**3GPP TSG-RAN WG4 Meeting # 104-e R4-2214282**

**Electronic Meeting, 15 – 26 August 2022**

**Agenda item:** 11.8.4

**Source:** Moderator (vivo)

**Title:** Email discussion summary for [104-e][233] FR2\_multiRx\_RRM

**Document for:** Information

# Introduction

This email discussion summary covers agenda 11.8.3 for RRM core requirements for simultaneous DL reception from different directions.

In the 1st round discussion, it is recommended to focus on general part, e.g., scope, considerations, restrictions, principles, scenarios, UE capabilities, architectures, feasibility/necessity of requirements etc., for the WI. Clarifications, questions and views on the proposals are expected. It is not intended to discuss the requirements details at least in the 1st round email discussion.

In the 2nd round discussion, it is recommended to also focus on general part, e.g., scope, considerations, restrictions, principles, scenarios, UE capabilities, architectures, feasibility/necessity of requirements etc., for the WI. Especially it is expected that we can reach agreements at least for feasibility/necessity of L1 measurement requirements so that we can work on enhanced requirements from next meeting.

It is appreciated that the delegates for this topic put their contact information in the table below.

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1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #1: FR2 multi-Rx DL reception

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211642 | CATT | Observation1: The scaling factor for FR2-1 for beam sweeping can be reduced because the UE can simultaneously perform DL reception in two different directions.  Observation 2: The scaling factor N1 = 8/5/4/3/2 defined for FR2 RRM requirements for RRC-IDLE state and for RRC\_INACTIVE state in different DRX cycle length may be modified as N1 = [4/3/2/2/1] for UE supporting simultaneous DL reception in two different directions.  Observation 3: Whether to apply the reduced N1 for high speed train UE needs further discussion.  Observation 4: The search time requirements for handover to FR2 unknown cell may be reduced for UE supporting simultaneous DL reception in two different directions.  Observation 5: The scaling factor N=8 may be reduced to [4] for TEvaluate\_out\_SSB and TEvaluate\_in\_SSB requirement for FR2 SSB based radio link monitoring for UE supporting simultaneous DL reception in two different directions.  Observation 6: The measurement restrictions for measurement two CSI-RSs in same OFDM symbol on same CC may not be need for FR2 CSI-RS based radio link monitoring for UE supporting simultaneous DL reception in two different directions.  Observation 7: The search time requirements for FR2 unknown cell in SCell activation may be reduced for UE supporting simultaneous DL reception in two different directions.  Observation 8: The scaling factor N=8 may be reduced in requirements of evaluation period TEvaluate\_BFD\_SSB for FR2 for SSB based beam failure detection for UE supporting simultaneous DL reception in two different directions.  Observation 9: The measurement restrictions for measurement two CSI-RSs in same OFDM symbol on same CC may not be need for FR2 CSI-RS based beam failure detection for UE supporting simultaneous DL reception in two different directions.  Observation 10: In Requirements for SSB based candidate beam detection, The scaling factor N=8 in the requirements for CSI-RS based candidate beam detection may alsobe reduced.  Observation 11: In PSCell Addition and Release Delay, the search time requirements for FR2 unknown cell may be reduced for UE supporting simultaneous DL reception with two different directions.  Observation 12: The scaling factors for beam sweeping in FR2 measurement requirements, such as Mpss/sss\_sync\_w/o\_gaps and Mmeas\_period\_w/o\_gaps should also be considered to reduce for UE supporting simultaneous DL reception in two different directions. |
| R4-2211768 | NTT DOCOMO, INC. | Observation 1: Thanks to the multi Rx chain architecture, UE can receive different signals simultaneously from different direction and then it can help beam related delay reduction and measurement and scheduling restrictions can be mitigated.  Proposal 1: New number of samples N and scaring factor P defined in L1-RSRP measurement requirements should be studied for multi Rx UE.  Proposal 2: Measurement restrictions for both SSB based and CSI-RS based L1-RSRP should be studied whether it can be removed or relaxed.  Proposal 3: Scheduling restrictions for both SSB based and CSI-RS based L1-RSRP should be studied whether it can be removed or relaxed.  Proposal 4: The study for L1-RSRP measurements for Reporting under CCA, for RedCap, for satellite access, and for a cell with different PCI from serving cell should be discussed later based on the normal case agreements.  Proposal 5: New N1 value for cell re-selection should be studied for multi Rx UE.  Proposal 6: Scaling factor Klayer1\_measurement should be studied whether it can be removed or relaxed.  Proposal 7: New number of samples N and scaring factor P defined in RLM and BFD/CBD requirements should be studied for multi Rx UE.  Proposal 8: Measurement restrictions for both SSB based and CSI-RS based RLM and BFD/CBD should be studied whether it can be removed or relaxed.  Proposal 9: Scheduling restrictions for both SSB based and CSI-RS based RLM and BFD/CBD should be studied whether it can be removed or relaxed.  Proposal 10: The study for RLM and BFD/CBD under CCA, for RedCap, for satellite access, and for a cell with different PCI from serving cell should be discussed later based on the normal case agreements.  Proposal 11: The scaling factor PTRP should be studied for multi Rx UE whether it can be relaxed.  Proposal 12: Study whether TCI state switching delay can be modified or not for multi Rx chain UE, e.g. how to evaluate known/unknown condition by using multi Rx chain, how to define TCI state change delay by the cases that dedicated Rx chain is used, partial Rx chains are used, or all Rx chains are used.  Proposal 13: Clarify the scope of this item and discuss whether existing spec can be modified for multi Rx chain UE or not under the clarified scope for receive timing difference between different directions. |
| R4-2211883 | Apple | Proposal 1: The receive timing difference between different directions is within CP.  Proposal 2: When specifying requirements to realize possible gains such as reduced measurement delay or easing of scheduling/measurement restriction, UE implementation constraints should be considered. |
| R4-2211940 | CMCC | Proposal 1: For L3 measurement in connected mode, all the existing scenarios (intra-frequency measurements without MG, intra-frequency measurements with MG, inter-frequency measurement with MG, inter-frequency measurement without MG) need to be considered for the delay improvement with multi-beam simultaneous reception.  Proposal 2: For L3 measurement in connected mode, with multi-beam simultaneous reception, Mpss/sss, Mmeas andMSSB\_index can be reduced.  Proposal 3: for intra-frequency measurement without MG and inter-frequency measurement without MG, it is proposed to consider the update of Klayer1\_measurement.   * In detail, with multiple simultaneous reception, even if there is overlapping between reference signals configured for RLM, BFD, CBD, L1-RSRP and SMTC, Klayer1\_measurement of 1.5 is not always applied, smaller value is expected.   Proposal 4: for L1-RSRP measurement based on SSB, it is proposed to update the value of N (smaller than 8 is expected.)  Proposal 5: for L1-RSRP measurement (including SSB based measurement and CSI-RS based measurement), it is proposed to consider the update of Psharing factor.   * In detail, with multiple simultaneous reception, even if there is overlapping between SSB/CSI-RS configured for L1-RSRP measurement and SSB symbols indicated by SSB-ToMeasure, Psharing factor of 3 is not always applied, smaller value is expected.   Proposal 6: for L1-SINR measurement with SSB based CMR and dedicated IMR configured, it is proposed to update the value of N (smaller than 8 is expected.)  Proposal 7: for L1-RSRP measurement (including L1-SINR measurement with CSI-RS based CMR and no dedicated IMR configured, L1-SINR measurement with SSB based CMR and dedicated IMR configured, L1-SINR measurement with CSI-RS based CMR and dedicated IMR configured), it is proposed to consider the update of Psharing factor.   * In detail, with multiple simultaneous reception, even if there is overlapping between SSB/CSI-RS configured for L1-SINR measurement and SSB symbols indicated by SSB-ToMeasure, Psharing factor of 3 is not always applied, smaller value is expected.   Proposal 8: For SSB based RLM/BFD measurement (TEvaluate\_out\_SSB, TEvaluate\_in\_SSB, TEvaluate\_BFD\_SSB), it is proposed to update the value of N (smaller than 8 is expected)  Proposal 9: For SSB based CBD and CSI-RS based CBD (TEvaluate\_CBD\_SSB, TEvaluate\_CBD\_CSI-RS), it is proposed to update the value of N (smaller than 8 is expected)  Proposal 10: For RLM/ BFD/CBD measurement (including both SSB based measurement and CSI-RS based measurement), it is proposed to consider the update of Psharing factor.   * In detail, with multiple simultaneous reception, even if there is overlapping between SSB/CSI-RS configured for RLM/ BFD/CBD measurement and SSB symbols indicated by SSB-ToMeasure, Psharing factor of 3 is not always applied, smaller value is expected.   Proposal 11: for MAC-CE based TCI state switch delay with unknown target TCI state, the reduction on switch delay requirements can be considered (i.e. consider the improvement of TL1-RSRP with multiple simultaneous reception)  Proposal 12: for cell re-selection requirements in idle/inactive mode, it is proposed to discuss whether to consider the reduction of N1 with multiple simultaneous reception. |
| R4-2212062 | OPPO/ | Proposal 1: Scaling factor of Rx beam sweeping could be revisited at least for SSB-based L1/L3 measurement.  Proposal 2: Study whether measured RS samples can be reduced for L1/L3 measurement delay in case of FR2 multi-Rx reception.  Proposal 3: Further consider to remove some measurement restriction for UE capable of simultaneous multi-Rx reception.  Proposal 4: Consider simultaneous reception of L1/L3 measured RS and data if UE supports simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.  Observation 1: RRM requirements of simultaneous multi-Rx reception could be revisited based on RF conclusions on UE assumption of spherical coverage.  Proposal 5: For dual TCI state switching delay requirements, which scenarios of triggering, known/unknown TCI state and TCI association to different PCI could be considered and clarified. |
| R4-2212180 | Qualcomm Incorporated | Proposal 1: UE requirements for FR2 multi-Rx chain DL reception shall be defined based on the following assumptions.  • UE does not have more than two cell searchers for cell and SSB detection and SSB measurements  • UE is configured with one TAG for uplink transmission  • UE does not perform RLM from a non-anchor TRP, i.e. no RLM for an auxiliary TRP  Proposal 2: With the proposal 1, RAN4 excludes the following aspects from the set of objectives, i.e. the legacy requirements are applied.  • L3 measurement delay  • RLM requirement |
| R4-2212219 | LG Electronics Inc. | Proposal 1: Clarify whether UE can perform SSB based measurement using multi-antenna panels when UE supports *simultaneousReceptionDiffTypeD*.  Proposal 2: Study whether or how to define measurement delay requirement and scheduling restriction (interruption) depending on UE behavior for s-DCI or m-DCI based multi-TRP  Proposal 3: RAN4 needs to consider activation delay from a single antenna panel to multi-antenna panels.  Proposal 4: RAN4 should study the RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.  Proposal 5: RAN4 needs to check whether it is available that the maximum receive timing difference between the DL transmission from two TRPs is within CP according to RAN2 specification. |
| R4-2212466 | Samsung | Observation 1: Rel-18 WI (NR\_FR2\_multiRX\_DL) is targeted to specify RAN4 requriements for ”enhanced FR2-1 UEs with simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier”, which is of necessity to support Rel-16 eMIMO feature of DL multi-TRP operation.  Proposal 1: RAN4 shall not introduce new, but reuse Rel-16 UE capability IE *simultaneousReceptionDiffTypeD-r16*, to indicate enhanced FR2-1 UEs supporting simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.  Observation 2: Simultaneous DL reception from different directions (i.e., AoA1 and AoA2 with discriminated directions) can be achieved by utilizing two panels located in opposite sides of handheld UE.  Observation 3: The spatial diversity or multiplexing from 2AoA can only be achieved based on the assumption of independence of fading characteristics from AoA1 and AoA2.  Proposal 2: Spatial MIMO (either spatial diversity or spatial multiplexing) by using one panel to achieve two independent signals from the same or nearly the same direction is not the scope of this work item.  Observation 4: Spatial MIMO (either spatial diversity or spatial multiplexing) performance will be degraded when the two AoAs are close to each other, even two antenna panels are located in the side of incoming signals of AoA1 and AoA2.  Observation 5: The applicable condition of simultaneous DL reception from different directions is the scope of UE RF session by specifying the requirements of dual AoA spherical coverage.  Proposal 3: RRM requirement of simultaneous DL reception from different directions shall be defined based on the applicable condition to be specified in UE RF session.  Proposal 4: RRM requirement discussion shall be focused on the case with different QCL TypeD RSs on a single component carrier, by excluding downlink CA operation.  Proposal 5: At least the following RRM requirements shall be studied on whether UE RRM performance can be enhanced by supporint the feature of simultaneous DL reception from different directions.   |  |  | | --- | --- | | **Impacted RRM requirement** | **Comments** | | Handover to unknown FR2 cell | Similar to FR2 RX beam sweeping number, need FFS on Tsearch to unknown cell | | Factor for FR2 RX beam sweeping | With multi-panel simultaneous reception, to reduce RX beam sweeping number = 8 needs FFS: RLM, BFD, CBD, L3/L1- Measurement | | Measurement restriction for CSI-RS-based operation | In current spec, UE is not required to both CSI-RS if “The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD” | | Scheduling restriction for CSI-RS-based operation | In current spec, no scheduling restriction only if “CSI-RS which is type-D QCLed with active TCI state for PDCCH or PDSCH” | | Active TCI switching delay | If the target TCI can be received simultaneously, then T\_L1-RSRP = 0 can be also possible for FR2 |   Observation 6: Given that independent RF and BB processing is of necessity to support two distinct AoAs, no restriction on MRTD between different directions (different QCL Type D RSs) should be provided.  Observation 7: From RRM testability studied in Rel-15 FR2 testability study item, there is no conclusion on the feasibility of generating the testable side conditions made for 2AoA Case 2 (Simultaneous transmission of signals from 2 probes).  Proposal 6: RAN4 RRM session shall provide input to Rel-18 testability study item (FS\_NR\_FR2\_OTA\_enh), by providing the needs of RRM performance requirement testing.  Proposal 7: RAN4 RRM session use the test parameters required given in 6.2.1.4.1 of TR 38.810 as the starting point to discussion on 2AoA setup needed for RRM performance requirement for UE supporting simultaneous DL reception from from different directions with different QCL TypeD RSs:   |  | | --- | | Test parameters for RRM testing to be controlled at the reference point:  - SNR of DL signal  - DL power level (e.g. EPRE) (from AoA)  - Relative DL power level of 2 signals  - From intra-frequency or inter-frequency cells  - From the same AoA or different AoAs.  - Relative DL timing of 2 signals  - Faded DL channel for each signal  - AoA for arriving signals | |
| R4-2212512 | MediaTek Inc. | Proposal 1: Not to enhance L3 measurement requirement in R18 multi-panel WI.  Observation 1: For L1 measurement, there are two scenarios (1) intra-cell mTRP (2) inter-cell BM/mTRP.  Proposal 2: For L1 measurement requirement, take R16 intra-cell mTRP, i.e. reception on two TRPs from one cell at a time, as a start point. Discuss R17 inter-cell BM/mTRP after the requirement of single serving cell is concluded.  Proposal 3: For the case when both different QCL-Type D RSs are received by two different UE Rx panels at a time, no measurement restriction and scheduling availability are needed because of beamforming conflict.  Observation 2: A multiple panels UE may use the “same” Rx panel to receive two different QCL-Type D RSs at a time.  Proposal 4: For the case when two different QCL-Type D RSs are received by same UE Rx panel at a time, the legacy R15/R16 requirement (e.g. measurement restriction and scheduling availability) should be reused.  Proposal 5: For dual TCI state switch, the legacy TCI state switch delay requirement can be reused.  Observation 3: For timing difference between different panels, the number of the FFT module, timing estimation/tracking/compensation will be double.  Proposal 6: The timing difference between different panels is at least within one CP. |
| R4-2212688 | Nokia, Nokia Shanghai Bell | Proposal 1: Rel-18 multi-RX chain UE should be able to support both intra-cell and inter-cell operation with TRPs located within reasonable intercell distance.  Proposal 2: The scope of a RX chain architecture includes possible implementations and UE capabilities as below:  Multiple Antenna panel  Multiple Antenna panel + AGC  Multiple Antenna panel + AGC + front-end (time and frequency sync)  Multiple Antenna panel + AGC + front-end + Demod/RRM  Proposal 3: RAN4 can consider two options for beam management for UE with multiple RX chains  Option-(i) Reuse independent beam management concept (IBM) from Inter-band CA study  Option-(ii) define panel or RX chain specific behaviors with RX panel control signal for DL  Proposal 4: Study independent beam managements for different QCL-D sources with multiple TRPs, and also study other QCL channel property impacts of {average gain, delay shift and doppler shift} for multi-RX chain requirements.  Proposal 5: Study UE behaviors and capability of multiple RX chains regarding handling Rx signal level difference between two channels.  Proposal 6: Study UE RX capability receiving extended MRTD based on non-collocated mTRP deployment scenario.  Proposal 7: Possible scenarios supporting simultaneous reception using multiple RX chains needs to be clarified in Rel-18 WI scope, including:  RRM and Demod simultaneous processing capability  RRM and CSI simultaneous measurements and processing  PDCCH/PDSCH simultaneous RX  PDSCH simultaneous RX (basic for 4 layers)  PDCCH simultaneous monitoring for multi-DCI dual-TCI ( Depending on the UE simultaneous RX capability, RX scheduling restriction rules can be discussed.)  Proposal 8: RAN4 to revisit the FR2 SMTC use case for ‘L1 and L3’ measurements and ‘serving cell and non-serving cell’ to reduce measurement latency. Rel-18 FR2 multi-RX chain UE may be able to measure RSs simultaneously with different QCL-D sources or with different beam assumptions (i.e. narrow and wide beam assumption)  Proposal 9: Each TCI switching per RX chain is assumed to be independent in aspect of TCI switching delay. RAN4 to study if Rel-17 TCI switching delay requirements can be applicable as Rel-18 UE requirements with multi-RX chains.  Proposal 10: RAN4 to study if a UE with multiple RX chains tracks time and frequency per TCI when dual TCIs are activated per RX chain.  Proposal 11: Power saving can be additional requirements of UE with multiple RX chains. |
| R4-2213054 | vivo | Proposal 1: At least following L1 measurement requirements need to be specified for multi-Rx chain DL reception  • L1-RSRP measurement delay  • RLM and BFD/CBD requirements  • Scheduling/measurement restrictions  • TCI state switching delay with dual TCI  Proposal 2: Simultaneous DL reception of same or different type of RSs from different directions is supported for defining L1 measurement requirements to support multi-TRP operation.  Proposal 3: It is assumed that UE is capable of supporting simultaneous reception from two different directions with two different QCL type D RSs.  Proposal 4: Pair of different directions with different QCL Type D RSs that UE can be used for simultaneous reception should be determined.  Proposal 5: Requirements for TRP specific link recovery are enhanced for UE supporting multi-Rx chain simultaneous reception.  Proposal 6: Requirements for scheduling restrictions and measurement restrictions for BFD/CBD are enhanced for UE supporting multi-Rx chain simultaneous reception.  Proposal 7: Requirements for inter-cell L1-RSRP measurement are enhanced for UE supporting multi-Rx chain simultaneous reception.  Proposal 8: Number of cells with PCI different from serving cells are further discussed for UE supporting multi-Rx chain simultaneous reception and the max number of cells is 8.  Proposal 9: Requirements for scheduling restrictions and measurement restrictions for inter-cell L1-RSRP measurement are enhanced for UE supporting multi-Rx chain simultaneous reception.  Proposal 9: Requirements for scheduling restrictions and measurement restrictions for RLM measurement are enhanced for UE supporting multi-Rx chain simultaneous reception.  Proposal 10: To define requirements for TCI switching delay with dual TCI, both R15/R16 TCI framework and R17 TCI framework, i.e., unified TCI, are considered for UE supporting multi-Rx chain simultaneous reception.  Proposal 11: A new capability, different from *simultaneousReceptionDiffTypeD-r16* or other L1 measurement related UE capability, should be introduced for L3 measurement delay reduction for UE supporting multi-Rx chain simultaneous reception.  Proposal 12: RAN4 to discuss how FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled.  Proposal 13: Receive time difference for configured different QCL Type D RSs is within CP.  Proposal 14: FFS receive time difference for configured different QCL Type D RSs is larger than CP.  Proposal 15: RAN4 to discuss if additional UE capability for indicating supporting of simultaneous reception with different QCL type D RS and PDSCH/PDCCH is needed.  Observation 1: Only single component carrier is considered in the WI. |
| R4-2213289 | ZTE Corporation | N/A |
| R4-2213495 | Huawei, HiSilicon | Proposal 1: In R18, UE is assumed to perform simultaneous data receptions with different beam directions or perform simultaneous L1 measurements with different beam directions.  Proposal 2: In R18, the enhanced UE in FR2 is still not required to perform L3 measurements and L1 measurements simultaneously.  Proposal 3: In R18, it is suggested that the existing L3 measurements can be reused for FR2 UEs capable of simultaneous DL reception from different directions.  Observation 1: UE may not support to perform simultaneous DL receptions on any combination of multiple beams.  Proposal 4: In R18, RAN4 needs to study the conditions when UE is able to perform simultaneous L1-RSRP measurements on two RSs from different TRPs, and investigate the impacts on sharing factors PSC and PCDP.  Proposal 5: In R18, the enhancement on simultaneous BFD/CBD measurements on two RSs from different resource sets can be considered.  Proposal 6: In R18, RAN4 needs to study the conditions when UE is able to perform simultaneous BFD/CBD measurements on two RSs from different resource sets, and investigate the impacts on sharing factor PTRP.  Proposal 7: In R18, the existing scheduling restriction requirements for L3 measurements can be reused for the UE supporting simultaneous DL reception from different direction in FR2.  Proposal 8: In R18, the existing scheduling restriction principles for L1 measurements can be reused for the UE supporting simultaneous DL reception from different direction in FR2.  Proposal 9: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.  Observation 2: For dual TCI state switch of PDCCH, for non-SFN scenario, each TCI is updated by single MAC CE; for SFN case, dual TCI can be updated by one MAC CE.  Observation 3: For dual TCI state switch of PDSCH, the TCI state switching can be triggered by single DCI/Multiple DCI.  Observation 4. RRC based Dual TCI state switching is not supported.  Proposal 10: Define dual TCI state switching requirements for following cases:  • PDCCH non-SFN: Two MAC CE with one for each TCI state  • PDCCH SFN: single MAC CE for two TCI states  • PDSCH single DCI: single DCI for two TCI states  • PDSCH multiple DCI: Two DCI with one for each TCI state  Observation 5: UE may not be able to receive simultaneously if RS/physical channels with different QCL typeD are received by the same panel.  Observation 6: The requirements shall apply provided that two directions with different QCL typeD are received by different UE panels.  Proposal 11: The requirements shall apply with the condition that two directions with different QCL typeD are received by different UE panels, and the conditions shall follow the conclusion in RF.  Observation 7: If dual TCI states are unknown, it is possible that the configured TCI states are ones that UE cannot receive simultaneously  Proposal 12: Discuss the known conditions of dual TCI and discuss whether to define requirements for unknown dual TCI state switch.  Proposal 13: The condition of receive timing difference between different directions with different TCI of QCL type-D shall take CP length as baseline. |
| R4-2213872 | ZTE Corporation | Observation 1: In fact from the perspective of UE capability, simultaneous multi-panel/beam reception has been supported from Rel-16/17, focus on CA scenario. However for this Rel-18 WID, the simultaneous multi-panel/beam reception is oriented to single component carrier scenario.  Proposal 1: In theory, the assumption of schaling factor N can be reduced to 4. However which is somehow related to the UE implementation of DL reception with two AoAs. So we need further discussion on the reduction of scaling factor N.  Proposal 2: Based on the two panels/RF chains assumption, UE is possible to preform L1 measurement and RRM measurement at the same time in FR2. So the scaling factor P used to deal with the conflict between L1 measurement and RRM measurement can be reduced or removed.  Proposal 3: The assumption of Rx beam number during cell identification can be reduced similar as in L1 measurement.  Proposal 4: The assumption of Rx beam number during RRM measurement can be reduced similar as in cell identification.  Proposal 5: For RLM/BFD, the reduction of scaling factor N can be considered under 2 panels/beams simultaneous reception. Further more, the measurement restriction can be relieved or removed.  Proposal 6: Except for the consideration of reduction of Rx beam number, considering inside-panel TCI state switching and cross-panel TCI state switching are both possible, so additional panel/RF chain switching time should be considered within the TCI state switching latency for the case of cross-panel TCI state switching.  Proposal 7: If keep the assumption of single FFT as in Rel-17, the receive timing difference between different directions should be not larger the CP length. But the legacy MRTD under inter-band CA is much larger than CP length for FR2-1, which is beyond UE capability.  Proposal 8: If UE is capable of supporting two FFTs for different TRP or panel/RF chain reception, the restriction of not larger the CP length can be ignored, so re-using the legacy requirement for inter-band CA is fine. |
| R4-2213957 | Ericsson | Proposal 1: For UE with the capability of simultaneous reception from different directions, the existing legacy RRM requirements continue to apply by default, unless a corresponding new enhanced requirement is introduced.  Proposal 2: A clarification is added in clause 3.6.13 of TS 38.133 (Applicability of requirements for FR2) that the new requirements defined in this WI are applicable only for FR2-1.  Proposal 3: The new improved RRM requirements should aim to reduce the delays during measurements and procedures (e.g., RLM evaluation period, measurement delays, etc.) while maintaining the existing accuracy requirements.  Proposal 4: RAN4 to discuss whether the new requirements will also be applicable when QCL type D is configured together with QCL type A and QCL type C.  Proposal 5: RAN4 to discuss defining new improved requirements for serving cells (PCell, PSCell, and SCells, whichever are relevant for each such requirement) as well as for non-serving cells.  Proposal 6: In an improved RRM requirement relying on a certain QCL relationship (QCL type D), not only the target signal but also the associated signal in the QCL information shall remain detectable during the entire measurement period.  Proposal 7: L1-RSRP measurement period: SSB-only based L1-RSRP measurement reporting does not benefit from QCL type D information.  Proposal 8: L1-RSRP measurement period: L1-RSRP measurement reporting based on CSI-RS or CSI-RS and SSB can be improved by reducing N parameter, depending on QCL information, applicable for:   * serving cell, * non-serving cell.   Proposal 9: Cell detection and L3 measurement period, SSB-based:   * No direct benefit from QCL type D information, * FFS: impact on CSSF.   Proposal 10: L3 measurement period, CSI-RS based:   * Simultaneous measurements for signals with QCL type D can reduce the measurement period.   Proposal 11: RLM evaluation period, SSB-based:   * No direct benefit from QCL type D information, * FFS: impact on P parameter.   Proposal 12: RLM evaluation period, CSI-RS based and SSB+CSI-RS based:   * The evaluation period can be improved by reducing N parameter, depending on QCL information, * FFS: impact on P parameter.   Proposal 13: CBD evaluation period, SSB-based:   * No direct benefit from QCL type D information, * FFS: impact on P parameter.   Proposal 14: CBD evaluation period, CSI-RS based and SSB+CSI-RS based:   * The evaluation period can be improved by reducing N parameter, depending on QCL information, * FFS: impact on P parameter.   Proposal 15: BFD evaluation period, SSB-based:   * No direct benefit from QCL type D information, * FFS: impact on P parameter.   Proposal 16: BFD evaluation period, CSI-RS based and SSB+CSI-RS based:   * The evaluation period can be improved by reducing N parameter, depending on QCL information, * FFS: impact on P parameter.   Proposal 17: Scheduling/measurement restrictions in TS 38.133 need to be updated (e.g., to reduce or exclude some restrictions) to allow for simultaneous reception on two chains, for UEs capable of this.  Proposal 18: The new RRM requirements defined for simultaneous measurements and procedures on two chains need to apply, provided the corresponding active TCI states are configured and used for simultaneous reception during the measurement or evaluation period.  Proposal 19: RAN4 to discuss the requirements for any change to the set of active TCI states used for simultaneous reception, e.g., active TCI state switching within this set.  Proposal 20: RAN4 to discuss whether there is an issue when the number of active TCI states is larger than the UE capability for simultaneous reception.  Observation 1: Up to and including 3GPP release-17 all MIMO signals fall withing CP.  Observation 2: Deployment flexibility is important. This merits study of cases where ∆τ > CP in WI.  Observation 3: Cases where ∆τ > CP CP will degrade performance severely unless the MIMO streams are isolated from each other spatially or interference is mitigated through other means.  Proposal 21: If we define cases where ∆τ > CP then we define a total MRTD budget, where ∆τ = TAE + ∆propagation and ∆τ < MRTD. This way TAE and ∆propagation can be balanced as terms, within the total MRTD budget. |
| R4-2211978 | Xiaomi | Observation 1: There are two scenarios with scenario 1 as two RX beams used for one cell and scenario 2 as two RX beams used for different cells.  Observation 2: Scaling factor of RX beam sweeping can be reduced with UE using its two RX beams for simultaneous measurement for one cell.  Observation 3: For scenario 1, legacy scheduling and measurement restrictions requirements apply.  Observation 4: The existing simultaneousRxDataSSB-DiffNumerology IE can be re-used for FR2.  Observation 5: For scenario 2 with multi-RX chain capability, UE can received PDCCH/PDSCH/TRS/CSI-RS for CQI (one beam) and on SSB symbols (another beam) to be measured.  Observation 6: The legacy TCI state switching delay requirement can apply for each RX beam.  Observation 7: The receive timing difference should be kept as within CP considering Rel-16 mTRP scenario is not changed. |
| R4-2213053 | vivo, Qualcomm | Work plan for RRM requirement for NR FR2 multi-Rx chain DL reception |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: General

