4 RF session dependency:
    - SCell activation/deactivation, deactivated SCell measurement, fast carrier setup based on 6G UE implementations (MTK(SCell activation), QC, vivo(activation), Ericsson, Nokia)
    - RRM conditions and requirements for Single Cell Multi-Carriers (MTK, vivo, Samsung, OPPO)
    - RRM impacts of DL and UL decoupling (Samsung, Ericsson)
    - Carrier switch enhancements for UL and DL (MTK)
    - RRM impacts of realistic SCS for spectrum (Samsung)
    - relaxation of the requirement on timing alignment between carriers (Ericsson)
    - RRM for MRSS (Samsung)
  + To be discussed:
    - Option 1: RAN4 to set check points to check whether or not starting discussion on other spectrum aggregation and CA related RRM topics if there are sufficient conclusions from other WGs and RAN4 RF session
      * FFS: Check point timeline
    - Option 2: RAN4 to check whether or not starting discussion on other spectrum aggregation and CA related RRM topics once there are sufficient conclusions from other WGs and RAN4 RF session

### Issue 9: MIMO and mTRP operation related RRM

Issue 9: MIMO and mTRP operation related RRM

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded):
* Proposal 1(Apple):
  + study RRM impact from mTRP on different carriers, if supported.
* Proposal 2(Samsung):
  + In 6GR, for MIMO operation and multi-TRP, RAN4 RRM to discussion on following aspects:
    - Multiple Tx and Multiple Rx with/without simultaneously in transmission/reception
    - TCI states: RRM only support unified TCI states framework
    - Further harmonized “TR point” and “cell” for mobility and measurement
* Proposal 3(vivo):
  + MIMO/mTRP related RRM requirements (e.g., measurement for beam management, TCI state switching) need be studied based on concrete RAN1 assumptions and progress, and early RAN4 evolvement is needed w.r.t UE implementation constraint (e.g., UE multi-panel, Rx/Tx timing difference).
* Proposal 4(Nokia):
  + RAN4 to study how to enable robust multi TRP operation considering both beam pairs and deployments

### Issue 10: NTN related RRM

Issue 10: NTN related RRM

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded)
* Proposal 1(Samsung, LGE):
  + RAN4 to discuss for harmonized 6G Radio design for TN and NTN, can start from these aspects:
    - Re-consider which procedures can be common for TN and NTN.
    - Integrated TN-NTN mobility support.
    - Re-consider the framework and mechanisms for the different NTN UE types.
* Proposal 2(CMCC):
  + Within the harmonized 6G Radio design for TN and NTN, if both TN measurement and NTN measurement are configured to UE, the measurement priority shall be under network control, the measurement on TN carrier shall have higher priority as the default assumption.
  + Towards 6G, the baseline UE measurement capability shall be reconsidered, at least the UE capability of parallelSMTC-r17, parallelMeasurementGap-r17, parallelMeasurementWithoutRestriction-r17 need to be inherited as mandatory to 6G.
* Proposal 3(Ericsson):
  + RAN4 shall ensure that NTN RRM requirements remain aligned with the TN RRM framework in 6G, while incorporating updates to address NTN-specific aspects (which have already been introduced in earlier releases or may be introduced in 6G).
  + RAN4 shall study valid and effective NTN RRM requirements remain under both GNSS-resilient and GNSS-less operation.(LGE)
* Proposal 4(Nokia):
  + NTN should be considered as a day-1 feature in NR and not be relegated to separate subclauses. This includes the measurement framework.
  + RAN4 to study how to simplify the measurement requirements for NTN. RAN4 to inform RAN1/2 about the conclusions of the study.
* Proposal 5(CATT):
  + For Space-Air-Ground Integrated Network, RAN4 to study the optimization of RLM and access performance with frequent and significant changes in propagation delay, which may involve multi-dimensional optimization at least including frequency layer and spatial layer.

### Issue 11: Initial access related RRM

Issue 11: Initial access related RRM

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded)
* Proposal 1(Samsung):
  + In 6GR, for initial access, RAN4 RRM to discussion on following aspects:
    - Whether to specify the RRM requirements for initial cell search. To consider on following aspects:
      * Whether can find the start point to define such RRM requirement like “power on”
      * Necessity to specify such RRM requirements if “UE is powered on” happened infrequently.
      * Part of UE performance in initial cell search can be ensured by other procedures like cell identification; sync raster
      * RRM requirements are needed for cell selection
    - Whether to specify the RACH RRM requirements as functionality as correct UE behavior and tests in RRM.
* Proposal 2(vivo):
  + The cell detection should be studied based on 6G SSB design. In addition, RAN4 may discuss whether necessary to introduce cell selection delay requirement whereas the same principle as that of 4G/5G, i.e., no corresponding cell selection delay requirement, can be used as the base.

