**3GPP TSG-RAN WG4 #** **116-bis R4-2514513**

**Prague, Czech Republic, 13th October 2025 – 17th October 2025**

**Agenda item:** 8.1

**Source:** MediaTek inc.

**Title:** Topic summary for [116bis][106] 6G Demod

**Document for:** Information

# Introduction

This document summarises the contributions for FS\_6G\_Radio under AI 8.8 corresponding to RAN4 driven non-AI demod topics at RAN4#116bis.

The proposals from the contributions are grouped into the following sub-topics:

* Sub-topic 1-1: General aspects
* Sub-topic 1-2: Channel models
* Sub-topic 1-3: Receiver assumptions
* Sub-topic 1-4: TxEVM and SNR
* Sub-topic 1-5: Interference modelling aspects
* Sub-topic 1-6: Performance testing and requirement
* Sub-topic 1-7: UE classification and applicability
* Sub-topic 1-8: Uplink demod

# Topic #1: 6G demod

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2513025 | Nokia | Proposal 1: 6GR demodulation and CSI reporting performance requirements for MIMO features shall be set using the rCDL as baseline propagation condition. The overall number of requirements may be limited, when rCDL is used.  Proposal 2: Additionally, a limited number of TDL requirements for MIMO features with single and multi-layer transmission within the same time/frequency resources may be considered.  Proposal 3: AIML extensions to the SCM framework shall be studied by the AIML 6GR study, if needed.  Observation 1: SNR limitations were imposed by consideration of worst-case configuration for the test equipment, e.g., OTA setup (with noise power transmission amplification), full power, full resource allocation, full CA, max bandwidths, and then enforced also on the majority of non-limited configuration, e.g., conducted test without carrier aggregation and with limited RE time/frequency domain allocation  Proposal 4: RAN4 shall abandon the SNR operating point limitations via fixed 20dB rule, or fixed TE TxEVM assumptions, and adopt a SNR limitation derivation based on actual TDRA/FDRA configuration.  Proposal 5: RAN4 to study demod requirement handling for UE classifications and agree on questions such as a baseline set of requirements for all devices vs. individual requirements for each UE classification.  Proposal 6: RAN4 to assume broadcast and feedback-less channels/signals to be testable. RAN4 to recommend to RAN5 to define needed test solutions.  Proposal 7: RAN4 to reaffirm the mission of RAN4 DMD to produce performance requirements, not functional requirements, and to refrain from seeing RRM performance requirements as “good enough” functional tests for demodulation performance.  Proposal 8: RAN4 to discuss appropriate performance requirement task separation between RRM and Demod when reports are involved.  Observation 2: 5GNR demodulation and CSI reporting requirements are often neglecting to dynamically react to DUT feedback and to consider scheduling aspects.  Proposal 9: RAN4 to study inclusion of higher layer aspects in demodulation requirements via increased and dynamic application of DUT feedback in the TE.  Proposal 10: RAN4 to study inclusion of higher layer aspects in demodulation requirements via dynamic TE decisions using known algorithms, e.g., SU/MU scheduling, dynamic resource allocation/slots, applying timing offset reports (CJT), OLLA, etc.  Observation 3: Including OLLA will provide more deployment aligned requirements. Further study is required to analyse and define a minimum performance procedure to implement OLLA in TE.  Proposal 11: Study the impact of including OLLA in ATP requirements with relation to actual deployment. Compare results with existing ATP requirements defined without OLLA. Use proposed OLLA model from [R4-2300703] as starting point.  Proposal 12: Study how a simple implementation model for OLLA can be defined. Target of the model is implementation in TE.  Proposal 13: RAN4 to consider having both baseline and advanced UE receiver requirements at day 1. |
| R4-2513033 | Apple | Proposal #1: Study if spatial channel models can be applicable to all frequency bands in FR1  Proposal #2: Develop channel models for different scenarios  Proposal #3: Evaluate necessity and study spatial channel model for other frequency ranges in 6GR  Proposal #4: In 6G performance requirements the adoption of CDL / SCM should be justified for each specific test purpose.  Proposal #5: TDL based channel models are employed for performance requirements in 6G.  Proposal #6: Study and develop channel modelling methodologies for requirements targeting AI/ML use cases.  Proposal #7: Study impact of TX EVM for higher modulation order/ MIMO layers on Demodulation requirements.  Proposal #8: Study practical MIMO correlation matrices for demodulation and performance requirements.  Proposal #9: Develop a testing framework relevant to real field deployment |
| R4-2513041 | Qualcomm | **Observation 1:** Existing RAN4 tests do not always ensure testing under field-relevant conditions.  **Proposal 1:** RAN4 should focus on enhancing the test framework to ensure that functionality and performance is tested under conditions that reflect field-relevant scenarios.  **Proposal 2:** RAN4 should ensure that the devices are tested under modes of operation that are encountered in field deployments to provide test coverage for a wide range of scenarios.  **Proposal 3:** RAN4 should ensure that the test framework allows verifying enhanced spectral efficiency and spectrum utilization in 6GR.  **Proposal 4:** The test framework should support the identification of root causes of test failures.  **Proposal 5:** RAN4 should assume non-AI/ML processing as baseline for defining demodulation performance requirements.  **Observation** **2**: Rel-18 Doppler codebook RAN4 requirement does not demonstrate superior performance with respect to Rel-16 eType-II codebook.  **Proposal 6:** RAN4 shall choose scenarios that demonstrate genuine performance gains realizable in the field.  **Observation 3**: No RI requirement that explicitly requires reported rank 4 for a 4Rx device.  **Observation 4:** Consistency of reported rank is not verified in current RAN4 tests.  **Proposal 7:** RAN4 to investigate alternative metric that measures consistency and accuracy of Rank Indicator (RI).  **Proposal 8**: RAN4 shall discuss throughput ratio between “follow rank” and “median rank” as a metric for RI requirements.  **Observation 5:** Typical 1st transmission BLER of 10% seen in field deployments is not used in RAN4 specifications.  **Proposal 9:** RAN4 should study to choose test settings that are close to field use cases.  **Observation 6:** Current link adaptation-based RAN4 requirements don’t measure the highest achievable throughput/spectral efficiency of the link.  **Proposal 10**: RAN4 to investigate Outer-Loop (gNB controlled) Link Adaptation (OLLA) and/or Inner-Loop (ILLA) methods to specify requirements for throughput.  **Observation 7:** In RAN4, performance requirements are typically not introduced for features involving network-side signal processing. While this allows flexibility for vendors and avoids standardizing deployment-specific behavior, it limits the ability to effectively assess UE performance in realistic deployment scenarios.  **Observation 8:** In RAN4, no performance requirements are introduced for SRS port grouping because its effectiveness depends on network-side beamforming. Due to the absence of such requirements, there is no guarantee for UE performance in realistic deployment scenarios.  **Observation 9:** RAN4 did not introduce performance requirements for CJT delay and frequency offsets reporting, as its effectiveness depends on how the gNB applies these offsets during beamforming and scheduling, both of which vary across network implementations and deployment scenarios. Due to variability in network implementations and the absence of a test framework, RAN4 does not define performance requirements for this feature.  **Observation 10:** RAN4 did not define performance requirements for the port-selection codebook due to its strong dependence on gNB-side beamforming behavior, which varies across implementations and deployment scenarios. This variability makes it impractical to guarantee UE performance in deployment scenarios or functionality of this this feature at the UE side.  **Proposal 11:** RAN4 should explore utilizing test equipment algorithms to evaluate features that rely on network-side processing, enabling realistic UE performance assessment without limiting network implementation flexibility.  **Proposal 12:** RAN4 should identify features dependent on network-side processing and aim to define corresponding performance requirements, where feasible, using test equipment-based evaluation methods.  **Observation 11:** The default receiver in 5G NR is MMSE. MMSE-IRC receivers are mandatory since Rel-17.  **Observation 12:** Non-linear R-ML receivers are widely available in real world UE devices.  **Proposal 13:** Both R-ML receiver and MMSE-IRC receiver should be baseline receivers for 6GR, independent on the number of Rx antennas.  **Observation 13:** The SNR in the 5G NR demodulation requirements is the non-beamformed SNR measured on the secondary synchronization signal of the SSB.  **Proposal 14:** To ensure good field coverage, the SNR values in the demodulation requirements should follow the SSB SNR values that can be measured in existing 5G NR scenarios and those SSB SNR values that can be expected in upcoming 6G deployments.  **Observation 14:** In field measurements, easily SSB SNR values of 35 dB and above can be observed per Rx antenna.  **Observation 15:** For single component carriers, UE demodulation performance is not well tested for a wide range of SSB SNR values above SNR = 25 dB.  **Proposal 15:** RAN4 should study whether the coverage range for relevant field scenarios can be extended by defining demodulation requirements for larger SNR values as currently being used in 5G NR.  **Observation 16:** Since in field measurements, SSB SNR values far beyond 29 dB, corresponding to 3.5% TxEVM, can be observed, it is evident that commercial base stations are exceeding this minimal TxEVM requirement significantly.  **Proposal 16:** RAN4 should study whether the TxEVM requirements for the base station, at least in the simulations for deriving the demodulation requirements, could be tightened.  **Proposal 17:** RAN4 should study whether the coverage range for relevant field scenarios can be extended for carrier aggregation. It should also be studied whether the SNR requirement should be dependent on the number of component carriers.  **Observation 17:** TDL models, while foundational for 5GNR, are spatially agnostic and in some cases have been shown not to sufficiently characterize spatially dependent features for the purpose of testing certain scenarios (e.g. advanced MIMO schemes, multiple codeword scenarios).  **Proposal 18:** Maintain both TDL and CDL models in future 6GR performance requirements. TDL should continue to serve as a reference and comparison, while CDL provides the spatial features that can be used to test advanced demodulation scenarios.  **Observation 18:** The deterministic nature of CDL models can lead AI/ML-based receivers to learn the channel behavior during testing, resulting in artificial performance that does not generalize to real-world conditions.  **Proposal 19:** Consideration of CDL modeling in 6GR for AI/ML receiver evaluations should follow the identification of robust countermeasures to prevent overfitting to deterministic channel behavior.  **Observation 19:** Stable spatial directions in CDL models can distort PMI prediction results, making them appear more effective than they would be in dynamic environments.  **Proposal 20:** Consideration of CDL modeling in 6GR for PMI report evaluation should follow the identification of robust countermeasures to prevent overfitting to deterministic channel behavior.  **Proposal 21:** Extend the current TDL framework to include more realistic antenna correlation values, enabling more advanced modeling while preserving backward compatibility.  **Observation 20:** RAN4 has recently concluded a study on CDL channel modeling for terrestrial networks, documented in TR 38.753.  **Proposal 22:** We propose initiating a similar study for NTN scenarios, focusing on the CDL-D variant to reflect the LOS-dominant nature of NTN links and enable more accurate performance evaluations for NTN systems under practical deployment scenarios.  **Proposal 23:** RAN4 to study the feasibility of considering higher than 8Rx scenarios when defining the BS demodulation requirements.  **Observation 21:** CDL channel models are expected to be considered in RAN4 for uplink to address base station demodulation performance.  **Observation 22:** The introduction of device types is an ongoing discussion in the plenary and in RAN1. RAN1 studies the device types form physical layer perspective to be supported by 6GR, subject to further discussion and confirmation in RAN.  **Proposal 24:** RAN4 should wait for further clarification in RAN and RAN1 what device types may get defined. Afterwards RAN4 should discuss how device types can be covered in the test framework of RAN4.  **Observation 23:** The current structure of applicability rules in TS 38.101-4 is fragmented and sometimes inconsistent across device types, making it difficult for stakeholders to interpret test requirements reliably, especially for different types of devices.  **Proposal 25:** RAN4 should discuss improving Demodulation spec in 6GR by replacing broad applicability statements with clear, centralized mappings of test coverage. This would enhance consistency and reduce ambiguity across device types and configurations.  **Observation 24:** RAN4 is defining performance requirements for emerging device types, recognizing that some devices may support TN functionality while others may operate independently without supporting it.  **Proposal 26:** RAN4 should implement a capability-aware test applicability framework that considers device functionality. For devices lacking legacy TN support, test applicability should be designed to avoid dependency on TN-related procedures and corresponding test cases. |
| R4-2513048 | Samsung | **Observation 1: Based on the lessons learned from 5G, we realized that five RAN4 meeting time which usually scheduled for RAN4 demodulation part is not sufficient for thorough technical discussions. This often led to rushed conclusions and compromised quality.**  **Proposal 1: For RAN4 6G Demodulation, RAN4 establish a more realistic and structured timeline to ensure adequate depth in technical deliberation and a well-paced progression toward completion.**  **Proposal 2: RAN4 6G Demodulation could start with CP-OFDM and DFT-s-OFDM waveforms for 6G uplink demodulation study, and CP-OFDM waveform for 6G downlink demodulation study.**  **Proposal 3: RAN4 6G Demodulation study could start with following SCS options**   * + **For sub 6GHz, 15kHz SCS for FDD, 30KHz SCS for TDD**   + **For around 7GHz, 30kHz, 60kHz**   + **For around 15GHz, 60kHz**   + **For between 24.25GHz - 52.6GHz, 120kHz**   **Proposal 4: RAN4 6G Demodulation study should cover following modulation schemes at least**   * + **For downlink, QPSK, 16QAM, 64QAM, 256QAM and 1024QAM**   + **For uplink with CP-OFDM waveform, QPSK, 16QAM, 64QAM, 256QAM**   + **For uplink with DFT-s-OFDM waveform, pi/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM**   **Proposal 5: RAN4 closely follow RAN1's discussion progress on other parameters related to 6G physical layer structure. Once relevant conclusions are available, RAN4 could consider adopting them for RAN4 6G Demodulation study.**  **Observation 2: RAN4 Demodulation requirements will be defined with both TDL and SCM (rCDL-C1) channel models for 5G from Rel-20.**  **Proposal 6: RAN4 clarify the channel model used for 6G demodulation requirements. Only SCM channel model, or both TDL and SCM channel model.**  **Proposal 7: RAN4 clarify the channel model used for one specific feature in 6G, prefer only one channel model selected (either TDL or SCM).**  **Observation 3: The outcome rCDL-C1 of SCM channel model in RAN4 SCM study item is for 3.5GHz Uma only.