*Sub-topic description: This sub-topic is intended for discussing general part, e.g., scope, considerations, restrictions, principles, scenarios, UE capabilities, architectures, feasibility/necessity of requirements etc., for the WI.*

**Issue 1-1-1: General principles**

* Proposals
  + P1: When specifying requirements to realize possible gains such as reduced measurement delay or easing of scheduling/measurement restriction, UE implementation constraints should be considered.
    - Power consumption constraints
    - RF constraints
    - BB constraints
  + P2: UE requirements for FR2 multi-Rx chain DL reception shall be defined based on the following assumptions.
    - UE does not have more than two cell searchers for cell and SSB detection and SSB measurements
    - UE is configured with one TAG for uplink transmission
    - UE does not perform RLM from a non-anchor TRP, i.e. no RLM for an auxiliary TRP
  + P3: Consider activation delay from a single antenna panel to multi-antenna panels.
  + P4: Study the RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.
  + P5: Spatial MIMO (either spatial diversity or spatial multiplexing) by using one panel to achieve two independent signals from the same or nearly the same direction is not the scope of this work item.
  + P6: RAN4 RRM session shall provide input to Rel-18 testability study item (FS\_NR\_FR2\_OTA\_enh), by providing the needs of RRM performance requirement testing.
  + P7: Rel-18 multi-RX chain UE should be able to support both intra-cell and inter-cell operation with TRPs located within reasonable intercell distance.
  + P8: There are two scenarios with scenario 1 as two RX beams used for one cell and scenario 2 as two RX beams used for different cells.
  + P9: RAN4 to discuss how FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-2: General considerations on defining requirements**

* Proposals
  + P1: RRM requirement discussion shall be focused on the case with different QCL TypeD RSs on a single component carrier, by excluding downlink CA operation.
  + P2: RAN4 to revisit the FR2 SMTC use case for ‘L1 and L3’ measurements and ‘serving cell and non-serving cell’ to reduce measurement latency. Rel-18 FR2 multi-RX chain UE may be able to measure RSs simultaneously with different QCL-D sources or with different beam assumptions (i.e. narrow and wide beam assumption)
  + P2a: In R18, the enhanced UE in FR2 is still not required to perform L3 measurements and L1 measurements simultaneously.
  + P3: Study whether or how to define measurement delay requirement and scheduling restriction (interruption) depending on UE behavior for s-DCI or m-DCI based multi-TRP
  + P4: Power saving can be additional requirements of UE with multiple RX chains.
  + P5: For UE with the capability of simultaneous reception from different directions, the existing legacy RRM requirements continue to apply by default, unless a corresponding new enhanced requirement is introduced.
  + P6: A clarification is added in clause 3.6.13 of TS 38.133 (Applicability of requirements for FR2) that the new requirements defined in this WI are applicable only for FR2-1.
  + P7: The new improved RRM requirements should aim to reduce the delays during measurements and procedures (e.g., RLM evaluation period, measurement delays, etc.) while maintaining the existing accuracy requirements.
  + P8: RAN4 to discuss whether the new requirements will also be applicable when QCL type D is configured together with QCL type A and QCL type C.
  + P9: RAN4 to discuss defining new improved requirements for serving cells (PCell, PSCell, and SCells, whichever are relevant for each such requirement) as well as for non-serving cells.
  + P10: In an improved RRM requirement relying on a certain QCL relationship (QCL type D), not only the target signal but also the associated signal in the QCL information shall remain detectable during the entire measurement period.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-3: Feasibility/necessity of enhancing requirements for L1 measurements**

* Proposals
  + Option 1: Following L1 measurements related requirements are enhanced in the multi-Rx chain DL reception WI
    - L1-RSRP measurement
    - BFD/CBD
    - RLM
    - L1-SINR
    - TCI state switching with dual TCI
    - Scheduling/measurement restrictions
  + Option 2: RAN4 excludes the following aspects from the set of objectives, i.e. the legacy requirements are applied
    - RLM requirement
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-4: Feasibility/necessity of enhancing requirements for L3 measurements**

* Proposals
  + Option 1: Following L3 measurements related requirements are enhanced in the multi-Rx chain DL reception WI
    - RRM measurement requirements for RRC-IDLE state and for RRC\_INACTIVE state.
    - Handover to FR2-1 unknown cell
    - FR2-1 unknown SCell activation
    - FR2-1 unknown PSCell addition and release
    - For L3 measurement in connected mode, including all the existing scenarios (intra-frequency measurements without MG, intra-frequency measurements with MG, inter-frequency measurement with MG, inter-frequency measurement without MG).
  + Option 2: RAN4 excludes the following aspects from the set of objectives, i.e., the legacy requirements are applied
    - L3 measurement delay
  + Option 2a: Not to enhance L3 measurement requirement in R18 multi-panel WI.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-5: Receive time difference**

* Proposals
  + Option 1: The timing difference between different panels is at least within one CP. FFS whether to define requirements with timing difference larger than one CP.
  + Option 1a: The condition of receive timing difference between different directions with different TCI of QCL type-D shall take CP length as baseline.
  + Option 1b: Receive time difference for configured different QCL Type D RSs is within CP. FFS receive time difference for configured different QCL Type D RSs is larger than CP.
  + Option 1c: If we define cases where ∆τ > CP then we define a total MRTD budget, where ∆τ = TAE + ∆propagation and ∆τ < MRTD. This way TAE and ∆propagation can be balanced as terms, within the total MRTD budget.
  + Option 1d:
    - Option a: If keep the assumption of single FFT as in Rel-17, the receive timing difference between different directions should be not larger the CP length. But the legacy MRTD under inter-band CA is much larger than CP length for FR2-1, which is beyond UE capability.
    - Option b: If UE is capable of supporting two FFTs for different TRP or panel/RF chain reception, the restriction of not larger the CP length can be ignored, so re-using the legacy requirement for inter-band CA is fine.
  + Option 2: The receive timing difference between different directions is within CP
  + Option 2a: Check whether it is available that the maximum receive timing difference between the DL transmission from two TRPs is within CP according to RAN2 specification.
  + Option 3: Given that independent RF and BB processing is of necessity to support two distinct AoAs, no restriction on MRTD between different directions (different QCL Type D RSs) should be provided
  + Option 4: Study UE RX capability receiving extended MRTD based on non-collocated mTRP deployment scenario.
  + Option 5: Clarify the scope of this item and discuss whether existing spec can be modified for multi Rx chain UE or not under the clarified scope for receive timing difference between different directions.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-6: UE capabilities**