### Issue 12: Other PHY signal/channel/procedure related RRM

Issue 12: Other PHY signal/channel/procedure related RRM

[Way forward]

* FFS followings in the RAN4#117 meeting (other sub-topics are not precluded)
* UE Tx timing:
  + Proposal 1(MTK):
    - Study PRACH (if introduced) specific timing accuracy requirement.
    - Study the feasibility of replacing gradual timing adjustment with UE pre-compensation, while retaining the Timing Advance command.
  + Proposal 2(Nokia):
    - In 6G, the UE transmit timing requirements would have to address practical aspects from deployments and define UE requirements for these.
* Inter-RAT sync:
  + Proposal 1(MTK):
    - Synchronized Inter-RAT to be the baseline assumption for 6G to enable inter-RAT measurement and mobility.
* Testability:
  + Proposal 1(QC):
    - RAN4 should study whether to use TDL, instead of AWGN, in more performance tests of 6G RRM.
* RRM-specific Categories:
  + Proposal 1(QC):
    - Study how to establish a more intuitive and practical framework for differentiating UE RRM performance beyond baseline RRM requirements and individual capabilities:
      * The framework aims to reflect real UE implementation-based RRM performance, while RRM requirements continue to serve as the baseline for minimum performance.
      * The framework aims to cover a limited set of scenarios and cases with field/deployment relevance, within those defined in the RRM requirement specification.
      * The framework aims to focus on the most important RRM KPIs, such as measurement latency, mobility latency, carrier aggregation latency, interruption, etc.
      * The framework aims to accommodate different UE implementations across vendors without requiring disclosure of implementation details, unless such details must be known to the network.
      * The framework aims to minimize impacts on existing 3GPP specifications.
      * The framework aims to provide relationships to UE capabilities, where applicable.
      * The framework aims to be maintainable and verifiable with minimal effort.
* TCI switching reduction:
  + Proposal 1(QC):
    - RAN4 should study the mechanisms to reduce TCI state switch timeline in 6G.
  + Proposal 2(Nokia):
    - RAN4 to study the steps involved in TCI switching and identify potential reductions in TCI switching delay for 6G.
* Duplexing:
  + Proposal 1(Samsung):
    - In 6GR, RAN4 RRM shall collaborate with RAN1 to discuss on how to support multiple types of duplexing including SBFD.
* RRM relaxation and simplification for 6G massive IoT:
  + Proposal 1(Sony):
    - RAN4 should study the RRM relaxation and simplification for 6G massive IoT, comparing it with legacy IoT devices, to reduce device complexity and improve network/device energy efficiency.
* Sensor based RRM:
  + Proposal 1(CATT):
    - RAN4 to consider enriching RRM measurement content and introducing sensing information based mobility management.
      * In addition to link quality measurement such as RSRP/RSRQ/SINR, the measurement content can also include speed, distance, angle, positioning, imaging, or activity detection, etc.
    - RAN4 to consider RRM impact for multi-functional RAN, where communication and sensing functionalities are jointly supported.
* user-centric based RRM:
  + Proposal 1(CATT):
    - RAN4 to study the RRM impact for user-centric operation.
* Unified UE capability:
  + Proposal 1(Xiaomi):
    - Unified modular based UE RRM Capability Definitions – Study common, reusable capability blocks for fundamental UE abilities (e.g., beam-sweeping factor, message-processing footprint) to improve consistency and scalability across RRM procedures.
* BWP switch:
  + Proposal 1(vivo):
    - For BWP switch, reduction on BWP switch time may need study once BWP design (if there is any) in 6G is clear. Particularly, the reduction on the duration for UE parsing time may be studied if the BWP framework is further simplified. At the same time, RAN4 could study whether the RF retuning time can be further improved or not.
* MRTD:
  + Proposal 1(Ericsson):
    - When feasible, in timing requirement, use a total budget that allows flexible allocation among subcomponents instead of specifying sub-requirements on part of the system.
    - When feasible, specify MRTD (RRM) as a total budget and avoid stating TAE (BS RF) between ARP.
* TDD Cell Phase Synchronization:
  + Proposal 1(Ericsson):
    - Keep TDD Cell Phase Synchronization requirement the same as in NR NR.
* CGI reading:
  + Proposal 1(Ericsson):
    - RAN4 should define the CGI reading requirement in 6G first release.
* Purpose-based measurement requirements:
  + Proposal 1(Nokia):
    - For Connected mode, Idle mode, and Inactive mode, RAN4 to study defining measurement requirements depending on purpose of the configured measurement: mobility or data (CA).
* FFS:
  + Due to the limited TU of the 6G SI for RRM, the topics in “Issue 13: Other PHY signal/channel/procedure related RRM” will not be studied in 6G SI timeline, unless it can be well justified with following criteria in RAN4#117 meeting:
    - Topics that can be initiated directly in RAN4
    - Topics with clear commercial demand for RRM
    - Topics for fundamental feature in RRM (not incremental enhancement from 5G)
    - Topics with the strongest support from companies
    - Topics whose study can address the most critical pain points in 5G RRM
    - Topics requested from other WGs

### Issue 13: RAN4 RRM spec simplification/improvement

Issue 13: RAN4 RRM spec simplification/improvement

* FL note: This issue 13 has been moved to [116bis][111] 6G operation efficiency.

### Recommendation for 6G RRM contribution preparation for RAN4#117 meeting

Strongly encourage companies to structure contribution and categorize proposals based on the following categories for RAN4#117:

* General RRM scope
* Measurement gap(MG) and interruption
  + Including MG and interruption related proposals
* RRM framework: Measurement capability/delay/overhead/accuracy/quantity/unified-measurement
* Mobility related RRM
* RRM related energy efficiency
* Spectrum aggregation related RRM
* MIMO and mTRP operation related RRM
* NTN related RRM
* Initial access related RRM
* Other PHY signal/channel/procedure related RRM