**  **Observation 4: The frequency range for 6G is wide and multiple typical values for the carrier frequency proposed for different 6G scenarios.**  **Proposal 8: Either an unified channel model agnostic to different carrier frequencies or seperate channel models for different carrier frequencies should be defined for RAN4 6G Demodulation.**  **Proposal 9: For 6G Demodulation with interference modelling, further discussion and analysis on the modelling of directions, INRs, modulation orders of interference(s), number of layers from interference(s) are needed.**  **Proposal 10: For 6G Demodulation, use MMSE-IRC as the baseline receiver algorithm for both UE and BS side.**  **Observation 5: For demodulation performance test, current method of using FRC style, i.e., specified MCS value, fixed rank value, fixed channel bandwidth and fixed subframe configuration is the correct and reasonable approach.**  **Proposal 11: For 6G Demodulation study, use 5G NR FRC style, i.e., specified MCS value, fixed rank value, fixed channel bandwidth and fixed subframe configuration as the starting point.**  **Proposal 12: For 6G Demodulation specification structures, take TS38.101-4 as a starting point.**  **Proposal 13: For 6G Demodulation specification drafting principles, the descriptions of test parameters should be aligned with RAN1/RAN2 descriptions as much as possible, in order to avoid ambiguous understanding.**  **Proposal 14: For FRCs in 6G Demodulation specification, prefer to use a formula-based or pseudo-code-based definition for FRCs instead of table-based approach listing every parameter combination.** |
| R4-2513059 | China Telecom | ***Proposal 1:*** *The 6G SI should cover 1/2/4/6/8Rx UE and 2/4/8Rx BS. For 8Rx UE, RAN4 to discuss whether to consider different receiver structures (e.g., baseline and simplified)*  ***Proposal 2:*** *The MMSE-IRC should be the baseline receiver for both UE and BS.*  ***Proposal 3:*** *As a preparation for 6G requirement with interference definition, RAN4 should make use of this study phase, to perform system level simulation and derive inter-cell interference model for the state-of-the-art network.*  ***Proposal 4:*** *Cover advanced receivers (R-ML, soft-IC, …) in the 6G study, to re-evaluate the performance gain and to re-visit the required information for MU-MIMO scenario.*  ***Proposal 5:*** *The UE computation time should be considered while studying the performance of advanced receivers.*  ***Proposal 6:*** *RAN4 should also be prepared to deal with the possible interference caused by MRSS, by interference cancellation or mitigation.*  ***Observation 1:*** *In Rel-19, RAN4 has performed studies for SCM for SU-MIMO scenario, PDSCH 4T4R rank4 and 8T8R rank8 cases and PMI type I and eType II cases are selected.*  ***Observation 2:*** *In Rel-20, RAN4 will do further studies based on simplified CDL channel model for MU-MIMO and both DL and UL will be covered under SI FS\_NR\_demod\_SCM\_Ph2, will be applicable for both 5G-A and 6G.*  ***Proposal 7:*** *For this 6G SI thread, RAN4 to study the simplified CDL performance for more DL SU-MIMO cases such as inter-cell interference, advanced receiver, CSI reporting.* |
| R4-2513131 | CMCC | ***Proposal 1: Considering the priority in 5G-A study i.e., FR1 and DL will be prioritized, to avoid duplicated discussion between 5G-A and 6G, SCM of UL, SCM of FR2 and new frequency range introduced in 6GR can be the starting point of 6G study.***  ***Proposal 2: It is proposed to study the inference profile for 6G DL/UL inter-cell interference scenario.***  ***Proposal 3: Use FRC as the baseline for 6G UE demodulation performance study. Further discuss the necessity and feasibility of VRC with normalized OLLA algorithm.***  ***Proposal 4: Study 6G UE performance under following baseline receiver framework assumption as the starting point, further study is needed after RAN1 finish the physical layer design:***   * ***SU-MIMO scenario: MMSE-IRC and/or R-ML*** * ***Inter-cell interference scenario: MMSE-IRC*** * ***Intra-cell inter-user interference scenario: MMSE-IRC***   ***Proposal 5: Study 6G BS performance under baseline receiver assumption of MMSE-IRC, further study is needed after RAN1 finish the physical layer design.*** |
| R4-2513143 | MediaTek | **Observation #1: In real-world scenarios, link performance is the result of CSI reporting and demodulation operating jointly.**  **Proposal #1: In 6G testing requirements, we propose not to decouple CSI reporting performance from demodulation performance.**  **Observation #2:** **5G UE downlink demodulation and CSI requirements the default baseline receiver is assumed as MMSE linear receiver.**  **Observation #3:** **5G UE downlink demodulation and CSI requirements can assume other advanced receiver types for specific tests.**  **Observation #4: When the UE is equipped with large number of antennas, it is possible to use several small number Rx MIMO detectors for data processing, e.g., 8Rx UE can use two joint 4Rx MIMO detectors instead of one 8Rx MIMO detector for data processing.**  **Proposal #2: We propose to study what would be most feasible and practical receiver assumption.**  **Observation #5: 5G TX EVM UE downlink simulation assumptions are not well aligned with 5G BS EVM requirements.**  **Observation #6: With the EVM values based on current TS 38.104, the max throughput cannot be achieved with more MIMO layers, and the degradation compared to EVM 0% can be huge in some scenarios.**  **Proposal #3: Study what EVM simulations assumptions should be used in demodulation and CSI requirements.**  **Observation #7: After Rel-19 study RAN4 has 3 channel model options available for 6G requirements.**  **Proposal #4: We propose to check in which use cases each channel model should be used in 6G requirements.**  **Observation #8: The legacy TDL channel antenna correlation definition is not well suited for large antenna arrays.**  **Proposal #5: We propose to further study how to define antenna correlation values for different antenna arrays.**  **Observation #9: There is misalignment of operation points in demodulation requirements and actual system target.**  **Observation #10: New channel models and precoding methodologies may impact demodulation alignment.**  **Proposal #6: We propose to study if test point of demodulation requirements could be better aligned with realistic transmission scenarios and operation points.**  **Observation #11: There are several methods to apply more realistic precoding in demodulation tests with spatial channel models.**  **Observation #12: SRS based precoding would be new methodology in RAN4.**  **Observation #13: SRS based precoding would require baseline definition of precoding processing in TE to enable aligned simulation assumptions.**  **Proposal #7: We propose to study different precoding options.**  **Proposal #8: We propose to define baseline precoding procedure in TE to enable aligned simulation assumptions.**  **Observation #14: In 5G there is very limited set of demodulation requirements with link adaptation.**  **Observation #15: In 5G demodulation requirements with link adaptation missed OLLA.**  **Observation #16: One possible reference baseline OLLA implementation has been shared in 5G WI.**  **Proposal #9: We propose to study extending scope of demodulation tests with link adaptation.**  **Proposal #10: We propose to study demodulation tests with link adaptation replacing simple demodulation or CSI tests.**  **Proposal #11: We propose to study adding OLLA to demodulation tests with link adaptation.**  **Observation #17: CQI reporting requirements use 2-step approach to evaluate all pass conditions.**  **Proposal #12: We propose streamlining CQI reporting testing into 1-step approach and setting requirements in terms of throughput/SNR and BLER limits.**  **Proposal #13: We propose to study the necessity of CQI reporting requirements in addition to combined demodulation and link adaptation testing.**  **Observation #18: Likely original intention of throughput ratio *γ* test metric was to make testing independent of demodulation performance.**  **Observation #19: Throughput ratio *γ* can be unreliable test metric in highly spatially selective channels.**  **Proposal #14: We propose simplifying the PMI reporting testing process and setting requirements directly in terms of throughput/SNR instead of measuring *γ*.**  **Proposal #15: We propose to study the necessity of PMI reporting requirements in addition to combined demodulation and link adaptation testing.**  **Observation #20: There are very few legacy rank reporting tests.**  **Observation #21: Maximum number of layers tested is just 2 in legacy rank reporting tests.**  **Observation #22: Test requirements are very loose in legacy rank reporting tests.**  **Proposal #16: We propose to study RI reporting requirements test metrics and test methodologies.**  **Proposal #17: We propose to study the necessity of RI reporting requirements in addition to combined demodulation and link adaptation testing.** |