* Proposals
  + P1: Consider simultaneous reception of L1/L3 measured RS and data if UE supports simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.
  + P2a: Clarify whether UE can perform SSB based measurement using multi-antenna panels when UE supports *simultaneousReceptionDiffTypeD*.
  + P2b: The existing *simultaneousRxDataSSB-DiffNumerology* IE can be re-used for FR2
  + P2c: RAN4 shall not introduce new, but reuse Rel-16 UE capability IE *simultaneousReceptionDiffTypeD-r16*, to indicate enhanced FR2-1 UEs supporting simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.
  + P2d: For scenario 2 (two RX beams used for different cells) with multi-RX chain capability, UE can received PDCCH/PDSCH/TRS/CSI-RS for CQI (one beam) and on SSB symbols (another beam) to be measured
  + P2e: It is assumed that UE is capable of supporting simultaneous reception from two different directions with two different QCL type D RSs.
  + P2f: RAN4 to discuss if additional UE capability for indicating supporting of simultaneous reception with different QCL type D RS and PDSCH/PDCCH is needed.
  + P3: Study UE behaviours and capability of multiple RX chains regarding handling Rx signal level difference between two channels.
  + P4: Possible scenarios supporting simultaneous reception using multiple RX chains needs to be clarified in Rel-18 WI scope, including:
    - RRM and Demod simultaneous processing capability
    - RRM and CSI simultaneous measurements and processing
    - PDCCH/PDSCH simultaneous RX
    - PDSCH simultaneous RX (basic for 4 layers)
    - PDCCH simultaneous monitoring for multi-DCI dual-TCI
      * (Depending on the UE simultaneous RX capability, RX scheduling restriction rules can be discussed.)
  + P5: A new capability, different from simultaneousReceptionDiffTypeD-r16 or other L1 measurement related UE capability, should be introduced for L3 measurement delay reduction for UE supporting multi-Rx chain simultaneous reception.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-7: UE architectures**

* Proposals
  + P1: The scope of a RX chain architecture includes possible implementations and UE capabilities as below:
    - Multiple Antenna panel
    - Multiple Antenna panel + AGC
    - Multiple Antenna panel + AGC + front-end (time and frequency sync)
    - Multiple Antenna panel + AGC + front-end + Demod/RRM
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-8: Beam management**

* Proposals
  + P1: RAN4 can consider two options for beam management for UE with multiple RX chains
    - Option-(i) Reuse independent beam management concept (IBM) from Inter-band CA study
    - Option-(ii) define panel or RX chain specific behaviors with RX panel control signal for DL
  + P2: Study independent beam managements for different QCL-D sources with multiple TRPs, and also study other QCL channel property impacts of {average gain, delay shift and doppler shift} for multi-RX chain requirements.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-1-9: Dependent on RF conclusions**

* Proposals
  + P1: RRM requirements of simultaneous multi-Rx reception could be revisited based on RF conclusions on UE assumption of spherical coverage
  + P2: RRM requirement of simultaneous DL reception from different directions shall be defined based on the applicable condition to be specified in UE RF session.
  + P3: The requirements shall apply with the condition that two directions with different QCL typeD are received by different UE panels, and the conditions shall follow the conclusion in RF.
  + P4: Pair of different directions with different QCL Type D RSs that UE can be used for simultaneous reception should be determined. RRM session follows conclusions from RF session.
* Recommended WF
  + Collect questions, clarifications, views, etc.

### Sub-topic 1-2: L1 measurements related

*Sub-topic description: This sub-topic is targeted for L1 measurements related enhancements, including scenarios, general considerations, requirements enhancement aspects.*

**Issue 1-2-1: Scenarios for L1 measurement requirements enhancements**

* Proposals
  + P1: R16 intra-cell mTRP, i.e., reception on two TRPs from one cell at a time, as a start point.
  + P2: Discuss R17 inter-cell BM/mTRP after the requirement of single serving cell is concluded
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-2-2: General part for L1 measurement requirements enhancements**

* Proposals
  + P1: For the case when both different QCL-Type D RSs are received by two different UE Rx panels at a time, no measurement restriction and scheduling availability are needed because of beamforming conflict.
  + P2: For the case when two different QCL-Type D RSs are received by same UE Rx panel at a time, the legacy R15/R16 requirement (e.g., measurement restriction and scheduling availability) should be reused.
  + P3a: UE is assumed to perform simultaneous data receptions with different beam directions or perform simultaneous L1 measurements with different beam directions.
  + P3b: Simultaneous DL reception of same or different type of RSs from different directions is supported for defining L1 measurement requirements to support multi-TRP operation.
  + P4: Study whether measured RS samples can be reduced for L1 measurement delay in case of FR2 multi-Rx reception
  + P5: The study for L1-RSRP/RLM/BFD/CBD measurements for Reporting under CCA, for RedCap, for satellite access, and for a cell with different PCI from serving cell should be discussed later based on the normal case agreements.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-2-3: L1-RSRP measurement requirements enhancement**

* Proposals
  + P1: L1-RSRP measurement requirements can be enhanced on following aspects
    - Number of samples *N*
    - Sharing factor *Psharing factor* for both SSB based measurement and CSI-RS based measurement
    - Measurement restrictions for both SSB based and CSI-RS based L1-RSRP
    - Scheduling restrictions for both SSB based and CSI-RS based L1-RSRP
  + P2: In R18, RAN4 needs to study the conditions when UE is able to perform simultaneous L1-RSRP measurements on two RSs from different TRPs, and investigate the impacts on sharing factors PSC and PCDP.
  + P3: L1-RSRP measurement period: SSB-only based L1-RSRP measurement reporting does not benefit from QCL type D information.
  + P4: Requirements for inter-cell L1-RSRP measurement are enhanced for UE supporting multi-Rx chain simultaneous reception.
  + P5: Number of cells with PCI different from serving cells are further discussed for UE supporting multi-Rx chain simultaneous reception and the max number of cells is 8.
* Recommended WF
  + Collect questions, clarifications, views, etc..

**Issue 1-2-4: L1-SINR measurement requirements enhancement**

* Proposals
  + P1: L1-SINR measurement requirements can be enhanced on following aspects
    - Number of samples *N*
    - Sharing factor *Psharing factor* for both SSB based measurement and CSI-RS based measurement
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-2-5: BFD/CBD measurement requirements enhancement**

* Proposals
  + P1: BFD/CBD measurement requirements can be enhanced on following aspects
    - Number of samples *N*
    - Sharing factor *Psharing factor* for both SSB based and CSI-RS based BFD/CBD
    - Measurement restrictions for both SSB based and CSI-RS based BFD/CBD
    - Scheduling restrictions for both SSB based and CSI-RS based BFD/CBD
    - The scaling factor PTRP for TRP specific requirements
  + P2: In R18, the enhancement on simultaneous BFD/CBD measurements on two RSs from different resource sets can be considered.
  + P3: In R18, RAN4 needs to study the conditions when UE is able to perform simultaneous BFD/CBD measurements on two RSs from different resource sets, and investigate the impacts on sharing factor PTRP.
  + P4: Requirements for TRP specific link recovery are enhanced for UE supporting multi-Rx chain simultaneous reception.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-2-6: RLM measurement requirements enhancement**

* Proposals
  + P1: RLM measurement requirements can be enhanced on following aspects
    - Number of samples *N*
    - Sharing factor *Psharing factor* for both SSB based and CSI-RS based RLM
    - Measurement restrictions for both SSB based and CSI-RS based RLM
    - Scheduling restrictions for both SSB based and CSI-RS based RLM
* Recommended WF
  + Collect questions, clarifications, views, etc.

### Sub-topic 1-3: TCI state switching

*Sub-topic description: This sub-topic is targeted for TCI related requirements enhancements.*

**Issue 1-3-1: General considerations for TCI related**

* Proposals
  + P1: Each TCI switching per RX chain is assumed to be independent in aspect of TCI switching delay. RAN4 to study if Rel-17 TCI switching delay requirements can be applicable as Rel-18 UE requirements with multi-RX chains.
  + P1a: RAN4 to study if a UE with multiple RX chains tracks time and frequency per TCI when dual TCIs are activated per RX chain.
  + P2: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.
  + P2a: To define requirements for TCI switching delay with dual TCI, both R15/R16 TCI framework and R17 TCI framework, i.e., unified TCI, are considered for UE supporting multi-Rx chain simultaneous reception.
  + P3: Define dual TCI state switching requirements for following cases:
    - PDCCH non-SFN: Two MAC CE with one for each TCI state
    - PDCCH SFN: single MAC CE for two TCI states
    - PDSCH single DCI: single DCI for two TCI states
    - PDSCH multiple DCI: Two DCI with one for each TCI state
  + P4: Except for the consideration of reduction of Rx beam number, considering inside-panel TCI state switching and cross-panel TCI state switching are both possible, so additional panel/RF chain switching time should be considered within the TCI state switching latency for the case of cross-panel TCI state switching.
  + P5: RAN4 to discuss whether there is an issue when the number of active TCI states is larger than the UE capability for simultaneous reception.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-3-2: Known/unknown conditions for TCI state switching for multi-Rx chain**

* Proposals
  + P1: Study whether TCI state switching delay can be modified or not for multi Rx chain UE, e.g. how to evaluate known/unknown condition by using multi Rx chain, how to define TCI state change delay by the cases that dedicated Rx chain is used, partial Rx chains are used, or all Rx chains are used.
  + P1a: For MAC-CE based TCI state switch delay with unknown target TCI state, the reduction on switch delay requirements can be considered (i.e. consider the improvement of TL1-RSRP with multiple simultaneous reception)
  + P1b: For dual TCI state switching delay requirements, which scenarios of triggering, known/unknown TCI state and TCI association to different PCI could be considered and clarified.
  + P1c: Discuss the known conditions of dual TCI and discuss whether to define requirements for unknown dual TCI state switch.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-3-3: Enhancement for TCI state switching delay requirements**

* Proposals
  + P1: For dual TCI state switch, the legacy TCI state switch delay requirement can be reused
  + P2: The new RRM requirements defined for simultaneous measurements and procedures on two chains need to apply, provided the corresponding active TCI states are configured and used for simultaneous reception during the measurement or evaluation period.
  + P3: RAN4 to discuss the requirements for any change to the set of active TCI states used for simultaneous reception, e.g., active TCI state switching within this set.
  + P4: The legacy TCI state switching delay requirement can apply for each RX beam.
* Recommended WF
  + Collect questions, clarifications, views, etc.

### Sub-topic 1-4: L3 measurements related

*Sub-topic description: This sub-topic is targeted for L3 measurements related enhancements, including general considerations, requirements enhancement aspects etc.*

**Issue 1-4-1: General part for L3 measurement requirements enhancements**

* Proposals
  + P1: In R18, it is suggested that the existing L3 measurements can be reused for FR2 UEs capable of simultaneous DL reception from different directions.
  + P2: Study whether measured RS samples can be reduced for L3 measurement delay in case of FR2 multi-Rx reception
  + P3: Cell detection and L3 measurement period, SSB-based:
    - No direct benefit from QCL type D information,
    - FFS: impact on CSSF.
  + P4: L3 measurement period, CSI-RS based: simultaneous measurements for signals with QCL type D can reduce the measurement period.
  + P5: Scaling factor for Rx beam sweeping for FR2-1 can be reduced by 2
    - FFS for HST scenario
  + P5a: The assumption of Rx beam number during cell identification/measurement can be reduced
  + P5b: Scaling factor of RX beam sweeping can be reduced with UE using its two RX beams for simultaneous measurement for one cell.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-4-2: How the requirements for L3 measurements in IDLE/INACTIVE mode are enhanced**

* Proposals
  + P1: For cell re-selection requirements, *N1* value is further studied.
* Recommended WF
  + Collect questions, clarifications, views, etc.

**Issue 1-4-3: How the requirements for L3 measurements in CONNECTED mode are enhanced**

* Proposals
  + P1: For L3 measurement in connected mode, with multi-beam simultaneous reception, Mpss/sss, Mmeas and MSSB\_index can be reduced.
  + P2: Scaling factor Klayer1\_measurement for intra-frequency measurement/inter-frequency measurement without gap should be studied whether it can be removed or relaxed.
  + P3: In R18, the existing scheduling restriction requirements for L3 measurements can be reused for the UE supporting simultaneous DL reception from different direction in FR2.
* Recommended WF
  + Collect questions, clarifications, views, etc.

## Companies’ views collection for 1st round

### Open issues

Comments for 1st round is collected in following sections.

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

**Issue 1-1-1: General principles**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 1-1-1: General principles**  We think multiple aspects covered here.  It is extension to Rel-17 multi-TRP and inter-cell BM. Whether Rel-18 MIMO features shall be considered or not is FFS  P1: of course, UE implementation options and such constraints need to be discussed together with the potential requirements, but do not agree with the formulation “considering … when specifying requirements”. Furthermore, when talking e.g., about power consumption one should not ignore also the gains of reduced time periods thanks to simultaneous receptions, since the total time becomes shorter.  P2: We agree with the searchers part. Regarding TAG part, we need to check Rel-17 RAN1 agreements. Do not understand the proposal about RLM, can the proponents please clarify RLM part of the proposal.  P3: too early for agreeing on such details  P4: do not agree.  P6: first we need to focus on the requirements, then discuss testing.  P7: Agree with P7.  P8: agree.  P9: agree on “discuss also the impact on SCell activation”. |
| LGE | P1: support P1. Further discussions on detailed constraints of power consumption, RF, and BB are needed.  P2: general assumption should be based on ~Rel-17 RAN1 features.  P3: support P3. Further discussion on detailed scenario for activation delay from single to multi antenna panels.  P4: support P4. The detailed condition of AoA would be discussed in RF session, and related requirements and behavior should be studied in RRM session.  P5: depending on single or multi antenna panels’ activation to receive two signals, RAN4 needs to study RRM impact.  P6: P6 is necessary, but we need to focus on general scope and requirements.  P7/P8: fine with P7 and P8.  P9: we prefer to focus on issues (objectives) listed in WID, and this WI is under single carrier only.. |
| NTT DOCOMO, INC. | P1: RF constraints should be discussed in RF discussion. BB constraints can be considered as an assumption for the studies but need more discussion. The necessity of consideration of power consumption constraints is unclear because the purpose of this work is utilizing multi-Rx chain to improve FR2 DL reception efficiency.  P2: The listed assumption seems to be too strict. We need more discussion.  P3: It is a one of the scenario for multi-Rx chain utilization. The baseline should be the condition that all Rx chains are activated.  P4: Same view as P3.  P5: It should be discussed in demod discussion rather than RRM.  P6: Basically agree if necessary. Requirements should be discussed first.  P7: Agree.  P8: Agree.  P9: Agree. |
| Qualcomm | P1: Although it is a high-level proposal, we agree in principle. Any increase in those aspect, if considered, should be limited to the ultimate goal of the WI which is T-put enhancement by achieving 4 layer-MIMO in FR2.  P2: multi-TAG based mTRP is in Rel-18 eFeMIMO. This WI should be standing on the existing mTRP schemes. To answer the question from Ericsson, the third bullet was meant to say TRP-specific RLM is out of the scope because it is not supported as of now.  P3: Needs more progress from RF  P4: Not clear  P5: The ultimate goal is to achieve 4-layer MIMO, not diversity gain. For the diversity, not clear whether RRM impact is expected. If the proposal is about traditional diversity scheme, it is already doable even without spec support.  P6: Support.  P7: Do not support. The main scenario here should be to receive one PDSCH QCL’ed with different QCL sources from one cell.  P8: Do not support “scenario 2”  P9: Do not support. One searcher will be always dedicated to PCell, and the remaining searcher is going to be shared by the rest of cells. Besides, UE memory size will be limited. “Multi-Rx Chain” does not necessarily mean UE has separate BB processors and so on. |
| Nokia | **Issue 1-1-1 – General principles**  Proposal 1 – in general we are fine with he proposal, but it would be nicer if the proponents specify better the intention on each constraints that were mentioned.  Proposal 2 – needs further consideration. We need to discuss more about the TAG, and RLM  Proposal 3 – Ok  Proposal 4 – Ok, but it should be considered jointly with proposal 3, meaning UE could switch from 1 panel to multiple pannels  Proposal 5 – We agree RF and RRM is discussing in parallel.  However, we believe that we need to keep discussing and decide on AoA constraints.  Our preference is that small AoA and large AoA are supported for good flexibility in the deployment.  Proposal 6 – Too early to make conclusions on testability  Proposal 7 – Agree with the proposal  Proposal 8 – Fine with the proposal |
| Huawei | P1: generally we can agree with the principles. But the assumption on RF constraints shall be discussed in RF session.  P2: we agree with 1st bullet. This WI is for DL reception not for UL transmission. 2nd bullet is out of scope. For 3rd bullet, since there is no additional PCI configuration for RLM-RS, UE can be assumed to perform RLM for TRP associated with serving PCI.  P3: it depends on whether to have the switching between single-panel and multi-panel, which needs RF inputs.  P4: we can agree to study the RRM impacts. However, UE is not assumed to use single panel for downlink reception with different UE Rx beam directions.  P5: it is not clear to us what the impact of RRM is.  P6: The related testing shall be discussed on performance stage. RAN4 shall focus on RRM core impacts firstly.  P7/P8: multi-TRP scenario can be used as starting point. Whether TRPs are intra-cell or inter-cell can be discussed later.  P9: FR2 SCell activation delay reduction is not within the scope if this WI. |
| ZTE | P1: Referring to BB constraints, it should be considered as an assumption of discussion. Regarding to Power consumption constraints, multi-pannel Rx would lead to latency reduction, and the cost of latency reduction is possible more power consumption. We should know which one is the main target.  P2: Agree with 1st bullet. For 2nd bullet, RAN1 has agreed to support two TA enhancement for both intra-cell and inter-cell multi-DCI multi-TRP scenarios in Rel-18. For 3rd bullet, FFS.  P3: in m-TRP scenario, switching between one TCI state case and dual TCI state case is possible. But whether the two antenna panels should both always in active status? Maybe we need to wait for RF session.  P4: Related P3, so FFS.  P5: Share similar view as QC.  P6: First we should focus on requirements.  P7: Agree.  P8: Does Scenario 1 mean intra-cell mTRP, and Scenario mean inter-cell mTRP? If yes, we agree.  P9: Agree. |
| OPPO | P1: Agree with the principles in general. RF constraints shall be discussed in RF session.  P2: we agree with 1st bullet. Clarification needs for other parts .  P3: It needs RF inputs.  P4/P5: Whether UE is assumed to use single panel for downlink reception with different UE Rx beam directions could depend on RF conclusion.  P6: Too early.  P7/P8: Whether TRPs are intra-cell or inter-cell needs to be clarified in RAN4. We prefer to start with intra-cell case.  P9: FR2 SCell activation delay reduction is not the goal of this WI. But open to discuss. |
| MediaTek | Support proposal 1, 2 (first bullet: cell searcher assumption), 6.  We are open to discuss proposal 3, 4, 5  Disagree with proposal 7, 8 and 9.  For proposal 4 and 5, technically, we are fine with proposal. But, how to receive the signals is up to UE implementation. So, we would like to further discuss how to make sure the understanding between UE and NW is consistence.  For proposal 7 and 8, we suggest to consider inter cell operation after the intra cell is concluded.  For proposal 9, according to WID, single CC is considered. So the SCell activation is out of scope. |
| vivo | **Issue 1-1-1: General principles**  P1: We agree these aspects should be taken into account when specifying requirements in principle. Since constraints are not specifically indicated, it would be better to identify firstly what the constraints of RF and BB would be.  P2:  The searcher assumption should not be changed for m-TRP use cases, so we agree with first sub-buttle.  For the TAG assumption, we agree it should be based on one TAG. 2 TAGs are to be supported in Rel-18.  We agree there is no TRP specific RLM, so no corresponding requirements should be specified. We are not sure if there is clear definition of non-anchor TRP and auxiliary TRP.  P3: It needs RF input on the activation delay from a single antenna panel to multi-antenna panels. We are open to consider if RRM requirements should be specified if there is conclusion from RF session.  P4: It needs clarification that when single antenna panel is used, it is for reception of one QCL-type D RS or two different QCL-type D RSs.  P5: Can be discussed together with P4. It also needs RF input.  P6: In our understanding, RRM session can only provide input to testability WI if there are specific questions being asked. It means testability WI should ask for input from multi-Rx chain WI.  P7: We support P7.  P8: Similar to P7 in our understanding.  P9: We prefer to discuss all multi-Rx chain related aspects, including FR2 SCell activation delay reduction, in this WI. |
| Apple | First, our view is this WI is to specify requirements for mTRP/multi-panel features supported in up to R17. Any R18 features being worked out in other WGs are out of scope.  P1: Support.  P2: On RLM, if TRP-specific RLM is not supported yet, it should not be considered in this WI.  P3: This can be further discussed, especially on the duration of the delay and how to consider it. May require RF input.  P4: Further clarification is needed, and we agree power consumption/saving should be considered.  P5: Wait for RF discussion on this.  P6: Support.  P7: Further clarification is needed.  P8: This can be discussed later.  P9: This can be discussed later. |
| Samsung | P1: In general, P1 is okay to us, but it should be emphasized that this R18 WI is intended for a UE type which is not yet available in the market, so we expect the UE implementation advance should be expected beyond current UE design. FFS details of the implementation constraints.  P2: 2 cell searchers seems a good starting point to be assumed. If this R18 RAN4 WI is limited to RAN1 features till R17, one TAG is straightforward, but it is better to align the common understanding here. Need further study on the assumption for RLM.  P3: In existing RAN4 requirement, switching delay among panels can be much smaller than and handled by CP length. Need more clarification on the intention of P3.  P4: Power saving can be considered, but the major target of this work item is to enable reception from multi-panel.  P5: As proponent of P5, we of course support P5. The key messenger behind P5 is to emphasize the using one panel to achieve two independent signals from the same or nearly the same direction is not the scope of this work item.  P6: As proponent of P6, we of course support P6. This is the general principle, and detailed input to testability can be discussed after the core requirement is stable.  P7: Agree. Inter-cell BM introduced in R17 FeMIMO should be considered also.  P8: Agree.  P9: It is okay to further study this. |
| CMCC | P8: Support  P9: according to the WID “Introduce necessary requirement(s) for enhanced FR2 UEs with simultaneous DL reception with two different QCL TypeD RSs on single component carrier with up to 4 layer DL MIMO”, it seems CA is not in the scope. But we are open to consider the conclusion of multi-Rx chain DL reception to the FR2 SCell activation delay reduction in NR\_RRM\_enh3 WI if necessary. |
| Xiaomi | **Issue 1-1-1: General principles**  P1: Support  P2: Agree with the 2 searcher part. For 1 TAG, currently RAN1 has agreed with different TAs for one TAG it is better to clarify that it only apple till Rel-17 features. For the RLM, we see that it is not included in Rel-17 FeMIMO WID and hence it is not included here with the assumption that only features till Rel-17 to be considered.  P3: Might need RF feedback.  P4: The power saving issue of activating two panels should be discussed in RAN1.  P6: Support.  P7: Support.  P8: Support as proponent.  P9: Support. |

**Issue 1-1-2: General considerations on defining requirements**

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| **Company** | **Comments** |
| Ericsson | We agree with P1: RRM requirement discussion shall be focused on the case with different QCL TypeD RSs on a single component carrier, by excluding downlink CA operation.  For P2: In inter-cell BM scenario, when SMTC and SC or NSC SSB are overlapped, we think UE can measure them using orthogonal beams if the SSB for L3 and SSB for L1 are transmitted from different TRP and their beams are not overlapping in spatial coverage.  We do not agree with P2a completely. It may be true if L3 and L1 beams spatial coverage overlaps. If it is non overlapping, we do not see any issue for measuring L3 and L1 using different antenna panels. In legacy requirements, we understand that L3 and L1 not measuring simultaneously is a RX beam issue and not a BB processing capability restriction.  P3: We are ok with P3  P4: We do not agree with P4 as power saving aspect is not part of this WID.  P5: We support P5. What we mean is at least legacy RRM requirement apply  We support P6, P7, P8, P9, P10. (These are our proposals and details can be discussed further.) |
| LGE | P1: support P1.  P2/P2a: further discussions are needed.  P3: support P3.  P4: support P4. UE power saving in FR2-2, especially activation of two antenna panels, is important.  P5: support P5, but RAN4 needs to further discuss.  P6: support P6.  P7: generally fine with P7, but not sure that the aim is only to reduce the measurement delay. |
| NTT DOCOMO, INC. | P1: Agree.  P2: Agree.  P2a: Basically agree unless there are benefits to operate L1 measurement and L3 measurement simultaneously.  P3: Agree.  P4: We need more clarification of the discussion point of power saving.  P5 to 10: Agree. |
| Qualcomm | P1: Agree.  P2: Do not support. We do not support the idea of extending multi-beam based measurement beyond group-based L1 measurement for mTRP selection and CSI report for one CW for the selected mTRPs.  P2a: Agree.  P3: Okay with the first part (s-DCI), and do not support m-DCI based mTRP. m-DCI really means separate two PDSCH which can be TDM-ed or FDM-ed, i.e. not real 4-layer MIMO.  P4: Not clear what “additional requirements” really means in “Power saving can be additional requirements”  P5: Do not yet support. Too much high-level. Better to discuss it one-by-one.  P7: Do not yet support.  P8: Support.  P9: Do not support “non-serving cell”. A bit unclear if “PCell/PSCell/SCell” contradicts P1.  P10: Not clear to us. |
| Nokia | Proposal 1 – fine, we think the WID includes single component carrier.  Proposal 2 – Agree with eh proposal  Proposal 2a – No need to limit simultaneous L1 and L3 for now  Proposal 3 – Fine with the proposal  Proposal 4 – This is also linked to proposals 3 and 4 from Issue 1-1-1. We believe the UE could switch between single panel and multi panel.  Proposal 5 – We agree with the proposal as a basic principle  Proposal 6 – The WID is indeed for FR2-1 only. It might be too early to define the specific text but we can come up with applicability once CR drafting starts.  Proposal 7 – Agree with the proposal. It is a good point that was raised by the proponents that measurement delays to be reduced while maintaining the accuracy.  Proposal 8 – We are ok with eh proposal.  Proposal 9 and Proposal 10 - not clear, can the proponent clarify? |
| Huawei | P1: agree.  P2: not agree. RAN4 study the enhancement for simultaneous DL receptions with different fine beams. Rough beam is assumed for L3 measurements. We suggest no enhancement on L3 measurements.  P2a: agree  P4: we can agree to study the power consumption issues due to multi-Rx. But it cannot be concluded that additional requirements are needed.  P5: it is too early to achieve the conclusion.  P6: FR2-1 can be used as starting point. FFS FR2-2  P7: we can agree to maintain the existing accuracy requirements, but whether to reduce measurement delay requirements need FFS.  P8: we suggest to focus on QCL-typeD firstly.  P9/P10: not clear to us. |
| ZTE | P1: Agree.  P2: Agree.  P2a: Do not agree. Why not simultaneous reception can be applicable to L3 measurements and L1 measurements? In our opinion, simultaneous reception can be applicable to any combination between L1 measurements, PDCCH/PDSCH reception and L3 measurements received from two panels under m-TRP scenario.  P3: Agree.  P4: Do not agree. As we analysized in Issue 1-1-1, power saving should not be the stumbling block of latency reduction. Further more, power saving is not included in the scope of WI.  P5 - P10: Agree. |
| OPPO | P1: Agree.  P2: not prefer.  P2a: Agree.  P4: need more discussion  P5: Do not yet support. Too much high-level. Better to discuss it one-by-one.  P7: need more discussion  P8: focus on QCL-typeD firstly.  P9: Depending on the assumption of intra-cell or inter-cell mTRP.  P10: Not clear . |
| MediaTek | Support proposal 1, 2a, 5, 6, 7, 8, 10  Disagree with proposal 2, 9.  More discussion is needed: proposal 3, 4, 8.  For proposal 2, from measurement schedule perspective, it would be very complicated to control L1 and L3 measurement on different UE Rx panels at a time.  For proposal 3, unclear the intention why we need to differentiate the requirement based on s-DCI and m-DCI based mTRP. Could proponent explain more? Thanks.  For proposal 4, technically, we are fine with proposal. But, we are not sure what is the concrete spec change.  For proposal 9, according to WID, single CC is consider. So, it is out of scope. Besides, we suggest to consider intra-cell case first and further discuss inter-cell when intra-cell is concluded. |
| Vivo | P1: In general, we agree the WI is focusing on single carrier. However, Single carrier may need further clarification, e.g., if UE is only configured with single carrier, or UE is configured with multiple carriers but multi-Rx chain is enabled on only one of the carriers. In addition, when enhancing measurement restrictions/scheduling restrictions requirements, it would be beneficial to also consider multi-carrier case.  P2: We prefer to focus on simultaneous reception of different QCL type D sources with same beam assumption, i.e., either L1 measurements or L3 measurements, in the first phase. Mixed reception may be studied depending on progress and necessity based on justification.  P2a: This issue is better to be discussed under mobility enhancement WI. We understand there could be similar discussions.  P3: Not clear how it will have different impact to RRM requirements for s-DCI and m-DCI multi-TRP operation.  P4: Not clear what requirements need to be considered as there is no power saving requirements. Does it mean relaxed measurements if certain conditions are met?  P5: In principle it may be fine. However, it depends on what requirements we are actually discussing.  P6: Clarification is fine. How to capture the clarification can be discussed later.  P7: Support  P8: It can be further discussed.  P9: Support  P10: The proposal is not clear to us. |
| Apple | P1: Support.  P2: Do not support, especially before we fully understand the implications on UE.  P2a: Support.  P3: Can be further discussed.  P4: Further clarification is needed on “power saving can be requirement”.  P5: Our understanding is legacy requirements continue to apply, and the applicability of new enhanced requirements will be discussed and decided later.  P6: can be discussed with P5 further.  P7: further discussion is needed, may also depend on RF discussion.  P8: Support.  P9: Not sure why non-serving cells are being considered.  P10: what is different from legacy requirement? |
| Samsung | P1: As proponent of P1, we support P1 which is aligned with WID.  P2: P2 seems okay to us. “With different beam assumption”, currently we still can’t confirm the consequence of having any beam assumption for different panel, need more discussion.  P2a: If that is proposed as an assumption to derive RAN4 requirement, we are okay with that.  P3: Further study this is okay.  P4: Not quite sure how RRM requirement can guarantee power saving? We don’t have metrics related to power saving.  P5: Support.  P6: Based on WID, FR2-1 is of interest. Agree with other companies’ comment, how to capture this is still too early to be discussed.  P7: Support.  P8: Support. Both A+D and C+D should be considered.  P9: I think here non-serving cell means inter-cell BM operation. We support to discuss this in the scope.  P10: Support. |
| CMCC | P1: Support, allign with the WID  P2: OK  P2a: We would like to know why L3 measurements and L1 measurements cannot be performed simultaneously? In our view, with simultaneous DL reception from different directions, it is feasible.  P7: OK  P9: according to the WID, single CC is considered |
| Xiaomi | P1: Support.  P2: Do not support the different beam assumption part.  P2a: Support.  P3: OK to further study.  P4: Not sure how RRM requirement can be related to power saving.  P5: Ok with the proposal.  P6: Agree only focus on FR2-1 in this WID. How to capture the requirement might need to be discussed further together with the detail requirement,  P7: Support.  P9: The inter-cell BM left-overs can be discussed in this WID. |

**Issue 1-1-3: Feasibility/necessity of enhancing requirements for L1 measurements**

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| **Company** | **Comments** |
| Ericsson | Support option 1, if this does not preclude L3. |
| LGE | Support option 1. |
| NTT DOCOMO, INC. | Support option 1. |
| Qualcomm | For Option 1, we are open to further discussion except for RLM.  Support Option 2 |
| Nokia | We agree with Option 1.  We think the multi Rx feature as providing benefits that will improve network efficiency by means of reduction of measurement delays and scheduling restrictions. |
| Huawei | We are open to discuss whether to have enhancement on the L1 measurements in option 1. Currently, the necessity to enhance RLM measurements is not clear to us. |
| ZTE | Support Option 1. |
| OPPO | Fine with Option 1 except RLM which needs more discussion. |
| MediaTek | Support option 1.  To our understanding, even though we do not have TRP specific RLM requirement, but we still can discuss the requirement for intra-cell mTRP RLM. |
| vivo | Support option 1.  For RLM, we agree no TRP specific requirements are to be specified. However, measurement restriction/scheduling restriction requirements enhancement for UE supporting multi-Rx chain are also beneifical. |
| Apple | It is a bit early to agree on Option 1, while some requirements would need more discussions pending the consideration of UE constraints. |
| Samsung | Agree with Option 1, and we are okay to FFS RLM. |
| CMCC | Support option 1. |
| Xiaomi | Support Option 1. |

**Issue 1-1-4: Feasibility/necessity of enhancing requirements for L3 measurements**

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| **Company** | **Comments** |
| Ericsson | In favor of option 1, with the following considerations:  We think when L1 RX beam and L3 RX beam are non-overlapping in spatial direction, L3 and L1 can be measured at the same time. For the above said cases, enhancement can be considered.  Furthermore, RAN4 needs to also discuss whether the enhanced requirements apply only when the QCL information is available, and the two TCIs are activated and can be used. |
| LGE | We are fine to study L3 measurement in connected mode, but not clear for other requirements in option 1. |
| NTT DOCOMO, INC. | Support option 1. |
| Qualcomm | Oppose Option 1.  Support Option 2 and 2a.  Again, the ultimate goal of the WI is to enhance UE DL T-put in RRC Connected mode when 2 layers from one TRP can be spatially separated from the other 2 layers from the other TRP in a high SNR regime. Beyond this scope, everything is to us a far stretched goal. |
| Nokia | We support option 1.  Multi Rx can provide gains for the RRM procedures listed in Option 1. |
| Huawei | Support option 2 and 2a.  UE performs L3 measurements mainly for detecting neighbor cells for mobility purpose. The enhancement of multi-Rx is mainly to improve the connection between UE and the serving cell. |
| ZTE | Support Option 1. |
| OPPO | Open to discuss. But L3 enhancement can be discussed after finalizing L1 enhancement. |
| MediaTek | Support option 2a.  To our understanding, there is no much gain if UE measures the SSB from neighboring frequently due to multi-panels. Fast L3 measurements are typically needed only when UE is moving faster. However, we do not see any difference in terms of UE mobility between UE with single activated panel and UE with multiple activated panels. |
| vivo | We are open to enhance L3 measurement requirements. However, if it is supported, a new UE capability should be introduced for L3 measurement delay reduction for UE supporting multi-Rx chain simultaneous reception. |
| Apple | As raised in this meeting and in previous RAN meeting, the need of enhancing L3 measurement requirements should be identified first. We are open to further discussion. |
| Samsung | Open to discuss on L3 measurement enhancement. |
| CMCC | OK with option 1. |
| Xiaomi | OK with option 1. As stated in the WID, the L3 enhancement can be further discussed based on the L1 enhancement result. |

**Issue 1-1-5: Receive time difference**

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| **Company** | **Comments** |
| Ericsson | If Rel-17 UE is taken as baseline, within CP is fine.  For other UE capability, we are fine to consider more than CP. |
| LGE | We think this WI is based on Rel-16/17 RAN1/RAN2 features. So, based on RAN2 specification of the condition for simultaneous reception with different QCL type D, we support option 2. |
| NTT DOCOMO, INC. | First we should discuss the assumption of the number of FFT blocks for multi-Rx chain UE, then define the MRTD requirement for multi-Rx chain UE. |
| Qualcomm | We are not sure even within-CP is okay if we take UL into consideration. To our understanding, the major target scenario of the WI is for a UE capable of receiving one PDSCH with one CW from two geographically separated TRPs while transmitting UL one specific TRP at a time. As the UE will apply one TA to UL transmission whichever TRP is scheduled for the transmission. Therefore, the max Rx time different here is not just about whether UE can deal with the Rx time different or not. The impact on UL should also have to be taken into consideration. |
| Nokia | We support Option 1c, Option 4  For multi TRP operation, it is very hard to keep within the CP length of 120 kHz SCS. That will limit significantly the deployment options, as the distance between TRPs will be extremely small.  Option 1d-a has a good point of using MRTD for inter-band CA as a baseline  Option 4 is also agreeable in our view, since it would not limit the deployment scenario. |
| Huawei | The receiving timing difference between different directions shall take CP as starting point. |
| ZTE | Whether independent RF and BB processing can be assumed, which should be identified firstly. |
| OPPO | We can start with option 1. |
| MediaTek | Support option 2.  The power consumption, timing estimation/compensation/tracking modules will be double if the timing difference between two panels is larger than one CP. |
| vivo | At least, RTD within CP should be supported. We are open to discuss the scenario with RTD larger than CP. Option 1/1b is fine. |
| Apple | We support Option 2 considering the impact on UE complexity. We are also open to consider UL impact. |
| Samsung | In Rel-16 eMIMO, RAN1 has the assumption that the timing difference should be within CP length. However, whether or not this should be included as MRTD requirement for this R18 UE is different story. Depends on UE RF architecture conclusion firstly. |
| CMCC | Similar view as ZTE, can be FFS. |
| Xiaomi | Support option 1. |