| R4-2513164 | CATT | **Proposal 1: RAN4 to study the demodulation for ISAC for 6G.**  **Proposal 2: RAN4 use spatial channel model (SCM) as one candidate channel model for demodulation for 6G.**  **Proposal 3: Widely linear MMSE-IRC (WLMMSE-IRC) detector can be considered as one candidate detector which benefits from network coordination of modulation type.** |
| R4-2513276 | Xiaomi | **Proposal 1: Postpone RAN4 discussion on demodulation requirements related to physical layer channel and procedure design until sufficient progress reached in RAN1 i.e., no early than Q2’26.**  **Proposal 2: RAN4 focus on following area in initial stage on 6GR demod area:**   * Reference receiver assumption * Interference modelling for SU-MIMO and MU-MIMO; intra-cell and inter-cell interference modelling (DL and UL) * Unified channel model for DL and UL considering AI use cases, ISAC, NTN (NGSO motion, Mobile VSAT), HST * Scalable requirements structure for different device types (CHBW, number of Rx)   **Proposal 3: RAN4 evaluate candidate receiver types on following scenarios in both DL and UL**   * Noise limited scenario * SU-MIMO /MU-MIMO scenario * Inter-cell interference scenario * Spectrum sharing/co-existence between 6G and 5G/4G * HST scenario   **Proposal 4: RAN4 further evaluate interference profiles for intra-cell/interference cell scenarios:**   * gNB and UE configuration e.g., power class, antenna configuration * Homogenous and heterogenous scenarios * Asynchronization TDD or dynamic TDD scenario * Semi-static/Dynamic SBFD operation in gNB   **Proposal 5: RAN4 evaluate candidate channel model for DL and UL considering new operating frequency, new use case including AI, ISAC, NTN, HST.**  **Proposal 6: RAN4 study scalable requirements structure for diverse device types especially different capabilities of number of Rx, CHBW and operating mode.**   * RAN4 shall develop common test configuration for 6GR on UE demodulation and CSI.   The common test configuration shall consider real deployment from operators meanwhile ensure sufficient test coverage and scalable rule for different device type. |
| R4-2513292 | NTT DOCOMO | **Observation 1: RAN1 agreed to adopt NR-based waveforms (CP-OFDM for DL, CP-OFDM and DFT-S-OFDM for UL) as the baseline for 6G. RAN4 needs to define corresponding RF and demodulation specifications and prepare for potential additional waveforms for new use cases or energy efficiency improvements.**  **Observation 2: Frame structure will follow NR basically, but FR3 introduces new challenges such as phase noise and Doppler effects. RAN4 must define test methodologies for FR3, including whether measurements are conducted or OTA.**  **Observation 3: For 6G, only one SCS per band is under consideration, RAN4 must define demodulation requirements for all SCSs agreed in RAN1.**  **Observation 4: To avoid excessive complexity, NR limited TDD configurations to practical patterns. A similar approach is needed for 6G, with FR1 and FR2 reusing NR baseline configurations.**  **Observation 5: No final agreement on channel coding exists in RAN1 yet. RAN4 should ensure that evaluation metrics (e.g., BLER, throughput) can be tested according to RAN1 definitions.**  **Observation 6: Baseline modulation follows NR, but new techniques (e.g., QPSK rotation, QAM-CS) are under discussion for UL to support higher data rates and coverage. RAN4 must prepare test specifications once new MCS tables are agreed in RAN1.**  **Observation 7: Energy efficiency and features like (e)RedCap and LP-WUS are targeted for day 1 introduction in 6G. RAN4 should coordinate with RAN1 to ensure testability and alignment with performance and energy-saving goals.**  **Observation 8: Experience from 5G showed that unspecified parameters, such as the number of BS RX antennas for certain performance tests, can lead to ambiguity. For 6G, specifications need to provide guidance for such cases to ensure clear and practical test procedures.**  **Proposal 1: RAN4 needs to develop testable specifications for waveform, frame structure, channel coding, and modulation as defined by RAN1, ensuring that these can be practically implemented and validated in real products.**  **Observation 9: Requirements of some feature enhancements were missing in 5G day 1 but should be included from day 1 in 6G. Both BS and UE demodulation requirements must be aligned within the same release.**  **Observation 10: CDL models, introduced in Rel-19, are expected to provide gains for UL (e.g., beam selection). RAN4 should adopt CDL where beneficial and maintain consistency to avoid mixing CDL and TDL requirements across functions.**  **Proposal 2: 5GA Topics that were studied and proven useful should be introduced from day 1 in 6G, and RAN4 needs start discussions on corresponding test specifications to enable early adoption.** |
| R4-2513309 | Huawei, HiSilicon | *Proposal 1: Study 6G CDL channel considering following objectives.*   * ***Study 6G CDL channel covering CDL-A/B/C/D/E based on 6G frequency range*** * ***The CDL channel should be based on latest version of 38.901*** * ***To ensure the alignment of CDL implementation, channel properties such as PSD, time correlation coefficient and frequency correlation coefficient should be aligned apart from SNR points alignment.***   ***Observation 1:*** *CDL channel is non-configurable which may cause the risk that the performance of some features under CDL channel cannot be adjusted to the desired level for testing by modifying the channel parameters. E.g. The performance gain of R-ML can be adjusted by configuring different correlation under TDL channel but cannot be adjusted under CDL channel.*  *Proposal 2: RAN4 shall include extension TDL agreed in Rel-19 SCM SI for demodulation performance definition in 6G.* |
| R4-2513323 | ZTE Corporation, Sanechips | **Observation 1. The demodulation framework of 5G mainly includes PBCH, PDSCH, PDCCH, CSI, SDR, APT for UE side, and PUSCH, PUCCH, and PRACH for BS side.**  **Observation 2. The 6G basic feature should include new numerologies, new bandwidths, new MIMO schemes, new coding schemes, etc.**  **Observation 3. Currently, the handle UE can support up to 6Rx, and the CPE/FWA/vehicle/ industrial devices can support up to 8Rx in 5G.**  **Observation 4. Linear receivers and non-linear reciters are studied in 5G, especially MMSE-IRC receiver is a mandatory feature from Re-17, and R-ML receiver is an optional feature for UE device. MMSE receiver is a default assumption in BS side.**  **Observation 5. The TDL channel model has been used as a propagation model for testing purposes since 4G.**  **Observation 6. The CDL channel model has been studied in Rel-19 and Rel-20, and limited test cases will be defined in Rel-20 for SU-PDSCH requirements. MU-MIMO scenarios will be further studied in Rel-20.**  **Observation 7. Currently, in RAN4 interference scenario evaluation, the interference profile based on the Rel-13 DIP values.**  **Observation 8. The dense deployment of 6G base stations and the emergence of new types of UE, such HPUEs have made interference problems even more severe.