**Issue 1-1-6: UE capabilities**

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| **Company** | **Comments** |
| Ericsson | P1: discussion is needed.  P2e: agree.  P5: no need for a separate capability for enhanced L3 measurements, they should be covered by the same capability as L1. |
| LGE | P1: further discussion is needed  P2c/P5: fine with P2c reusing existing UE capability.  P2a/P2d: existing UE capability for simultaneous reception of different QCL type D can be reused for P2a and P2d.  P3: is it RRM issue? |
| NTT DOCOMO, INC. | In general, we first should specify the requirements, and then summarize whether existing UE capability can cover these requirements or not and send LS to RAN2 with RAN4 understanding. |
| Qualcomm | Do not support “L3” and “non-serving cell”  P3: If the Rx power at one panel is much different from that on the other panel, anyway it would be hard to expect a 4-layer MIMO.  P4: PDCCH should be from only one specific TRP (so called anchor TRP) |
| Nokia | Proposal 1 – ok  Proposal 2a – we are ok to clarify it  Proposal 2b – We don’t need new capability for FR2  Proposal 2c – Better to postpone discussion  Proposal 2d – We agree with the proposal  Proposal 2e – Agree  Proposal 2f – Agree with the proposal  Proposal 3 – Agree with the proposal  Proposal 4 - agree with the proposal  Proposal 5 – Depends on the outcome of discussions on architecture and L1/L3. |
| Huawei | P1: we suggest not to consider simultaneous reception of L3 measurements.  P2a-P2e: FFS.  P3: this issue seems need to be discussed in RF session.  P4: we suggest to focus on RRM impacts. The conditions that UE is not assumed to perform RRM and PDCCH/PDSCH simultaneous shall be studied for scheduling restriction requirements. |
| ZTE | General agree with P1 and P4.  Not agree with P2c since the legacy R16 capability *simultaneousReceptionDiffTypeD-r16* only indicate simultaneous reception of RS, not referring to PDCCH/PDSCH. |
| OPPO | P1: open to discuss  P2c: too early  P2f/P5: open to discuss.  P4: we suggest to focus on RRM impacts. |
| MediaTek | Support proposal 2e, 2f, 3  More discussion is needed : proposal 3, 4  Disagree with proposal 1, 2d, 5  For proposal 1, from measurement scheduling perspective, it would be very complicated if UE needs to control L1/L3 measurement on the different panels at a time.  For proposal 2a, 2c, 2f, to make the UE capability clearer, slightly prefer to introduce a new capability in R18.  For proposal 2b, more time is needed for whether the signaling can be applied across different panels.  For proposal 2d, suggest to discuss intra-cell scenario first. And further discuss inter-cell when intra-cell is concluded.  For proposal 3, RAN4 can further check whether there is any limitation of Rx signal level difference between two received signals.  For proposal 4, to our understanding, for “PDCCH/PDSCH simultaneous RX”, “PDSCH simultaneous RX” and “PDCCH simultaneous monitoring for multi-DCI dual-TCI”, they should be discussed in demod session.  For proposal 5, suggest not to enhance L3 measurement in R18 multi-panel. (please refer to our comment in Issue 1-1-4) |
| vivo | P1: For simultaneous reception of L1 RS and data, it should be fine. For simultaneous reception of L3 RS and data, it needs further discussion.  P2a: It is not clear what UE can perform SSB based measurement means.  P2b: FFS  P2c: Before reusing the existing UE capability, it would be better to algin understanding in RAN4 on the existing UE capability.  P2d: It is complicated to mix everything together. Whether UE is capable of receiving data and SSB simultaneously or different RSs from different direction simultaneously may needs separated discussion.  P2e: We support.  P2f: Support.  P3: Support.  P4: Purely data reception related capabilities should be discussed in demodulation session. In RRM session, we should focus on simultaneous reception of RSs or RS and data.  P5: Support. It is clarified that if L3 measurement enhancement is supported, then a new UE capability is needed. |
| Apple | It is likely one or more UE capabilities are needed in addition to the R16 capability *simultaneousReceptionDiffTypeD.* We perhaps should see what the requirements look like before reaching an agreement. |
| Samsung | P2c is our proposal.  Considering other restriction P2f is also a good proposal to be further discussed. |
| Xiaomi | P2b: Support as proponent.  P2c: Need further discussion to figure whether different capability is indicated in different release.  P2d: Support as proponent.  P2e: Seems straight forward.  P2f: Support.  P3: Seems like the power imbalance discussing in RF part.  P5: Need further study. |

**Issue 1-1-7: UE architectures**

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| **Company** | **Comments** |
| Ericsson | As a principle, we should not restrict to any specific implementation as long as UE can meet the feature requirements. |
| Qualcomm | More investigation is needed. |
| Nokia | We brought this topic for discussion, and we believe that Multi Rx UE should include independent AGC + front-end (time and frequency sync) + Demod/RRM. |
| Huawei | We can agree with P1 generally, but RF inputs are needed. |
| OPPO | We can start with P1 but RF inputs are needed. |
| MediaTek | We would like to hear other companies’ view on this issue. At the same time, we prefer to allow different UE implementation for requirement. |
| vivo | FFS. Not clear what RRM impact would be different for the different implementations. RF input may also be needed. |
| Apple | RF session is looking at this issue and we don’t need to duplicate the effort. |
| Samsung | To support 4-layer, Multiple Antenna panel + AGC + front-end + Demod/RRM seems of necessity. |

**Issue 1-1-8: Beam management**

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| **Company** | **Comments** |
| Ericsson | P1: there are some specifics for Rel-18, just purely reusing the CA concept may not be sufficient |
| NTT DOCOMO, INC. | We think that IBM concept can be the starting point for this discussion but we need discussion whether it can be reused or not case by case. |
| Qualcomm | P1: Option-(ii) is not really clear to us |
| Nokia | We agree with P1 (Option 1) and P2  The intention is similar in both proposals.  We want to discuss how we manage the multi-panel beam.  We think that it is optimal to assume independent beam management |
| Huawei | The capability of IBM cannot be directly reused since some RF/BB implementation may be different for simultaneous multi-panel reception. |
| ZTE | Similar view as NTT DOCOMO, IBM concept can be a starting point of discussion. |
| OPPO | Share the similar view as Huawei that IBM can not be reused directly. The different implementation should be first discussed in RF session. |
| MediaTek | We are open discuss for proposal 1 and 2.  For proposal 1, according to WID, to our understanding, no new procedure/reporting will be introduced. But, we are open to discuss.  For proposal 2, it would be helpful the real field measurement results can be provided in meeting to discuss. |
| vivo | P1: FFS UE capabilities for beam management. Option-(ii) needs RAN1 involvement.  P2: Support to study. |
| Apple | Can proponents of this proposal clarify the purpose? |
| Samsung | IBM can’t be reused directly. As mentioned in our paper, it is not possible if 2AoA come from the similar direction, while that is not a restriction for inter-band CA IBM BM. |
| Xiaomi | Different beam management can be started as baseline but not to use the IBM since it is specifically defined for CA. |

**Issue 1-1-9: Dependency to RF conclusions**

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| **Company** | **Comments** |
| Ericsson | The discussions for RRM and RF should go in parallel. In the end the UE will have to meet both RF and RRM requirements. |
| LGE | RRM session can follows conclusion of RF session for the condition of receiving two different QCL type D signals with two panels, but RRM session should discuss the impact of UE behavior depending on the condition. |
| NTT DOCOMO, INC. | Basically all proposals are fine. We need to check the RF discussion and conclusion in parallel. |
| Qualcomm | In principle, we agree that the overall transceiver architecture needs to be first studied in RF. In case any conflict between sessions (RF and RRM) RRM should not proceed with work based on kind of RRM-only assumptions. |
| Nokia | We agree RF and RRM is discussing in parallel.  However, we believe that we need to keep discussing and decide on AoA constraints.  Our preference is that small AoA and large AoA are supported for good flexibility in the deployment. |
| Huawei | Generally we can agree with the principles. |
| ZTE | The basic architecture should be firstly identified in RF. |
| OPPO | Generally fine with P1/P2/P4 |
| MediaTek | Four options are similar.  Slightly prefer option 3. We suggest RAN4 can discuss the requirement first can further revisit if there is any update from RF session. To our understanding, the main key point here is how network and UE can have the same understanding on how many UE Rx panel is used. |
| vivo | We agree RF input on AoA is needed to decide applicability of RRM requirements. On the other hand, RRM discussions can be going under the assumption that corresponding requirements apply to suitable AoA configurations. |
| Apple | In general, all the proposals are quite similar and can be further discussed. |
| Samsung | Similar proposals.  The intention here is: It should be UE RF session’s scope to discuss the impact of close AoAs, and what should be applicable condition for dual AoA spherical coverage requirements. For the relevant RRM requirement, UE should follow the applicable condition of simultaneous DL reception to be defined in UE RF session. |

#### Sub-topic 1-2: L1 measurements related

**Issue 1-2-1: Scenarios for L1 measurement requirements enhancements**

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| **Company** | **Comments** |
| Ericsson | We do not agree with P1. Rel-17 mTRP should be baseline. |
| LGE | We think the RRM requirements should be discussed based on both intra-cell mTRP and inter-cell mTRP. |
| NTT DOCOMO, INC. | We understood that P1 proposes about intra-cell case specified in Rel-16 and P2 proposes about inter-cell case specified in Rel-17. If so, we are fine. |
| Qualcomm | Support Intra-cell mTRP based 4-layer MIMO. |
| ZTE | From the scope of WID, both intra-cell mTRP and inter-cell mTRP are not excluded. |
| OPPO | OK to start with P1. |
| MediaTek | Support proposal 1 and disagree with proposal 2.  This is the first time to discuss the requirement for multiple panel UE. So, we suggest RAN4 to define the requirement for intra cell first as a start point. |
| vivo | Both intra-cell m-TRP operation scenario and inter-cell m-TRP operation should be supported. The discussion can be going in parallel. |
| Apple | It is reasonable to start with P1. |
| Samsung | Both intra-cell and inter-cell mTRP should be considered. Focus on P1 firstly is okay to us. |
| Nokia | We agree with Ericsson comment that Rel 17 mTRP should be baseline.  But there is no need to wait for final conclusions, since there are agreements in place which can be used as a baseline. |
| Xiaomi | Ok to P1 and P2. |

**Issue 1-2-2: General part for L1 measurement requirements enhancements**

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| **Company** | **Comments** |
| Ericsson | Agree with P1, P2, P3b, P4.  Clarification question on P3a: Does this mean data+L1 measurement is not supported?  P5: partly agree, since we think that the cell with different PCI should be covered in the discussion. Can accept “The study for L1-RSRP/RLM/BFD/CBD measurements for Reporting under CCA, for RedCap, for satellite access~~, and for a cell with different PCI from serving cell~~ should be discussed later based on the normal case agreements.”. |
| LGE | P1: generally fine with P1, but we need to further discuss whether to apply no measurement and scheduling restriction when both different QCL-Type D RSs are received by two different UE Rx panels.  P2/P3a/P3b: fine with the proposals, and need to discuss related capability issue.  P4: can reduce L1 measurement delay, but not sure how to reduce measured RS sample.  P5: we prefer to focus on normal case not joint other features. |
| NTT DOCOMO, INC. | Agree with P1 to P4. About P5 (our proposal), we are fine with Ericsson’s modification. |
| Qualcomm | P1-P4: open to further discussions based on more specific examples.  P5: Completely out of scope |
| Huawei | P1: FFS. For example, for TRP specific BFR, there is no need to perform BFD measurements on two RS in the same BFD set.  P2/P3a: we can agree it.  P3b: it is related to P2.  P4: we suggest to focus on the enhancement for multiple RS case.  P5: we suggest not to involve other features firstly. We start to investigate the RRM impacts based on simple case. |
| ZTE | Agree with P1-P3b.  For P4, not sure how to reduce the measurement sample.  For P5, fine with Ericsson’s revision. |
| OPPO | P1-P4: open to further discuss.  P5: too early |
| MediaTek | Support proposal 5.  Open to discuss proposal 1, 2, 3a and 3b.  More discussion is needed: proposal 4  For proposal 1 and 2, we would like to hear other companies’ voice on these proposals. To our understanding, whether UE uses the same panel to receive the signals is transparent to network and it is up to UE implementation. We suppose it should be up to UE to receive the signals by one panel or two panels. In other words, whether UE is required to receive two signals at a time is up to UE.  For proposal 3a and 3b, in general, we are fine with proposal but whether the two signals are received by the same Rx panel or different Rx panel should be clarified first.  For proposal 4, one question for clarification, the scenario here is one QCL-type D or two QCL-Type D RSs? If one, it should be deprioritized according to WID “The case of single TCI is handled as a second priority. Additional aspects related to single TCI can be further revisited.”.  For proposal 5, suggest to deprioritize the joint requirement between R18 multi-panels and other R17/R18 requirement. |
| vivo | P1: Agree in principle. Can be discussed for different measurements case-by-case.  P2: Agree.  P3a: Agree.  P3b: Agree.  P4: No clear about the impact to accuracy by reducing measurement samples.  P5: Support to study the cases as revised P5 by Ericsson. If the scope is too large, it may be considered as further enhancement in next release. |
| Samsung | P1: If the two RSs with different QCL Type-D have the AoA directions close to each other, interference could exist.  P2 is agreeable to us. |
| CMCC | P1/3a/3b: ok |
| Nokia | Proposal 1 :support.  Proposal 2 : If it is about legacy UEs, it is fine.  Proposal 3a and 3b: We agree with the proposals.  Proposal 4: Agree with the proposal  Proposal 5: This needs more discussion. Additionally, RedCap focus is on low cost like 1Rx UE, which is in the opposite direction to what is discussed in this WID. |
| Xiaomi | P1: We support not to prevent the implementation that some overlap of the two panels might happen.  P2: We support not to prevent the UE using one panel for two RX, i.e. partial beamforming.  P3a,b: Support  P4: Agree. |

**Issue 1-2-3: L1-RSRP measurement requirements enhancement**

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| **Company** | **Comments** |
| Ericsson | P1: confusing formulation. N is not the number of physical samples but scaling due to beam sweeping in FR2. We think scaling factor N should be considered.  Details may be way early to be discussed. We can agree to look at requirement enhancement. That means study number of TRP UE can measure, and the sharing factor, etc. |
| LGE | P1/P2: need further discussion  P3: we think the measurement delay for SSB based L1-RSRP can be reduced  P4: support P4, and detailed discussions are needed with other issues. |
| NTT DOCOMO, INC. | P1: Basically we are fine, but we should discuss not only *Psharing factor* but also entire scaring factor P.  P2: Agree.  P4 and 5: Agree. |
| Qualcomm | P1-P3: Open to further discussions  P4 and P5: Do not support |
| Huawei | P1: we are open for 3rd bullet and not agree 1st and 2nd bullets. For 4th bullet, scheduling restrictions only apply to data reception/transmission due to L1/L3 measurements.  P2-P5: we are open to further discuss. |
| ZTE | P1: Same view as Ericsson.  Agree with P2, P4, P5. |
| OPPO | P1/P2: open to discuss all aspects. |
| MediaTek | Agree with proposal 1 for measurement restriction and scheduling restriction.  Disagree with proposal 2, 4 and 5.  More discussion is needed: proposal 3.  For N factor, we are open to discuss.  For P factor, we do not think it can be enhanced if L1/L3 measurement cannot be performed at a time.  For proposal 2, 4 and 5, we suggest to discuss one cell in one carrier as a start point. And further discuss inter-cell BM after one cell is concluded.  For proposal 3, could proponent explain more? |
| vivo | P1: Agree.  P2: Agree in general. Whether UE is able to perform L1-RSRP measurement based on same or different type of RS from different TRPs is depending on UE capability discussion.  P3: FFS.  P4: Support  P5: Support to further discuss |
| Samsung | P3 needs FFS. Reduced measurement period should still possible for SSB-based L1-RSRP measurement. |
| CMCC | P1: in our view, N is RX beam sweeping factor, which can be enhanced. We agree the sharing factor Psharing factor for both SSB based measurement and CSI-RS based measurement can be enhanced. We are open with 3rd and 4th bullet. |
| Nokia | P1 –agree with the proposal in general. Reduction on beam sweeping factor should be added.  P2 – Needs further discussion  P3 – Do no agree.  P4 – agree with proposal  P5 – too early for discussion on the max number of cells. FFS since the configurable number of cells and the number for requirements may not be same. |
| Xiaomi | Support P1, P2, and P4.  Agree that the N should be beam sweeping scaling factor but not the sample number. |

**Issue 1-2-4: L1-SINR measurement requirements enhancement**

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| **Company** | **Comments** |
| Ericsson | P1: same comment as for 1-2-3 |
| NTT DOCOMO, INC. | Same view as P1 of issue 1-2-3. |
| Qualcomm | P1: Open to further discussion. |
| Huawei | Same comments as P1 of issue 1-2-3. |
| ZTE | Same comments as for P1 in Issue 1-2-3. |
| OPPO | P1: Open to further discussion. |
| MediaTek | For N factor, we are open to discuss.  But, for P factor, we do not think it can be enhanced if L1/L3 measurement cannot be performed at a time. |
| vivo | P1: FFS  It is noted that L1-SINR is not included in the scope of the WI. But we are open to discuss if it is necessary to enhance. |
| Samsung | N can be considered as enhancement target, while need FFS on P\_sharing factor. |
| CMCC | Same comments as P1 for Issue 1-2-3. |
| Nokia | Same view as P1 of issue 1-2-3. |
| Xiaomi | P1 and same comment on N of issue 1-2-3. |