**  **Observation 9. The current methodology for calculating the antenna correlation in RAN4 is very different from the actual measurement correlation.**  **Observation 10. Additional margins and measurements uncertainty are considered for conformance testing in 5G.**  **Observation 11. Conducted test method is used for low frequency range and OTA test method is used for high frequency range in 5G NR.**  **Proposal 1. The demodulation framework of 6G under study can keep in the same scope of 5G to ensure the verification of basic 6G feature, e.g., new numerologies, new bandwidths, new MIMO schemes, new coding schemes, etc. as the PBCH, PDSCH, PDCCH, CSI (CQI, PMI, and RI), SDR for the UE side, and PUSCH, PUCCH, and PRACH for BS side.**  **Proposal 2. The key issue to be discussed for the 6GR study is the number of antennas required for different frequency ranges.**  **Propose 3. RAN4 needs to discuss the default receiver assumptions for both the UE side and BS side in 6GR.**  **Proposal 4. RAN4 needs to discuss the default propagation channel models for DL and UL in 6GR. The work on Rel-20 can be as starting point for SU-MIMO PDSCH.**  **Proposal 5. RAN4 needs to discuss whether a new methodology of interference modeling is required in 6GR day 1.**  **Proposal 6. RAN4 needs to discuss how to model antenna correlation in 6GR day 1.**  **Proposal 7. RAN4 needs to discuss the additional margins and measurements uncertainty for requirements definition of 6GR.**  **Proposal 8. RAN4 needs to discuss the SNR derivation procedure for 6GR, the span of ideal results span is <= [X] dB.**  **Proposal 9. Conducted test method can be considered for FR1 frequency range, and OTA test method can be considered for FR2 frequency range for both UE and BS demodulation requirements.** |
| R4-2513332 | Ericsson | **Observation 1 PA should operate in a linear region to ensure reliable signal reception. For PA to be linear, UE needs to back-off power which affects UL coverage and energy efficiency.**  **Observation 2 Advanced DPD can be energy- and computation-intensive for UEs, making it a potentially challenging solution for UL transmissions to avoid power back-off.**  **Observation 3 The practical gain of DPoD is limited to in-channel distortion and not unwanted emissions.**  **Observation 4 The wide variety of UE RF front-end models in the market could make it challenging to evaluate specific models or to define RAN4 performance requirements and test parameters accordingly.**  **Observation 5 The current UE EVM measurement procedure and corresponding equalizer should be revisited to fully capture transmitter behavior modeled in the algorithmic DPoD and if UE requirements are modified.**  **Observation 6 UL post-distortion may have potential to achieve good performance without UE power-backoff, enabling potentially higher UE output power and more power-efficient operation for higher order modulation.**  **Observation 7 Uplink performance is impacted not only by PA non-linearities but also by other RF impairments (e.g., oscillator phase noise, IQ imbalance), requiring a holistic view of the UE front-end.**  **Observation 8 In order to properly evaluate the potential MPR reduction, an up-to-date UE and MPR modelling approach may be needed to capture the true benefits.**  **Observation 9 The current UE EVM requirements and EVM measurement procedure including equalizer may need updating to account for factors such as the UE front-end characteristics and the interference environment, in order to more accurately reflect real-world performance.**  **Observation 10 Both memoryless and memory polynomial PA models can be considered in RAN4 for initial studies and evaluations.**  **Observation 11 The progress in Rel-20 would impact the following CDL models used in stage 6G.**  **Observation 12 The FR2 BS and UE variants could have higher impact on channel model derivation than FR1.**  **Observation 13 Only up to 2 antennas can be tested for FR2 OTA which will lead to CDL models are not attractive than in FR1 condition.**  **Observation 14 The new propagation parameter values and scenario for frequency range 7 – 24 GHz is introduced to TR38.901 v19.0.0 and RF would focus on 7 – 15GHz spectrum in 6G stage.**  **Observation 15 There is no reference in previous release on key parameters configuration and randomness reduction.**  **Proposal 1 RAN4 to clarify the extent to which 6G UEs may support digital pre-distortion.**  **Proposal 2 DPoD at the BS receiver offers solution to compensate UE RF non-linearity to reduce UEs MPR for higher order and thus improve UL high data rate availability.**  **Proposal 3 RAN4 could consider adjusting the UE EVM requirements but also evaluate any additional constraints or dependencies affecting this limit.**  **Proposal 4 UE may adjust EVM and reduce MPR only under explicit network control; otherwise, existing RF requirements apply.**  **Proposal 5 RAN4 should study UL post-distortion techniques that jointly compensate for multiple non-linear components in the UE RF chain to improve uplink performance and efficiency.**  **Proposal 6 RAN4 to evaluate the potential MPR reduction enabled by DPoD and its impact on UL coverage and UE transmit energy efficiency.**  **Proposal 7 RAN4 to evaluate the extent to which UE EVM requirements can be adjusted when DPoD compensates for PA and other RF components non-linearity at the base station.**  **Proposal 8 Beyond just the PA model, the entire UE RF front-end needs to be studied by RAN4, with particular attention to the potential variation in impairments across different UEs.**  **Proposal 9 RAN4 to study feasibility of UE non-linearity estimation methods with reference signals or actual data and assess their suitability for supporting post-distortion and compensation techniques.**  **Proposal 10 RAN4 to study inclusion of oscillator phase noise and IQ imbalance in UL post-distortion schemes, evaluating feasibility and performance gains for high-order modulations and higher-frequency operation.**  **Proposal 11 RAN4 to evaluate RF front-end variation from multiple UEs in the market into account and define suitable baseline/reference models for UL post-distortion studies.**  **Proposal 12 RAN4 to evaluate UE PA non-linearity and related impairments across both FR1 and FR2 for UL-Post distortion compensation at BS receiver. Further, this would impact both BS and UE model.**  **Proposal 13 RAN4 to study CP-OFDM and DFT-s-OFDM for UL evaluation of this feature.**  **Proposal 14 RAN4 to evaluate channel models for link-level simulation with DPoD feature, considering their impact on test metrics under higher UE transmit power.**  **Proposal 15 RAN4 to evaluate DPoD performance with higher modulation orders focusing on high-SNR conditions.**  **Proposal 16 If there are important issues that are not treated in 5G-A stage, they should be captured in 6G study.**  **Proposal 17 RAN4 to study the complexity and benefit of applying CDL model for FR2 DL demodulation.**  **Proposal 18 Setup study on how to derive DL CDL channel model for frequency range 7~15GHz demodulation.**  **Proposal 19 As the lower priority comparing to DL side, RAN4 to study the how to derive proper CDL models for UL demodulation performance regarding to different BS types, antenna variants and capabilities in 6G stage.**  **Proposal 20 RAN4 needs to discuss how to specify FRC table in the specification for both BS and UE demodulation performance, considering the discussion in SI modernization of specification format and procedures for 6G.** |
| R4-2513348 | BT | 1. Performance requirement setting to move beyond individual component verification to assessment of the integrated performance of key functionalities and processes in 6G. 2. CDL-based channel modelling methodology should be used as a starting point for setting performance requirements for 6G. 3. Performance benchmarks should be set using modern, competitive receiver and transmitter technologies to ensure that the specifications drive innovation and reflect the capabilities of state-of-the-art devices. |