**Issue 1-2-5: BFD/CBD measurement requirements enhancement**

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| **Company** | **Comments** |
| Ericsson | P1: Same comment as for 1-2-3 (we are ok to enhance N, but it’s scaling factor and it’s not the number of physical samples).  P4: Ok |
| LGE | For BFD/CBD, generally we are fine with the proposals and need to discuss the scope such as intra-cell mTRP and inter-cell mTRP. |
| NTT DOCOMO, INC. | P1: Same view as P1 of issue 1-2-3.  P2 to P4: Agree. |
| Qualcomm | P1-P4: Open to further discussion. In general, negative to the idea of enhancing measurement requirements without a very specific context. |
| Huawei | P1: same comments as P1 of issue 1-2-3.  P2/P3: agree  P4: RAN4 need to study whether and how to enhance. |
| ZTE | P1: Same view as P1 of Issue 1-2-3.  Agree with P2-P4. |
| OPPO | P1-P4: Open to further discussion |
| MediaTek | For proposal 1,   * For N factor, we are open to discuss. * for P factor, we do not think it can be enhanced if L1/L3 measurement cannot be performed at a time.   For proposal 2,3 and 4 are similar, we are open to discuss proposal 3. |
| vivo | P1: Agree  P2: FFS  P3: OK to study  P4: Support |
| Samsung | BFD/CBD can be enhanced, so in general P1-4 can be further discussed. |
| CMCC | Same comments as P1 for Issue 1-2-3. |
| Nokia | P1 – Same view as P1 of issue 1-2-3.  P2 - agree  P3 - agree  P4 - agree |
| Xiaomi | Support p1-p4. |

**Issue 1-2-6: RLM measurement requirements enhancement**

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| **Company** | **Comments** |
| Ericsson | Fine for further study.  P1: Same comment as for 1-2-3 (we are ok to enhance N, but it’s scaling factor and it’s not the number of physical samples). |
| NTT DOCOMO, INC. | Same view as P1 of issue 1-2-3. |
| Qualcomm | P1-P4: Open to further discussion. In general, negative to the idea of enhancing measurement requirements without a very specific context. |
| Huawei | Same comments as P1 of issue 1-2-3. |
| ZTE | Fine with P1.  For the 1st bullet, same view as P1 of Issue 1-2-3. |
| OPPO | P1-P4: Open to further discussion |
| MediaTek | More discussion is needed.  For proposal 1,   * For N factor, we are open to discuss. * For P factor, the proposal is unclear to us and it may depend on whether UE can perform L1 and L3 measurement at a time. |
| vivo | Fine to study all the aspects. |
| Samsung | Okay to study based on P1. |
| CMCC | Same comments as P1 for Issue 1-2-3. |
| Nokia | FFS |
| Xiaomi | Support P1. |

#### Sub-topic 1-3: TCI state switching

**Issue 1-3-1: General considerations for TCI related**

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| **Company** | **Comments** |
| Ericsson | P1: Ok to further study this option, without precluding other options, while keeping in mind that the enhanced requirements can only apply when both TCIs are activated during the entire measurement/evaluation period and actually used.   * Another option: consider the set of active TCI states used for simultaneous reception and discuss requirements for any change to that set, including adding, removing, or switching within this set.   P1a: agree, RAN4 to study if a UE with multiple RX chains tracks time and frequency per TCI when dual TCIs are activated per RX chain.  P2/P2a: do not agree. We think Rel-17 can be taken as baseline for P2 and p2a.  P3: Rel-17 supports single DCI and multi-DCI framework. We think all the scenarios supported in Rel-17 can be considered.  P4: FFS. We do not agree with P4 yet, may need further study.  P5: agree. |
| LGE | We are fine to further study based on the listed proposals. But for P4, for further clarification, is it different from existing TCI switching behavior (inside-panel TCI switching and cross panel TCI switching) ? |
| NTT DOCOMO, INC. | First we should define the scenario when multi-Rx chain is used. Each proposal should be discussed case by case. |
| Qualcomm | P1a: Okay  P3: Do not support m-DCI. The WI is not for the case of receiving two PDSCHs.  P4: Needs more input from RF session  P5: Please provide more specific examples. |
| Huawei | P1: Open to further discuss.  P1a: More details are needed about impact on TCI switching requirements.  P2/2a: unified TCI combined with mTRP is not considered in Rel-17, and it will be discussed in Rel-18 in RAN1.  P3: Open to further identify interested scenarios.  P4: More clarification is needed  P5: More clarification is needed. |
| ZTE | Between P2 and P2a, we prefer P2a.  For others, agree to discuss. |
| OPPO | P1a/P2a: Fine to discuss based on the assumptions.  P3: Prefer not to support m-DCI.  P4/P5: Needs more discussion |
| MediaTek | Agree with proposal 1a, 2.  Disagree with proposal 1, 2a  For proposal 3, 4 and 5, we are open to discuss.  For proposal 1, because it is first time to discuss multi-panels feature, we suggest to further study the timing tracking and frequency tracking issues.  For proposal 2a, we suggest the multi-panel requirement should start from basic requirement (R15) and further discuss the advanced joint requirement (e.g. R17 inter cell BM)  For proposal 3 and 5, could proponent explain more? |
| vivo | P1: Further study is needed.  P1a: Support to study this aspect.  P2/P2a: For R17 TCI framework, it may be discussed in MIMO evo WI or in this WI. Our preference is to treat all multi-Rx chain related discussion within this WI. R15/R16 TCI framework should be supported.  P3: First two cases are not clear. Open to discuss.  P4: Needs clarification.  P5: Clarification is needed. |
| Apple | We support P1a and would like to further discuss other proposals. |
| Samsung | P1a is a good starting point to be studied.  P2/P2a: we prefer P2a.  P3: all scenario can be considered.  P4: Currently, even TCI switching is performed from UE panel-1 to UE panel-2, or within one UE panel, the delay requirement don’t discriminate them. Why here?  P5: clarify more. |
| Nokia | P1, P1a we agree with the proposals  P2/P2a, why is Rel15/16 proposed as baseline? Needs further evaluation  P3 ok  P4 needs further consideration  P5 May need to review this point.  The number of active TCI state is reported as UE capability. When a UE reports the number of active TCI state=1, what does it mean for simultaneous RX? At least, it should be the number of active TCI state=2 for simultaneous RX? |
| Xiaomi | Agree with P1 and P1a that use Rel-17 as baseline.  Ok with P3. |

**Issue 1-3-2: Known/unknown conditions for TCI state switching for multi-Rx chain**

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| **Company** | **Comments** |
| Ericsson | These details can be ffs |
| NTT DOCOMO, INC. | The intention of P1 (our proposal), first we should define the scenario when multi-Rx chain is used. Each proposal should be discussed case by case. |
| Qualcomm | Open to further discussion. Would be interesting to see more concrete examples and proposals if proponents have any. |
| Huawei | For P1c, the known conditions shall guarantee that the target TCI pair is one that can be received simultaneously (maybe RF conclusion shall be considered). Otherwise, for “unknown” dual TCI switching, UE may not be able to receive simultaneously by the configured TCI pair, then the dual TCI switch requirements does not make sense. |
| ZTE | All of them can be discussed. |
| OPPO | Open to discuss |
| MediaTek | Support proposal 1.  For the known condition, we agree RAN4 should further to study it. It is possible that only one panel is activated to measure the source RS, and one L1-RSRP report is transmitted for one TCI state. After a while, two panels are activated. In that case, could we still regard the TCI state as a known TCI state?  In addition, we suggest to discuss the delay requirement after the known/unknown TCI state condition for multi-panels is concluded. |
| vivo | We should discuss what the known/unknown conditions are for multi-Rx chain simultaneous reception firstly. |
| Apple | Prefer to have more discussion. |
| Samsung | P1: We are open to discuss P1 further.  P1a is straightforward, if L1-measurement delay is reduced.  P1b and P1c are similar, and both can be FFS. |
| CMCC | P1a: support |
| Nokia | P1 – This is baseline, and discuss if it is possible  P2 – ok  P3 – FFS.  P4 – This is baseline, and discuss if it is possible |

**Issue 1-3-3: Enhancement for TCI state switching delay requirements**

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| **Company** | **Comments** |
| Ericsson | P1: FFS  P2: agree  P3: agree  P4: ffs |
| Qualcomm | More details and examples would be appreciated. |
| Huawei | P1/4: Too early to draw this conclusion. Open to further discuss  P2/3: More clarification is needed. |
| ZTE | All of them can be discussed. |
| MediaTek | We would like to hear other companies’ view on this issue. |
| vivo | P1: Needs further study.  P2: Further study  P3: Clarification is needed.  P4: Needs further study. |
| Apple | We need more discussions on the proposals. |
| Samsung | Need more discussion. |
| Nokia | P1 – This is baseline, and discuss if it is possible  P2 – ok  P3 – FFS.  P4 – This is baseline, and discuss if it is possible |
| Xiaomi | Agree with P1 P2 and P4. |

#### Sub-topic 1-4: L3 measurements related

**Issue 1-4-1: General part for L3 measurement requirements enhancements**

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| **Company** | **Comments** |
| Ericsson | As mentioned in previous comments L3 measurement can be enhanced under some scenarios, e.g., the number of beam sweeps N or when RX beam on antenna panels do not have overlapping coverage.  P2: agree to change the number of sweeps but not the minimum number of actual physical samples  P3: agree  P4: agree  P5: agree to reduce but the number if FFS  P5a: prefer to not change the number of beams |
| LGE | P2/P4/P5//P5a/P5b : generally agree the proposals, but the assumption of Rx beam number should be discussed. |
| NTT DOCOMO, INC. | P1: In some cases the existing requirements are reused but they should not be the general requirements for this work.  P2: Agree.  P4: Agree.  P5: Agree but the exact number should be further discussed.  P5b: Agree. |
| Qualcomm | Do not want to spend time discussing L3 measurements. The multi-Rx chain in this WI is for data reception with 4-layers when circumstances allow. |
| Huawei | P1: agree  L3 measurements are also limited due to searcher capability. Assuming of simultaneous L3 measurements with different beam directions on the same CC will impact the searcher capability. So, we suggest no enhancement for L3 measurements. |
| ZTE | Do not agree with P1.  Others can be discussed. |
| OPPO | Depending on whether to enhance L3 measurement. If yes, we support P2/P5a/P5b. |
| MediaTek | Disagree with all proposals. They are depending on whether to enhance L3 measurement in R18 multi-panel UE.  Suggest no need to enhance L3 measurement in R18. As our comment in Issue 1-1-4, to our understanding, there is no much gain if UE measures the SSB from neighboring frequently due to multi-panels. Fast L3 measurements are typically needed only when UE is moving faster. However, we do not see any difference in terms of UE mobility between UE with single activated panel and UE with multiple activated panels. |
| vivo | P1: Depending on conclusion of whether L3 measurement enhancement for multi-Rx chain UE is supported or not.  For other proposals, it can be further discussed after feasibility/necessity of L3 measurement enhancement is confirmed. |
| Apple | As commented earlier, we can discuss further the need to enhance L3 measurements before discussing each requirement. |
| Samsung | Discussion on whether or not L3 measurement is in the scope or not. |
| CMCC | P5/5a/5b: agree that the RX beam sweeping factor can be enhanced, the details can be FFS. |
| Nokia | P1 We don’t agree. Measurement period can be reduced.  P2 Agree  P3 don’t agree. A UE can use L1 and L3 beams simultaneously at multiple panels. Study if this impacts on L3 requirements.  P4 ok  P5 Agree, ok to have exact number as FFS  P5a – not ok  P5b - ok |
| Xiaomi | P1: Do not agree. With the enhancement of beam sweeping, the L3 measurement can be enhanced. |

**Issue 1-4-2: How the requirements for L3 measurements in IDLE/INACTIVE mode are enhanced**

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| **Company** | **Comments** |
| Ericsson | Can be further studied |
| LGE | We prefer focus on Connected mode first. |
| NTT DOCOMO, INC. | Agree with the proposal. |
| Qualcomm | Do not want to spend time discussing L3 measurements and non-connected mode. The multi-Rx chain in this WI is for data reception with 4-layers when circumstances allow in RRC connected mode. |
| Huawei | Same comments as issue 1-4-1, no enhancement for L3 measurements. |
| ZTE | Can be discussed. |
| MediaTek | No need to discuss the IDLE mode enhancement. To our understanding, it is out of scope. Besides, we do not think UE is required to active two panels at a time in IDLE mode due to power consumption issue. |
| vivo | Can be discussed after feasibility/necessity of L3 measurement enhancement is confirmed. |
| Samsung | Same comment as issue 1-4-1. |
| CMCC | Ok with P1. |
| Nokia | Agree to study. |

**Issue 1-4-3: How the requirements for L3 measurements in CONNECTED mode are enhanced**

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| **Company** | **Comments** |
| Ericsson | Can be further studied.  Also think that the impact on CSSF may need to be discussed or its definition may need to be clarified. |
| LGE | Fine to further discuss to enhance L3 measurement requirement |
| NTT DOCOMO, INC. | P1: Generally agree but need further discussions.  P2: Agree.  P3: Generally agree but need further discussions. |
| Qualcomm | Do not want to spend time discussing L3 measurements. The multi-Rx chain in this WI is for data reception with 4-layers when circumstances allow. |
| Huawei | Same comments as issue 1-4-1, no enhancement for L3 measurements. |
| ZTE | All of them can be discussed. |
| MediaTek | Same comment in Issue 1-4-1. |
| vivo | Can be discussed after feasibility/necessity of L3 measurement enhancement is confirmed. |
| Samsung | Same comment as issue 1-4-1. |
| CMCC | P1: OK  P2: OK |
| Nokia | We are fine with the proposals in general. Need further study when each of these apply |
| Xiaomi | Agree with P1 and P2. |

### CRs/TPs comments collection

*Companies are encouraged to provide comments in the 1st round since the draft CRs will be endorsed in the meeting for finalization of performance work of FeRRM WI.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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

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|  | **Status summary** |
| **Issue 1-1-1: General principles** | ***Tentative agreements:***  *For P1, majority of companies agree with it in principle. There are also comments that RF constraints should be considered in RF session. It is moderator understanding that RF constraints could be discussed in RF session, but the impact on RRM requirements should also belong to RRM session discussion.*   * FFS potential UE implementation constraints from power consumption and baseband constraints perspective * FFS impact on RRM requirements due UE implementation constraints, including power consumption constraints, baseband constraints and RF constraints.   *There is no clear consensus on the three aspects proposed in P2. It is suggested to further study. For RLM, it will be discussed with issues for RLM and necessity study of L1 measurements.*   * FFS assumption on number of searchers for cell detection and measurements. * FFS TAG assumption for uplink transmission   *For P3, several companies think it may need input from RF session.*   * FFS whether to define activation delay from a single antenna panel to multi-antenna panels.   *For P4, there are diverse views and at least clarification on the proposal is needed.*   * FFS RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.   *For P5, there are diverse views. Clarification is needed.*   * FFS: Spatial MIMO (either spatial diversity or spatial multiplexing) by using one panel to achieve two independent signals from the same or nearly the same direction is not the scope of this work item.   *For P6, there are different views.*   * FFS: RAN4 RRM session shall provide input to Rel-18 testability study item (FS\_NR\_FR2\_OTA\_enh), by providing the needs of RRM performance requirement testing.   *For P7, no consensus is observed. For P8, companies think it should be the same issue as P7. Moderator would like to combine P7 and P8 together.*   * FFS: Rel-18 multi-RX chain UE should be able to support both intra-cell and inter-cell operation with TRPs located within reasonable intercell distance.   *For P9, there are different views.*   * FFS: RAN4 to discuss how FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled.   ***Candidate options:***  *Based on comments on initial proposals in the 1st round, moderator would like to treat different proposals separately from now on.*  **Issue 1-1-1-1: UE implementation constraints and impact to RRM requirements**   * Proposals   + Option 1:     - FFS potential UE implementation constraints from power consumption and baseband constraints perspective     - FFS impact on RRM requirements due UE implementation constraints, including power consumption constraints, baseband constraints and RF constraints.   **Issue 1-1-1-2: Number of searchers for cell detection and measurements**   * Proposals   + Option 1: 2   **Issue 1-1-1-3: TAG assumption for uplink transmission**   * Proposals   + Option 1: 1 TAG   + Option 2: 2 TAGs   **Issue 1-1-1-4: Whether to define activation delay from a single antenna panel to multi-antenna panels**   * Proposals   + Option 1: Depending on RF conclusion   + Option 2: Study in RRM session   **Issue 1-1-1-5: RRM impact of the UE behaviour using a single antennal panel**   * Proposals   + Option 1: FFS RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.   **Issue 1-1-1-6: Spatial MIMO (either spatial diversity or spatial multiplexing) by using one panel**   * Proposals   + Option 1: FFS RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.   **Issue 1-1-1-7: Input to Rel-18 testability SI**   * Proposals   + Option 1: RAN4 RRM session shall provide input to Rel-18 testability study item (FS\_NR\_FR2\_OTA\_enh), by providing the needs of RRM performance requirement testing.   **Issue 1-1-1-8: Scenarios for Rel-18 multi-Rx DL reception**   * Proposals   + Option 1: support both intra-cell and inter-cell operation with TRPs located within reasonable intercell distance.   + Option 2: Working on inter-cell operation with TRPs located within reasonable intercell distance after intra-cell multi-TRP operation work is completed.   + Option 3: intra-cell multi-TRP operation only   **Issue 1-1-1-9: How to handle FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception**   * Proposals   + Option 1: FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled in this WI, if necessary.   + Option 2: FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled in RRM enh3 WI, if necessary.   ***Recommendations for 2nd round:***  *Discuss on the candidate options for open issues.* |
| **Issue 1-1-2: General considerations on defining requirements** | ***Tentative agreements:***  *All companies except one agree with P1. One company thinks clarification on single carrier need to be further clarified.*   * FFS: RRM requirement discussion shall be focused on the case with different QCL TypeD RSs on a single component carrier, by excluding downlink CA operation.   *No consensus is observed for P2.*   * FFS: RAN4 to revisit the FR2 SMTC use case for ‘L1 and L3’ measurements and ‘serving cell and non-serving cell’ to reduce measurement latency. Rel-18 FR2 multi-RX chain UE may be able to measure RSs simultaneously with different QCL-D sources or with different beam assumptions (i.e. narrow and wide beam assumption)   *No consensus is observed for P2a.*   * FFS: In R18, the enhanced UE in FR2 is still not required to perform L3 measurements and L1 measurements simultaneously.   *No consensus is observed for P3. Clarification is needed.*   * FFS: Study whether or how to define measurement delay requirement and scheduling restriction (interruption) depending on UE behavior for s-DCI or m-DCI based multi-TRP   *No consensus is observed for P4. Clarification is needed.*   * FFS: Power saving can be additional requirements of UE with multiple RX chains.   *For P5, companies think it would be fine in principle. However, it may be too high level to agree or too early to discuss. Moderator would like to keep it open for further discussion.*   * FFS: For UE with the capability of simultaneous reception from different directions, the existing legacy RRM requirements continue to apply by default, unless a corresponding new enhanced requirement is introduced.   *For P6, there are different views.*   * FFS: A clarification is added in clause 3.6.13 of TS 38.133 (Applicability of requirements for FR2) that the new requirements defined in this WI are applicable only for FR2-1.   *For P7, no consensus is observed.*   * FFS: The new improved RRM requirements should aim to reduce the delays during measurements and procedures (e.g., RLM evaluation period, measurement delays, etc.) while maintaining the existing accuracy requirements.   *For P8, no consensus is observed.*   * FFS: RAN4 to discuss whether the new requirements will also be applicable when QCL type D is configured together with QCL type A and QCL type C.   *For P9, no consensus is observed.*   * FFS: RAN4 to discuss defining new improved requirements for serving cells (PCell, PSCell, and SCells, whichever are relevant for each such requirement) as well as for non-serving cells.   *For P10, no consensus is observed.*   * FFS: In an improved RRM requirement relying on a certain QCL relationship (QCL type D), not only the target signal but also the associated signal in the QCL information shall remain detectable during the entire measurement period.   ***Candidate options:***  *Based on comments on initial proposals in the 1st round, moderator would like to treat different proposals separately from now on.*  **Issue 1-1-2-1: Single carrier for defining RRM requirements**   * Proposals   + Option 1: RRM requirement discussion shall be focused on the case with different QCL TypeD RSs on a single component carrier, by excluding downlink CA operation.   + Option 2: UE can be configured with multiple carriers but multi-Rx chain is enabled on only one of the carriers.   **Issue 1-1-2-2: Simultaneous L3 measurements and L1 measurements**   * Proposals   + Option 1: RAN4 to revisit the FR2 SMTC use case for ‘L1 and L3’ measurements and ‘serving cell and non-serving cell’ to reduce measurement latency. Rel-18 FR2 multi-RX chain UE may be able to measure RSs simultaneously with different QCL-D sources or with different beam assumptions (i.e. narrow and wide beam assumption)   + Option 2: In R18, the enhanced UE in FR2 is still not required to perform L3 measurements and L1 measurements simultaneously   + Option 3: The issue is discussed under mobility enhancement WI   **Issue 1-1-2-3: Support of single-DCI and/or multi-DCI multi-TRP operation**   * Proposals   + Option 1: Define RRM requirements depending on UE behaviour for single-DCI and multi-DCI multi-TRP operation   + Option 2: Define RRM requirements for single-DCI multi-TRP operation   **Issue 1-1-2-4: Whether and how to define power saving related requirements**   * Proposals   + Option 1: Power saving can be additional requirements of UE with multiple RX chains   + Option 2: Power saving is not part of this study   **Issue 1-1-2-5: Applicability of existing requirements for UE with the capability of simultaneous reception from different directions**   * Proposals   + Option 1: The existing legacy RRM requirements continue to apply by default, unless a corresponding new enhanced requirement is introduced.   **Issue 1-1-2-6: Applicability of new requirements for UE with the capability of simultaneous reception from different directions**   * Proposals   + Option 1: A clarification is added in clause 3.6.13 of TS 38.133 (Applicability of requirements for FR2) that the new requirements defined in this WI are applicable only for FR2-1.   **Issue 1-1-2-7: Accuracy assumption when defining RRM core requirements**   * Proposals   + Option 1: The new improved RRM requirements should aim to reduce the delays during measurements and procedures (e.g., RLM evaluation period, measurement delays, etc.) while maintaining the existing accuracy requirements.   **Issue 1-1-2-8: Applicability of new requirements to different QCL types**   * Proposals   + Option 1: RAN4 to discuss whether the new requirements will also be applicable when QCL type D is configured together with QCL type A and QCL type C   **Issue 1-1-2-9: Requirements applicability for serving cells**   * Proposals   + Option 1: Defining new improved requirements for serving cells (PCell, PSCell, and SCells, whichever are relevant for each such requirement) as well as for non-serving cells.   **Issue 1-1-2-10: RS signals that shall remain detectable during measurement period**   * Proposals   + Option 1: In an improved RRM requirement relying on a certain QCL relationship (QCL type D), not only the target signal but also the associated signal in the QCL information shall remain detectable during the entire measurement period.   ***Recommendations for 2nd round:***  *Discuss on the candidate options for open issues.* |
| **Issue 1-1-3: Feasibility/necessity of enhancing requirements for L1 measurements** | *Majority of companies agree with option 1 if RLM is not considered. One company commented it is too early to agree on option 1.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-1-3: Feasibility/necessity of enhancing requirements for L1 measurements**   * Proposals   + Option 1: Following L1 measurements related requirements are enhanced in the multi-Rx chain DL reception WI     - L1-RSRP measurement     - BFD/CBD     - RLM     - L1-SINR     - TCI state switching with dual TCI     - Scheduling/measurement restrictions   + Option 2: Following L1 measurements related requirements are enhanced in the multi-Rx chain DL reception WI     - L1-RSRP measurement     - BFD/CBD     - L1-SINR     - TCI state switching with dual TCI     - Scheduling/measurement restrictions   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-1-4: Feasibility/necessity of enhancing requirements for L3 measurements** | *No consensus.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  *Option 2 and 2a can be down-selected to option 2a only based on moderator’s understanding of comments.*  *Option 1a is added for L3 measurements in connected mode only.*  **Issue 1-1-4: Feasibility/necessity of enhancing requirements for L3 measurements**   * Proposals   + Option 1: Following L3 measurements related requirements are enhanced in the multi-Rx chain DL reception WI     - RRM measurement requirements for RRC-IDLE state and for RRC\_INACTIVE state.     - Handover to FR2-1 unknown cell     - FR2-1 unknown SCell activation     - FR2-1 unknown PSCell addition and release     - For L3 measurement in connected mode, including all the existing scenarios (intra-frequency measurements without MG, intra-frequency measurements with MG, inter-frequency measurement with MG, inter-frequency measurement without MG).   + Option 1a: Following L3 measurements related requirements are enhanced in the multi-Rx chain DL reception WI     - Handover to FR2-1 unknown cell     - FR2-1 unknown SCell activation     - FR2-1 unknown PSCell addition and release     - For L3 measurement in connected mode, including all the existing scenarios (intra-frequency measurements without MG, intra-frequency measurements with MG, inter-frequency measurement with MG, inter-frequency measurement without MG).   + Option 2a: Not to enhance L3 measurement requirement in R18 multi-panel WI.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-1-5: Receive time difference** | *Diverse views from companies.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-1-5: Receive time difference**   * Proposals   + Option 1: The timing difference between different panels is at least within one CP. FFS whether to define requirements with timing difference larger than one CP.   + Option 1a: The condition of receive timing difference between different directions with different TCI of QCL type-D shall take CP length as baseline.   + Option 1b: Receive time difference for configured different QCL Type D RSs is within CP. FFS receive time difference for configured different QCL Type D RSs is larger than CP.   + Option 1c: If we define cases where ∆τ > CP then we define a total MRTD budget, where ∆τ = TAE + ∆propagation and ∆τ < MRTD. This way TAE and ∆propagation can be balanced as terms, within the total MRTD budget.   + Option 1d:     - Option a: If keep the assumption of single FFT as in Rel-17, the receive timing difference between different directions should be not larger the CP length. But the legacy MRTD under inter-band CA is much larger than CP length for FR2-1, which is beyond UE capability.     - Option b: If UE is capable of supporting two FFTs for different TRP or panel/RF chain reception, the restriction of not larger the CP length can be ignored, so re-using the legacy requirement for inter-band CA is fine.   + Option 2: The receive timing difference between different directions is within CP   + Option 2a: Check whether it is available that the maximum receive timing difference between the DL transmission from two TRPs is within CP according to RAN2 specification.   + Option 3: Given that independent RF and BB processing is of necessity to support two distinct AoAs, no restriction on MRTD between different directions (different QCL Type D RSs) should be provided   + Option 4: Study UE RX capability receiving extended MRTD based on non-collocated mTRP deployment scenario.   + Option 5: Clarify the scope of this item and discuss whether existing spec can be modified for multi Rx chain UE or not under the clarified scope for receive timing difference between different directions.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-1-6: UE capabilities** | *Diverse views from companies.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  *The UE capabilities are further categorized based on comments in the 1st round for better discussion.*  *For P4, companies commented some of the combinations would be demodulation scope. No specific issue is listed for P4. Proponent may provide concrete proposals related for RRM in the 2nd round or in the next meeting.*  **Issue 1-1-6-1: UE capability of simultaneous reception of measured RS and data**   * Proposals   + Option 1: Consider simultaneous reception of L1/L3 measured RS and data if UE supports simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.   + Option 2: Consider simultaneous reception of L1 measured RS and data if UE supports simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.   + Option 3: For scenario 2 (two RX beams used for different cells) with multi-RX chain capability, UE can receive PDCCH/PDSCH/TRS/CSI-RS for CQI (one beam) and on SSB symbols (another beam) to be measured   + Option 4: RAN4 to discuss if additional UE capability for indicating supporting of simultaneous reception with different QCL type D RS and PDSCH/PDCCH is needed.   **Issue 1-1-6-2: Clarification/understanding on existing UE capabilitiy *simultaneousRxDataSSB-DiffNumerology***   * Proposals   + Option 1: Clarify whether UE can perform SSB based measurement using multi-antenna panels when UE supports *simultaneousReceptionDiffTypeD*.   + Option 2: The existing *simultaneousRxDataSSB-DiffNumerology* IE can be re-used for FR2   + Option 3: RAN4 shall not introduce new, but reuse Rel-16 UE capability IE *simultaneousReceptionDiffTypeD-r16*, to indicate enhanced FR2-1 UEs supporting simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.   + Option 4: It is assumed that UE is capable of supporting simultaneous reception from two different directions with two different QCL type D RSs.   **Issue 1-1-6-3: UE behaviour and capability of handling Rx signal level difference between two channels**   * Proposals   + Option 1: Study UE behaviours and capability of multiple RX chains regarding handling Rx signal level difference between two channels.   + Option 2: Discuss in RF session   **Issue 1-1-6-4: UE capability for L3 measurement enhancement for UE supporting multi-Rx chain simultaneous reception**   * Proposals   + Option 1: A new capability, different from simultaneousReceptionDiffTypeD-r16 or other L1 measurement related UE capability, should be introduced for L3 measurement delay reduction for UE supporting multi-Rx chain simultaneous reception.   + Option 2: Same UE capability as for L1 measurement   ***Recommendations for 2nd round:***  *Further discuss on the candidate options for open issues.* |
| **Issue 1-1-7: UE architectures** | *Diverse views from companies.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-1-7: UE architectures**   * Proposals   + Option 1: The scope of a RX chain architecture includes possible implementations and UE capabilities as below:     - Multiple Antenna panel     - Multiple Antenna panel + AGC     - Multiple Antenna panel + AGC + front-end (time and frequency sync)     - Multiple Antenna panel + AGC + front-end + Demod/RRM   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-1-8: Beam management** | *Diverse views from companies.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-1-8: Beam management**   * Proposals   + P1: RAN4 can consider two options for beam management for UE with multiple RX chains     - Option-(i) Reuse independent beam management concept (IBM) from Inter-band CA study     - Option-(ii) define panel or RX chain specific behaviors with RX panel control signal for DL   + P2: Study independent beam managements for different QCL-D sources with multiple TRPs, and also study other QCL channel property impacts of {average gain, delay shift and doppler shift} for multi-RX chain requirements.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-1-9: Dependent on RF conclusions** | ***Tentative agreements:***  *None.*  ***Candidate options:***  *Companies thinks the proposals for this issue is quite similar. Moderator kept one by considering better inclusive of the proposal for further discussion. Comments in 1st round are also taken into account.*  **Issue 1-1-9: Dependent on RF conclusions**   * Proposals   + Option 1: RRM requirement of simultaneous DL reception from different directions shall be defined based on applicable conditions/architecture to be concluded in UE RF session.   + Option 2: RRM requirements discussion and RF discussion are in parallel.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |

#### Sub-topic 1-2: L1 measurements related

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| **Issue 1-2-1: Scenarios for L1 measurement requirements enhancements** | ***Tentative agreements:***  *None.*  ***Candidate options:***  *Candidate options are updated based on comments in the 1st round.*  **Issue 1-2-1: Scenarios for L1 measurement requirements enhancements**   * Proposals   + Option 1: R16 intra-cell mTRP, i.e., reception on two TRPs from one cell at a time, as a start point.   + Option 2:     - R16 intra-cell mTRP, i.e., reception on two TRPs from one cell at a time, as a start point.     - Discuss R17 inter-cell BM/mTRP after the requirement of single serving cell is concluded   + Option 3: Both intra-cell m-TRP operation scenario and inter-cell m-TRP operation scenario should be supported. The discussion can be going in parallel.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-2-2: General part for L1 measurement requirements enhancements** | ***Tentative agreements:***  *None.*  ***Candidate options:***  *The proposals are further categorized based on 1st round comments.*  **Issue 1-2-2-1: Simultaneous reception of two different QCL-Type D RSs for L1 measurement**   * Proposals   + Option 1: For the case when both different QCL-Type D RSs are received by two different UE Rx panels at a time, no measurement restriction and scheduling availability are needed because of beamforming conflict.   + Option 2: For the case when two different QCL-Type D RSs are received by same UE Rx panel at a time, the legacy R15/R16 requirement (e.g., measurement restriction and scheduling availability) should be reused.   + Option 3: UE is assumed to perform simultaneous data receptions with different beam directions or perform simultaneous L1 measurements with different beam directions.   + Option 4: Simultaneous DL reception of same or different type of RSs from different directions is supported for defining L1 measurement requirements to support multi-TRP operation.   **Issue 1-2-2-2: whether measured RS samples can be reduced for L1 measurement delay in case of FR2 multi-Rx reception**   * Proposals   + Option 1: Yes   + Option 2: No   **Issue 1-2-2-3: Features for L1 measurement requirements enhancement**   * Proposals   + Option 1: The study for L1-RSRP/RLM/BFD/CBD measurements for Reporting under CCA, for RedCap and for satellite access should be discussed later based on the normal case agreements.   + Option 2: The study for L1-RSRP/RLM/BFD/CBD measurements for Reporting under CCA, for RedCap, for satellite access, and for a cell with different PCI from serving cell should be discussed later based on the normal case agreements.   + Option 3: Deprioritize joint feature of multi-Rx chain DL reception and other features.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options for open issues.* |
| **Issue 1-2-3: L1-RSRP measurement requirements enhancement** | ***Tentative agreements:***  *None.*  ***Candidate options:***  *The proposals are further categorized based on 1st round comments.*  **Issue 1-2-3-1: Aspects for L1-RSRP measurement requirements enhancement**   * Proposals   + Option 1: L1-RSRP measurement requirements can be enhanced on following aspects     - Beam sweeping factor *N*     - Sharing factor *Psharing factor* for both SSB based measurement and CSI-RS based measurement     - Measurement restrictions for both SSB based and CSI-RS based L1-RSRP     - Scheduling restrictions for both SSB based and CSI-RS based L1-RSRP   **Issue 1-2-3-2: impacts on sharing factors PSC and PCDP when UE is performing simultaneous L1-RSRP measurements on two RSs from different TRPs**   * Proposals   + Option 1: Study the conditions when UE is able to perform simultaneous L1-RSRP measurements on two RSs from different TRPs, and investigate the impacts on sharing factors PSC and PCDP.   **Issue 1-2-3-3: SSB based L1-RSRP measurement period**   * Proposals   + Option 1: L1-RSRP measurement period: SSB-only based L1-RSRP measurement reporting does not benefit from QCL type D information.   **Issue 1-2-3-4: Requirements enhancement for inter-cell L1-RSRP measurement**   * Proposals   + Option 1: Requirements for inter-cell L1-RSRP measurement are enhanced for UE supporting multi-Rx chain simultaneous reception.   **Issue 1-2-3-5: Number of cells with PCI different from serving cells for inter-cell BM**   * Proposals   + Option 1: Number of cells with PCI different from serving cells are further discussed for UE supporting multi-Rx chain simultaneous reception and the max number of cells is 8.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options for open issues.* |
| **Issue 1-2-4: L1-SINR measurement requirements enhancement** | ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-2-4: L1-SINR measurement requirements enhancement**   * Proposals   + Option 1: L1-SINR measurement requirements can be enhanced on following aspects     - Beam sweeping factor *N*     - Sharing factor *Psharing factor* for both SSB based measurement and CSI-RS based measurement   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |
| **Issue 1-2-5: BFD/CBD measurement requirements enhancement** | ***Tentative agreements:***  *None.*  ***Candidate options:***  *The proposals are further categorized based on 1st round comments.*  **Issue 1-2-5-1: Aspects for BFD/CBD measurement requirements enhancement**   * Proposals   + Option 1: BFD/CBD measurement requirements can be enhanced on following aspects     - Beam sweeping factor *N*     - Sharing factor *Psharing factor* for both SSB based and CSI-RS based BFD/CBD     - Measurement restrictions for both SSB based and CSI-RS based BFD/CBD     - Scheduling restrictions for both SSB based and CSI-RS based BFD/CBD     - The scaling factor PTRP for TRP specific requirements   **Issue 1-2-5-2: Simultaneous BFD/CBD measurements on two RSs from different resource sets**   * Proposals   + Option 1: In R18, the enhancement on simultaneous BFD/CBD measurements on two RSs from different resource sets can be considered.   + Option 2: In R18, RAN4 needs to study the conditions when UE is able to perform simultaneous BFD/CBD measurements on two RSs from different resource sets, and investigate the impacts on sharing factor PTRP.   **Issue 1-2-5-3: BFD/CBD measurement requirements enhancement for TRP specific link recovery**   * Proposals   + Option 1: Requirements for TRP specific link recovery are enhanced for UE supporting multi-Rx chain simultaneous reception.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options for open issues.* |
| **Issue 1-2-6: RLM measurement requirements enhancement** | ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-2-6: RLM measurement requirements enhancement**   * Proposals   + Option 1: RLM measurement requirements can be enhanced on following aspects     - Beam sweeping factor *N*     - Sharing factor *Psharing factor* for both SSB based and CSI-RS based RLM     - Measurement restrictions for both SSB based and CSI-RS based RLM     - Scheduling restrictions for both SSB based and CSI-RS based RLM   ***Recommendations for 2nd round:***  *Further discuss on the candidate options.* |