## Open issues summary

### Sub-topic 1-1: General aspects

**Issue 1-1-1: RAN4 demod study timeline**

* Proposals
  + Option 1: For RAN4 6G Demodulation, RAN4 establish a more realistic and structured timeline to ensure adequate depth in technical deliberation and a well-paced progression toward completion (Samsung)
  + Option 2: RAN4 closely follow RAN1's discussion progress on other parameters related to 6G physical layer structure. Once relevant conclusions are available, RAN4 could consider adopting them for RAN4 6G Demodulation study (Samsung)
  + Option 3: Postpone RAN4 discussion on demodulation requirements related to physical layer channel and procedure design until sufficient progress reached in RAN1 i.e., no early than Q2’26 (Xiaomi)
  + Option 4: 5GA Topics that were studied and proven useful should be introduced from day 1 in 6G, and RAN4 needs start discussions on corresponding test specifications to enable early adoption (NTT DOCOMO)
* Recommended WF
  + More discussion is needed.

**Issue 1-1-2: Waveform and modulation study**

* Proposals
  + Option 1: RAN4 6G Demodulation could start with CP-OFDM and DFT-s-OFDM waveforms for 6G uplink demodulation study, and CP-OFDM waveform for 6G downlink demodulation study. (Samsung)
  + Option 2: RAN4 6G Demodulation study should cover following modulation schemes at least (Samsung)
    - For downlink, QPSK, 16QAM, 64QAM, 256QAM and 1024QAM
    - For uplink with CP-OFDM waveform, QPSK, 16QAM, 64QAM, 256QAM
    - For uplink with DFT-s-OFDM waveform, pi/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM
  + Option 3: RAN4 needs to develop testable specifications for waveform, frame structure, channel coding, and modulation as defined by RAN1, ensuring that these can be practically implemented and validated in real products (NTT DOCOMO)
* Recommended WF
  + More discussion is needed. Wait for RAN1 decisions?

**Issue 1-1-3: SCS**

* Proposals
  + Option 1: RAN4 6G Demodulation study could start with following SCS options (Samsung)
    - For sub 6GHz, 15kHz SCS for FDD, 30KHz SCS for TDD
    - For around 7GHz, 30kHz, 60kHz
    - For around 15GHz, 60kHz
    - For between 24.25GHz - 52.6GHz, 120kHz
* Recommended WF
  + Wait for RAN1 decisions?

**Issue 1-1-4: Demodulation specification principles**

* Proposals
  + Option 1: For 6G Demodulation specification structures, take TS38.101-4 as a starting point. (Samsung)
  + Option 2: For 6G Demodulation specification drafting principles, the descriptions of test parameters should be aligned with RAN1/RAN2 descriptions as much as possible, in order to avoid ambiguous understanding. (Samsung)
  + Option 3: For FRCs in 6G Demodulation specification, prefer to use a formula-based or pseudo-code-based definition for FRCs instead of table-based approach listing every parameter combination (Samsung)
    - Option 3A: RAN4 needs to discuss how to specify FRC table in the specification for both BS and UE demodulation performance, considering the discussion in SI modernization of specification format and procedures for 6G (Ericsson)
* Recommended WF
  + More discussion is needed.

**Issue 1-1-5: Broadcast and feedback-less channels/signals testing**

* Proposals
  + Option 1: RAN4 to assume broadcast and feedback-less channels/signals to be testable. RAN4 to recommend to RAN5 to define needed test solutions (Nokia)
* Recommended WF
  + More discussion is needed.

**Issue 1-1-6: ISAC study**

* Proposals
  + Option 1: RAN4 to study the demodulation for ISAC for 6G (CATT)
* Recommended WF
  + More discussion is needed.

**Issue 1-1-7: Conducted and radiated testing**

* Proposals
  + Option 1: Conducted test method can be considered for FR1 frequency range, and OTA test method can be considered for FR2 frequency range for both UE and BS demodulation requirements (ZTE)
  + Option 2: RAN4 must define test methodologies for FR3, including whether measurements are conducted or OTA (NTT DOCOMO)
* Recommended WF
  + More discussion is needed.

### Sub-topic 1-2: Channel models

**Issue 1-2-1: Channel type**

* Observation:
  + Rel-19 SCM SI introduced rCDL and xTDL channel models for RAN4. All RAN4 demod requirements have been based on legacy TDL channel model before Rel-20.
* Proposals
  + Option 1: Clarify use of TDL and SCM models for 6G (Samsung, MediaTek)
    - Option 1A: Use rCDL baseline for MIMO (Nokia)
    - Option 1B: Use CDL/rCDL as baseline for 6G (BT)
    - Option 1C: Maintain TDL and CDL (Qualcomm)
    - Option 1D: Continue TDL for simplicity (Apple)
    - Option 1E: Include xTDL (Huawei)
    - Option 1F: Define default CDL propagation models (ZTE)
    - Option 1G: Adoption of SCM should be justified for each test purpose (Apple)
    - Option 1H: Study practical MIMO correlation matrices for TDL (Apple, MediaTek, ZTE, Qualcomm)
    - Option 1I: Use rCDL baseline for MIMO and a limited number of TDL requirements for MIMO features with single layer transmission (Nokia)
    - Option 1J: select one channel model (either TDL or CDL) for one specific feature
      * Option 1Ja: The criteria of selection should be clarified and applied for all features (Ericsson).
* Recommended WF
  + More discussion is needed. It may be useful to discuss per use case and scenario what channel model can be justified.

**Issue 1-2-2: Specialized propagation channels**

* Proposals
  + Option 1: RAN4 evaluate candidate channel model for DL and UL considering new use cases including AI, ISAC, NTN, HST (Xiaomi)
  + Option 2: We propose initiating a similar study for NTN scenarios, focusing on the CDL-D variant to reflect the LOS-dominant nature of NTN links and enable more accurate performance evaluations for NTN systems under practical deployment scenarios (Qualcomm)
* Recommended WF
  + More discussion is needed.

**Issue 1-2-3: Frequency related aspects of channel model**

* Observations
  + Rel-19 SCM SI focused only on downlink on FR1. Legacy TDL is agnostic to carrier frequency.
* Proposals
  + Option 1: Study new frequency range (CMCC, Xiaomi)
    - Option1A: Study new frequency ranges of 6G (CMCC, Huawei)
      * Derive CDL for 7-15 GHz (Ericsson, Huawei)
    - Option1B: Study FR2 (CMCC, Ericsson)
    - Option 1C: Evaluate necessity and study spatial channel model for other frequency ranges in 6GR (Apple)
  + Option 2: Study if channel model is agnostic to different carrier frequencies or separate models are needed (Samsung, Apple)
  + Option 3: The key issue to be discussed for the 6GR study is the number of antennas required for different frequency ranges (ZTE)
* Recommended WF
  + More discussion is needed if channel model would be agnostic to carrier frequency, and if not how to take different carrier frequencies into account.

**Issue 1-2-4: Uplink aspects of channel model**

* Observations
  + Rel-19 SCM SI focused only on downlink on FR1.
* Proposals
  + Option 1: Study UL CDL for BS variants(Ericsson, CMCC)
    - Option 1a: Study UL CDL for BS variants if key issues in DL CDL study are settled. (Ericsson)
* Recommended WF
  + Discuss if Option 1a can be accepted.

**Issue 1-2-5: AI/ML aspects of channel model**

* Proposals
  + Option 1: AIML extensions to the SCM framework shall be studied by the AIML 6GR study, if needed (Nokia)
  + Option 2: Study and develop channel modelling methodologies for requirements targeting AI/ML use cases (Apple)
  + Option 3: Consideration of CDL modeling in 6GR for AI/ML receiver evaluations should follow the identification of robust countermeasures to prevent overfitting to deterministic channel behavior. (Qualcomm)
* Recommended WF
  + More discussion is needed.

**Issue 1-2-6: Channel model alignment**

* Proposals
  + Option 1: To ensure the alignment of CDL implementation, channel properties such as PSD, time correlation coefficient and frequency correlation coefficient should be aligned apart from SNR points alignment (Huawei)
* Recommended WF
  + More discussion is needed.

**Issue 1-2-7: Other issues of channel model**

* Proposals
  + Option 1: If any important issues are not treated in 5G-A stage, capture in 6G study (Ericsson)
  + Option 2: Consideration of CDL modeling in 6GR for PMI report evaluation should follow the identification of robust countermeasures to prevent overfitting to deterministic channel behavior. (Qualcomm)
* Recommended WF
  + Follow if any important issues are not treated in 5G-A stage, and capture those in 6G study.

### Sub-topic 1-3: Receiver assumptions

**Issue 1-3-1: Receiver assumption for UE**

* Observations
  + MMSE-IRC as a baseline receiver in 5G.
* Proposals
  + Option 1: MMSE-IRC as a baseline receiver (Samsung, CT)
  + Option 2: MMSE-IRC and R-ML as baseline receivers (Qualcomm, Nokia. CMCC)
    - CMCC: with the prerequisite that the receiver is transparent to the network and does not require any PHY layer modification and additional assistance information.
  + Option 3: Cover advanced receivers (R-ML, soft-IC) (CT)
    - CT: Study the required information for advanced Rec for MU-MIMO
  + Option 4: Study baseline and simplified structures (CT, MediaTek)
  + Option 5: Study widely linear MMSE-IRC (CATT)
* Recommended WF
  + More discussion is needed.

**Issue 1-3-2: Receiver assumption for BS**

* Observations
  + MMSE-IRC as a baseline receiver in 5G.
* Proposals
  + Option 1: MMSE-IRC as a baseline receiver (Samsung, CT, CMCC, Nokia, Ericsson)
  + Option 2: Study feasibility of considering higher than 8Rx scenarios (Qualcomm)
* Recommended WF
  + Discuss if MMSE-IRC can be assumed as a baseline receiver for BS.

### Sub-topic 1-4: TxEVM and SNR

**Issue 1-4-1: TxEVM aspects**

* Proposals
  + Option 1: Study what EVM simulations assumptions should be used in demodulation and CSI requirements (MediaTek)
    - Option 1A: Study impact of TX EVM for higher modulation order/ MIMO layers on Demodulation requirements (Apple)
    - Option 1B: RAN4 shall abandon the SNR operating point limitations via fixed 20dB rule, or fixed TE TxEVM assumptions, and adopt a SNR limitation derivation based on actual TDRA/FDRA configuration (Nokia)
    - Option 1C: RAN4 should study whether the TxEVM requirements for the base station, at least in the simulations for deriving the demodulation requirements, could be tightened (Qualcomm)
* Recommended WF
  + More discussion is needed.

**Issue 1-4-2: SNR aspects**

* Proposals
  + Option 1: To ensure good field coverage, the SNR values in the demodulation requirements should follow the SSB SNR values that can be measured in existing 5G NR scenarios and those SSB SNR values that can be expected in upcoming 6G deployments (Qualcomm)
  + Option 2: RAN4 should study whether the coverage range for relevant field scenarios can be extended by defining demodulation requirements for larger SNR values as currently being used in 5G NR (Qualcomm)
  + Option 3: RAN4 should study whether the coverage range for relevant field scenarios can be extended for carrier aggregation. It should also be studied whether the SNR requirement should be dependent on the number of component carriers (Qualcomm)
  + Option 4: RAN4 shall abandon the SNR operating point limitations via fixed 20dB rule, or fixed TE TxEVM assumptions, and adopt a SNR limitation derivation based on actual TDRA/FDRA configuration. (Nokia)
* Recommended WF
  + More discussion is needed.

### Sub-topic 1-5: Interference modelling aspects

**Issue 1-5-1: Interference profile**

* Proposals
  + Option 1: Study the interference profile for 6G DL/UL inter-cell interference scenario (Samsung, CMCC, ZTE, Xiaomi, CT)
    - Option 1A: RAN4 further evaluate interference profiles for intra-cell/interference cell scenarios: gNB and UE configuration e.g., power class, antenna configuration Homogenous and heterogenous scenarios Asynchronization TDD or dynamic TDD scenario Semi-static/Dynamic SBFD operation in gNB (Xiaomi)
    - Option 1B: For 6G Demodulation with interference modelling, further discussion, and analysis on the modelling of directions, INRs, modulation orders of interference(s), number of layers from interference(s) are needed. (Samsung)
  + Option 2: RAN4 should also be prepared to deal with the possible interference caused by MRSS, by interference cancellation or mitigation (CT)
* Recommended WF
  + More discussion is needed.

### Sub-topic 1-6: Performance testing and requirement

**Issue 1-6-1: General performance requirement aspects**

* Observations
  + Existing 5G requirements often target to minimum requirements that is not always well aligned with real field conditions.
* Proposals
  + **Option 1: Reaffirm the mission of RAN4 demod to produce performance requirements, not functional requirements (Nokia)**
  + Option 2: Develop a testing framework relevant to real field conditions (Apple, Qualcomm, MediaTek, Xiaomi)
  + Option 3: Ensure test coverage for a wide range of scenarios (Qualcomm)
  + Option 4: Test framework shall allow verification of spectral efficiency and spectrum utilization (Qualcomm)
  + Option 5: Test framework should support the identification of root causes of test failures (Qualcomm)
  + Option 6: Test framework should assume non-AI/ML processing as a baseline (Qualcomm)
  + Option 7: Performance requirement setting to move beyond individual component verification to assessment of the integrated performance of key functionalities and processes in 6G (BT)
  + Option 8: In 6G testing requirements, CSI reporting performance and demodulation performance should not be decoupled. (MediaTek)
  + Option 9: RAN4 shall choose scenarios that demonstrate genuine performance gains realizable in the field. (Qualcomm)
* Recommended WF
  + More discussion is needed. There seems to be intention to have tests better matching real field conditions**.**

Xiaomi:it is important to reflect the real deployment in the test and requirement discussion and decision

Nokia:

Huawei: test condition and requirement should be part of the framework discussion

Samsung:can proponent provide more details. Are we aiming for a unified framework for all test?

OPPO:real field situation can be complicated

Qualcomm:test configuration and scenario are the primary consideration by referring to real field situation.

Apple:same view as Qualcomm.

CT: we support the idea to take real field condition into consideration

Ericsson: similar view as OPPO. Test complexity and cost should be considered too

ZTE:suppor the idea in general

CMCC: we have done something in this direction in 5G, e.g.ATP. however, the real field scenarios can be complicated also. Need further discussion on how to prioritize the scenarios.

Huawei: TE limitation should be understood first also.

CATT: the intention is good. How to realise this can be challenging.

MTK: agree to balance the complexity and the real field condition in the test.

Xiaomi: this work is relavent to the system parameter discussion as well as the practical deployment from operator side.

Agreement

In 6G SI, RAN4 will study how to strive to develop a demod/test performance requirement framework for the minimum performance to better reflect real field conditions than 5G, if necessary, by taking into consideration of the requirement/test coverage/alignmentablity and the test feasibility, complexity and cost/resources.

**Issue 1-6-2: Demodulation testing**

* Proposals
  + Option 1: For 6G demodulation study, use FRC style, MCS value, fixed rank, fixed channel bandwidth, fixed subframe configuration as a starting point (Samsung)
  + Option 2: Study extending scope of demodulation tests with link adaptation (MediaTek, Qualcomm)
  + Option 3: RAN4 needs to discuss the additional margins and measurements uncertainty for requirements definition of 6GR (ZTE)
  + Option 4: RAN4 needs to discuss the SNR derivation procedure for 6GR, the span of ideal results span is <= [X] dB. (ZTE)
  + Option 5: Define baseline SRS based precoding procedure in TE to enable aligned simulation assumptions (MediaTek)
    - Xiaomi: on option 5, more discussion is needed.
    - Nokia: fond of the idea. Also think it can be extended to FDD. More discussion is needed.
    - Samsung: TE vendor support on the feasibility is needed
    - CT: need to understand the feasibility
    - CMCC: TE feasibility should be understood first
    - Apple: need to clarify the motivation behind this.
    - Huawei: see the value to study this.
    - Ericsson:reasonable idea to be considered
    - Qualcomm: TE support is needed. It can make the test close to the field.
    - R&S: need to study this.
    - ZTE: simiar view as Samsung.
* Recommended WF
  + More discussion is needed.

**Issue 1-6-3: OLLA with link adaptation**

* Observations
  + 5G has implemented a few demodulation requirements with link adaptation.
* Proposals
  + Option 1: Study to include OLLA in ATP requirements (Nokia, MediaTek, Qualcomm, CMCC)
    - Option 1A: Use proposed OLLA model from R4-2300703 as a starting point. (Nokia, MediaTek)
    - Option 1B: Study the feasibility of including OLLA in ATP requirements (CMCC)
* Recommended WF
  + More discussion is needed. Can we agree to Use proposed OLLA model from R4-2300703 as a starting point?

FL: this OLLA is at NW side.

CT:it has been discussed in 5G and there is technical difficulty which results in no agreement in 5G. what differently we can do in 6G?

Nokia: OLLA reflects the real field situation.

Huawei: OLLA can make the related performance requirement closer to the field.

Xiaomi: without 6G phy design, how OLLA can be evaluated? Also, it is unclear how to ensure the OLLA assumed in RAN4 study close enough to the one used in the field

Ericsson: similar view as xiaomi

Apple: OLLA related requirement is for UE or NW? shall we align OLLA algorithm among infra vendors?

ZTE: similar view as Xiaomi.

CMCC: support the ideal in high level. Meanwhile, it is unclear how to split the responsibility between UE and NW/TE during the test. Also, the alignment among infra vendors on the algorithm is needed

Qualcomm: both OLLA and ILLA(inner loop link adaptation) should be considered to make the system completed.

Samsung:similar view as Xiaomi.

Nokia:prefer to consider OLLA only.

Apple:10% BLER is not used in ATP and it is only for the static channel.

MTK: support the OLLA study

FL:given the divided views, more discussion is needed,.

Agreement:

**Issue 1-6-4: CSI reporting test methodologies**

* Proposals
  + Option 1: We propose streamlining CQI reporting testing into 1-step approach and setting requirements in terms of throughput/SNR and BLER limits (MediaTek)
  + Option 2: We propose to study the necessity of CQI reporting requirements in addition to combined demodulation and link adaptation testing (MediaTek)
  + Option 3: We propose simplifying the PMI reporting testing process and setting requirements directly in terms of throughput/SNR instead of measuring γ (MediaTek)
  + Option 4: We propose to study the necessity of PMI reporting requirements in addition to combined demodulation and link adaptation testing (MediaTek)
  + Option 5: Study RI reporting requirements test metrics and test methodologies (MediaTek, Qualcomm)
    - Option 5A: RAN4 to investigate alternative metric that measures consistency and accuracy of Rank Indicator (RI). (Qualcomm)
    - Option 5B: RAN4 shall discuss throughput ratio between “follow rank” and “median rank” as a metric for RI requirements. (Qualcomm)
* Recommended WF
  + More discussion is needed.

**Issue 1-6-5: New dynamic TE functionalities**

* Proposals
  + Option 1: RAN4 to study inclusion of higher layer aspects in demodulation requirements via increased and dynamic application of DUT feedback in the TE. (Nokia)
  + Option 2: RAN4 to study inclusion of higher layer aspects in demodulation requirements via dynamic TE decisions using known algorithms, e.g., SU/MU scheduling, dynamic resource allocation/slots, applying timing offset reports (CJT), OLLA, etc. (Nokia)
  + Option 3:RAN4 should explore utilizing test equipment algorithms to evaluate features that rely on network-side processing, enabling realistic UE performance assessment without limiting network implementation flexibility. (Qualcomm)
  + Option 4:RAN4 should identify features dependent on network-side processing and aim to define corresponding performance requirements, where feasible, using test equipment-based evaluation methods. (Qualcomm)
* Recommended WF
  + More discussion is needed.

### Sub-topic 1-7: UE classification and applicability

**Issue 1-7-1: UE classification**

* Proposals
  + Option 1: RAN4 to study demod requirement handling for UE classifications and agree on questions such as a baseline set of requirements for all devices vs. individual requirements for each UE classification (Nokia)
* Recommended WF
  + More discussion is needed.

**Issue 1-7-2: Applicability rules**

* Proposals
  + Option 1: RAN4 should discuss improving Demodulation spec in 6GR by replacing broad applicability statements with clear, centralized mappings of test coverage. This would enhance consistency and reduce ambiguity across device types and configurations (Qualcomm)
  + Option 2: RAN4 should implement a capability-aware test applicability framework that considers device functionality. For devices lacking legacy TN support, test applicability should be designed to avoid dependency on TN-related procedures and corresponding test cases. (Qualcomm)
* Recommended WF
  + More discussion is needed.

**Issue 1-7-3: Device types**

* Proposals
  + Option 1: RAN4 should wait for further clarification in RAN and RAN1 what device types may get defined. Afterwards RAN4 should discuss how device types can be covered in the test framework of RAN4 (Qualcomm)
* Recommended WF
  + More discussion is needed.

### Sub-topic 1-8: Uplink demod

**Issue 1-8-1: Digital Pre-Distortion and Post-Distortion Techniques**

* Proposals
  + Option 1: RAN4 to clarify the extent to which 6G UEs may support digital pre-distortion. (Ericsson)
  + Option 2: DPoD at the BS receiver offers solution to compensate UE RF non-linearity to reduce UEs MPR for higher order and thus improve UL high data rate availability. (Ericsson)
  + Option 3: RAN4 should study UL post-distortion techniques that jointly compensate for multiple non-linear components in the UE RF chain to improve uplink performance and efficiency. (Ericsson)
  + Option 4: RAN4 to evaluate the potential MPR reduction enabled by DPoD and its impact on UL coverage and UE transmit energy efficiency. (Ericsson)
  + Option 5: RAN4 to evaluate the extent to which UE EVM requirements can be adjusted when DPoD compensates for PA and other RF components non-linearity at the base station. (Ericsson)
  + Option 6: RAN4 to study inclusion of oscillator phase noise and IQ imbalance in UL post-distortion schemes, evaluating feasibility and performance gains for high-order modulations and higher-frequency operation. (Ericsson)
  + Option 7: RAN4 to evaluate DPoD performance with higher modulation orders focusing on high-SNR conditions. (Ericsson)
* Recommended WF
  + More discussion is needed.

**Issue 1-8-2: UE RF Impairment Modelling and Compensation**

* Proposals
  + Option 1: Beyond just the PA model, the entire UE RF front-end needs to be studied by RAN4, with particular attention to the potential variation in impairments across different UEs. (Ericsson)
  + Option 2: RAN4 to study feasibility of UE non-linearity estimation methods with reference signals or actual data and assess their suitability for supporting post-distortion and compensation techniques. (Ericsson)
  + Option 3: RAN4 to evaluate RF front-end variation from multiple UEs in the market into account and define suitable baseline/reference models for UL post-distortion studies. (Ericsson)
  + Option 4: RAN4 to evaluate UE PA non-linearity and related impairments across both FR1 and FR2 for UL-Post distortion compensation at BS receiver. Further, this would impact both BS and UE model. (Ericsson)
* Recommended WF
  + More discussion is needed.

**Issue 1-8-3: EVM Requirements and Network Control**

* Proposals
  + Option 1: RAN4 could consider adjusting the UE EVM requirements but also evaluate any additional constraints or dependencies affecting this limit. (Ericsson)
  + Option 2: UE may adjust EVM and reduce MPR only under explicit network control; otherwise, existing RF requirements apply. (Ericsson)
* Recommended WF
  + More discussion is needed.

**Issue 1-8-4: Evaluation Methods and Simulation Models**

* Proposals
  + Option 1: RAN4 to study CP-OFDM and DFT-s-OFDM for UL evaluation of this feature. (Ericsson)
  + Option 2: RAN4 to evaluate channel models for link-level simulation with DPoD feature, considering their impact on test metrics under higher UE transmit power. (Ericsson)
* Recommended WF
  + More discussion is needed.