#### Sub-topic 1-3: TCI state switching

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| **Issue 1-3-1: General considerations for TCI related** | ***Tentative agreements:***  *None.*  ***Candidate options:***  *The proposals are further categorized based on 1st round comments for efficient discussion.*  **Issue 1-3-1-1: Independent TCI switching for dual TCIs for multi-Rx chain UE**   * Proposals   + Option 1: Each TCI switching per RX chain is assumed to be independent in aspect of TCI switching delay. RAN4 to study if Rel-17 TCI switching delay requirements can be applicable as Rel-18 UE requirements with multi-RX chains.   + Option 2: RAN4 to study if a UE with multiple RX chains tracks time and frequency per TCI when dual TCIs are activated per RX chain.   + Option 3: RAN4 to discuss the requirements for any change to the set of active TCI states used for simultaneous reception, e.g., active TCI state switching within this set.   **Issue 1-3-1-2: TCI framework for dual TCIs**   * Proposals   + Option 1: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.   + Option 2: To define requirements for TCI switching delay with dual TCI, both R15/R16 TCI framework and R17 TCI framework, i.e., unified TCI, are considered for UE supporting multi-Rx chain simultaneous reception.   **Issue 1-3-1-3: Cases for defining dual TCI state switching requirements**   * Proposals   + Option 1: Define dual TCI state switching requirements for following cases:     - PDCCH non-SFN: Two MAC CE with one for each TCI state     - PDCCH SFN: single MAC CE for two TCI states     - PDSCH single DCI: single DCI for two TCI states     - PDSCH multiple DCI: Two DCI with one for each TCI state   **Issue 1-3-1-4: Inside-panel TCI state switching and cross-panel TCI state switching**   * Proposals   + Option 1: Except for the consideration of reduction of Rx beam number, considering inside-panel TCI state switching and cross-panel TCI state switching are both possible, so additional panel/RF chain switching time should be considered within the TCI state switching latency for the case of cross-panel TCI state switching.   **Issue 1-3-1-5: Whether number of active TCI states can be larger than the UE capability for simultaneous reception**   * Proposals   + Option 1: RAN4 to discuss whether there is an issue when the number of active TCI states is larger than the UE capability for simultaneous reception.   ***Recommendations for 2nd round:***  *Further discuss on the candidate options for open issues.* |
| **Issue 1-3-2: Known/unknown conditions for TCI state switching for multi-Rx chain** | ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-3-2: Known/unknown conditions for TCI state switching for multi-Rx chain**   * Proposals   + P1: Study whether TCI state switching delay can be modified or not for multi Rx chain UE, e.g. how to evaluate known/unknown condition by using multi Rx chain, how to define TCI state change delay by the cases that dedicated Rx chain is used, partial Rx chains are used, or all Rx chains are used.   + P1a: For MAC-CE based TCI state switch delay with unknown target TCI state, the reduction on switch delay requirements can be considered (i.e. consider the improvement of TL1-RSRP with multiple simultaneous reception)   + P1b: For dual TCI state switching delay requirements, which scenarios of triggering, known/unknown TCI state and TCI association to different PCI could be considered and clarified.   + P1c: Discuss the known conditions of dual TCI and discuss whether to define requirements for unknown dual TCI state switch.   ***Recommendations for 2nd round:***  *Further discuss on the candidate proposals.* |
| **Issue 1-3-3: Enhancement for TCI state switching delay requirements** | ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-3-3: Enhancement for TCI state switching delay requirements**   * Proposals   + P1: For dual TCI state switch, the legacy TCI state switch delay requirement can be reused   + P2: The new RRM requirements defined for simultaneous measurements and procedures on two chains need to apply, provided the corresponding active TCI states are configured and used for simultaneous reception during the measurement or evaluation period.   + P3: The legacy TCI state switching delay requirement can apply for each RX beam.   ***Recommendations for 2nd round:***  *Further discuss on the candidate proposals.* |

#### Sub-topic 1-4: L3 measurements related

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| **Issue 1-4-1: General part for L3 measurement requirements enhancements** | *No consensus is observed.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-4-1: General part for L3 measurement requirements enhancements**   * Proposals   + P1: In R18, it is suggested that the existing L3 measurements can be reused for FR2 UEs capable of simultaneous DL reception from different directions.   + P2: Study whether measured RS samples can be reduced for L3 measurement delay in case of FR2 multi-Rx reception   + P3: Cell detection and L3 measurement period, SSB-based:     - No direct benefit from QCL type D information,     - FFS: impact on CSSF.   + P4: L3 measurement period, CSI-RS based: simultaneous measurements for signals with QCL type D can reduce the measurement period.   + P5: Scaling factor for Rx beam sweeping for FR2-1 can be reduced by 2     - FFS for HST scenario   + P5a: The assumption of Rx beam number during cell identification/measurement can be reduced   + P5b: Scaling factor of RX beam sweeping can be reduced with UE using its two RX beams for simultaneous measurement for one cell.   ***Recommendations for 2nd round:***  *Depending on issue 1-1-4. No further discussion in the 2nd round.* |
| **Issue 1-4-2: How the requirements for L3 measurements in IDLE/INACTIVE mode are enhanced** | *No consensus is observed.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-4-2: How the requirements for L3 measurements in IDLE/INACTIVE mode are enhanced**   * Proposals   + P1: For cell re-selection requirements, *N1* value is further studied.   ***Recommendations for 2nd round:***  *Depending on issue 1-1-4. No further discussion in the 2nd round.* |
| **Issue 1-4-3: How the requirements for L3 measurements in CONNECTED mode are enhanced** | *No consensus is observed.*  ***Tentative agreements:***  *None.*  ***Candidate options:***  **Issue 1-4-3: How the requirements for L3 measurements in CONNECTED mode are enhanced**   * Proposals   + P1: For L3 measurement in connected mode, with multi-beam simultaneous reception, Mpss/sss, Mmeas and MSSB\_index can be reduced.   + P2: Scaling factor Klayer1\_measurement for intra-frequency measurement/inter-frequency measurement without gap should be studied whether it can be removed or relaxed.   + P3: In R18, the existing scheduling restriction requirements for L3 measurements can be reused for the UE supporting simultaneous DL reception from different direction in FR2.   ***Recommendations for 2nd round:***  *Depending on issue 1-1-4. No further discussion in the 2nd round.* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

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

**Issue 1-1-1: General principles**

*Since proposals for Issue 1-1-1 are focusing on different general aspects, it is further split as follows for efficient discussion.*

**Issue 1-1-1-1: UE implementation constraints and impact to RRM requirements**

* Proposals
  + Option 1:
    - FFS potential UE implementation constraints from power consumption and baseband constraints perspective
    - FFS impact on RRM requirements due UE implementation constraints, including power consumption constraints, baseband constraints and RF constraints.
* Recommended WF
  + The proposals would be better to be further elaborated so that RAN4 can continue work on in the next meeting.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | We’d like to not make it as a discussion topic. If we want to discuss everything even for this high level view, we will end up seeing tons of open issues. |
| Huawei | Basically, we can agree to study the impacts on RRM requirements based on potential UE implementation. |
| Ericsson | We share same view as Qualcomm |
| Apple | The reason we brought up this point is to ensure when RAN4 considers enhanced requirements, RAN4 keeps the potential constraints in mind. Without it, RAN4 can assume a UE with simultaneous reception of two AoAs can do simultaneous L1 measurements, L3 measurements, L1 and L3 measurements, and L1 or L3 measurements and PDCCH/PDSCH reception.  Therefore, as a high-level principle, can we agree to the following:  “When specifying RRM requirements, UE implementation constraints should be considered. FFS how to apply to specific requirements.” |
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**Issue 1-1-1-2: Number of searchers for cell detection and measurements**

* Proposals
  + Option 1: 2
* Recommended WF
  + Agree on option 2.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 1 is OK. We are also open to more discussions. |
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**Issue 1-1-1-3: TAG assumption for uplink transmission**

* Proposals
  + Option 1: 1 TAG
  + Option 2: 2 TAGs
* Recommended WF
  + Further Collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Support Option 1. As the main scenario here is 4-layer MIMO on one carrier, we don’t see any reason to consider multi-TAG at all. If this is from the context of Rel-18 RAN1-led eFeMIMO for multi-TAG based m-TRP, this is not included in this WI scope. |
| Huawei | We suggest not to discuss it in this WID. The objectives of WID are related to simultaneous downlink receptions with multi-panels, while TAG configuration is related to uplink transmission and does not impact downlink reception. |
| Ericsson | We agree with Huawei. |
| Apple | As we commented in the first round, we’d like to understand more details about this proposal and its impact on DL reception. |
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**Issue 1-1-1-4: Whether to define activation delay from a single antenna panel to multi-antenna panels**

* Proposals
  + Option 1: Depending on RF conclusion
  + Option 2: Study in RRM session
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 1. |
| Huawei | Agree with option 1. |
| Ericsson | Option 1 |
| Apple | Option 1. |
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**Issue 1-1-1-5: RRM impact of the UE behaviour using a single antennal panel**

* Proposals
  + Option 1: FFS RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | We’d like to understand more what this proposal means. |
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**Issue 1-1-1-6: Spatial MIMO (either spatial diversity or spatial multiplexing) by using one panel**

* Proposals
  + Option 1: FFS RRM impact of the UE behavior using a single antennal panel rather than multi-antenna panels depending on the AoA of downlink signals from a different direction for power saving.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not subdivide issues. Issue 1-1-1-5 and 1-1-1-6 do not have to be discussed separately. There are too many sub-issues to find issue numbers and check proposals/options/other companies views on each. The issue number is now composed of 4 digits A-B-C-D. |
| Apple | Similar comment as above. |
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**Issue 1-1-1-7: Input to Rel-18 testability SI**

* Proposals
  + Option 1: RAN4 RRM session shall provide input to Rel-18 testability study item (FS\_NR\_FR2\_OTA\_enh), by providing the needs of RRM performance requirement testing.
* Recommended WF
  + In general, moderator thinks it should be no problem to provide input for R18 testability. However, it needs R18 testability SI input to know what information should be provided. Since R18 testability SI is ongoing parallel with other RRM WIs, it does not need to wait until the performance part of this WI to consider testability issue.
  + Moderator would like to check with companies if following recommended WF is fine.
  + WF: The WI will provide necessary input to Rel-18 testability study item (FS\_NR\_FR2\_OTA\_enh), when it is requested by R18 FS\_NR\_FR2\_OTA\_enh WI.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | What is this discussion for? Let’s do not discuss this. We anyway have to consider the testability issue for this type of UE. |
| Huawei | Currently, it is not clear to us what kind of inputs need to be provided from RRM session at this stage. |
| Apple | We agree that we may not need to have an agreement on this. RRM session needs to interact with the OTA SI to understand testing constraints and share the testing request from the requirements’ perspective. |
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**Issue 1-1-1-8: Scenarios for Rel-18 multi-Rx DL reception**

* Proposals
  + Option 1: support both intra-cell and inter-cell operation with TRPs located within reasonable intercell distance.
  + Option 2: Working on inter-cell operation with TRPs located within reasonable intercell distance after intra-cell multi-TRP operation work is completed.
  + Option 3: intra-cell multi-TRP operation only
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 3. Other than 4-layer MIMO reception for one PDSCH with two QCL sources, everything is out of the scope of the WI. |
| Huawei | Generally we are fine with option 2. RAN4 discuss intra-cell multi-TRP case firstly, then FFS whether inter-cell multi-TRP case can be applied. |
| Ericsson | We think rel-17 inter-cell multi TRP and BM should be baseline. We support Option 1 |
| Apple | We are OK to start with intra-cell multi-TRP. |
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**Issue 1-1-1-9: How to handle FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception**

* Proposals
  + Option 1: FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled in this WI, if necessary.
  + Option 2: FR2 SCell activation delay reduction by multi-Rx chain simultaneous reception is handled in RRM enh3 WI, if necessary.
* Recommended WF
  + Further collect views. It may need coordination with RRM enh3 WI.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not discuss anything outside of the WI scope. Please bring this to RAN plenary and update the scope if anyone wants to discuss it under this WI umbrella.  We strongly recommend moderator to not capture this in WF in any form. |
| Huawei | We have same view as QC. The enhancements on SCell activation is out of scope. |
| Apple | Similar views, let’s focus on the requirements listed in the WID first. |
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**Issue 1-1-2: General considerations on defining requirements**

*Since proposals for Issue 1-1-2 are focusing on different general aspects for defining RRM requirements, it is further split as follows for efficient discussion.*

**Issue 1-1-2-1: Single carrier for defining RRM requirements**

* Proposals
  + Option 1: RRM requirement discussion shall be focused on the case with different QCL TypeD RSs on a single component carrier, by excluding downlink CA operation.
  + Option 2: UE can be configured with multiple carriers but multi-Rx chain is enabled on only one of the carriers.
* Recommended WF
  + Further collect views and reach agreements if possible.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 1 shall be the starting point of the item. Let’s focus on the key aspect. |
| Huawei | Option 1.  RAN4 focuses on the case that simultaneous downlink receptions with different beam directions are on a single CC. |
| Ericsson | We think requirements are defined per single carrier. We do not see why we need to exclude option 2. |
| Apple | Option 1. Let’s focus on single carrier first. |
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**Issue 1-1-2-2: Simultaneous L3 measurements and L1 measurements**

* Proposals
  + Option 1: RAN4 to revisit the FR2 SMTC use case for ‘L1 and L3’ measurements and ‘serving cell and non-serving cell’ to reduce measurement latency. Rel-18 FR2 multi-RX chain UE may be able to measure RSs simultaneously with different QCL-D sources or with different beam assumptions (i.e. narrow and wide beam assumption)
  + Option 2: In R18, the enhanced UE in FR2 is still not required to perform L3 measurements and L1 measurements simultaneously
  + Option 3: The issue is discussed under mobility enhancement WI
* Recommended WF
  + Further collect views. It may need coordination with mobility enh2 WI if option 3 is agreeable.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not discuss anything not immediately related to this WI. No cross-WI discussion is recommended. |
| Huawei | Option 2. There is no need to coordinate with R18 mobility enh2 WI. |
| Ericsson | For inter-cell mTRP and BM framework, when UE supports simultaneous reception from two QCL type-D, L1-RSRP measurement requirements are impacted. Since some occasions of L1-RSRP and L3-RSRP measurements are shared, we think RAN4 need to discuss L3 measurements at least in the inter-cell mTRP and BM framework. |
| Apple | We agree at least this topic can be deprioritized. |
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**Issue 1-1-2-3: Support of single-DCI and/or multi-DCI multi-TRP operation**

* Proposals
  + Option 1: Define RRM requirements depending on UE behaviour for single-DCI and multi-DCI multi-TRP operation
  + Option 2: Define RRM requirements for single-DCI multi-TRP operation
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 2. It is the main scenario of the WI. Multi-DCI based m-TPR means two separate PDSCHs which is not the original intent of the item. Those PDSCHs are not always going to be SDMed. |
| Ericsson | We can further discuss if the Rel-18 features are in the scope or not. |
| Apple | We are open to further discussion. |
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**Issue 1-1-2-4: Whether and how to define power saving related requirements**

* Proposals
  + Option 1: Power saving can be additional requirements of UE with multiple RX chains
  + Option 2: Power saving is not part of this study
  + Option 3: no need to define additional requirements for power saving.
* Recommended WF
  + Further collect views. Proponent needs to elaborate the proposal so that RAN4 can have same understanding on the proposal.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not have a separate issue item for this. |
| Huawei | Option 3. The UE implementation from power consumption perspective can be considered, but there is no need to define additional requirements for it. |
| Ericsson | Agree with QC. And support option 2 and 3. |
| Apple | We’d like to understand what power saving requirement is. More details are appreciated. |
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**Issue 1-1-2-5: Applicability of existing requirements for UE with the capability of simultaneous reception from different directions**

* Proposals
  + Option 1: The existing legacy RRM requirements continue to apply by default, unless a corresponding new enhanced requirement is introduced.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not have a separate issue item for this until any specific/explicit issue is identified by any company. |
| Huawei | RAN4 needs to study which RRM aspect will be impacted firstly. For the non-impacted RRM aspects, obviously the legacy RRM requirements are applied. |
| Ericsson | This is our proposal. We would like to provide bit of clarification. We would like to point that in the existing specification it is mentioned that NO requirements apply as RRM requirements are not supported for different QCL type-D. In case if we do not define requirements for any particular subtopic, we can agree that existing requirement apply instead of NO requirements. |
| Apple | Our initial view is we can discuss the applicability of requirements later. |
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**Issue 1-1-2-6: Applicability of new requirements for UE with the capability of simultaneous reception from different directions**

* Proposals
  + Option 1: A clarification is added in clause 3.6.13 of TS 38.133 (Applicability of requirements for FR2) that the new requirements defined in this WI are applicable only for FR2-1.
* Recommended WF
  + It would be too early to consider how the requirements are specified. Can we agree with high principal on applicability of requirements at this stage? Moderator would like to propose following WF.
  + Recommended WF: New requirements defined in the multi-Rx chain WI are applicable for FR2-1 only.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Okay with Recommended WF. Do we need a technical discussion on this? |
| Huawei | RAN4 needs to investigate the RRM impacts firstly. |
| Ericsson | Agree. We can discuss this at later stage. |
| Apple | Same comment as above. |
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**Issue 1-1-2-7: Accuracy assumption when defining RRM core requirements**

* Proposals
  + Option 1: The new improved RRM requirements should aim to reduce the delays during measurements and procedures (e.g., RLM evaluation period, measurement delays, etc.) while maintaining the existing accuracy requirements.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Do not support yet. No details and analysis at all. |
| Huawei | The accuracy related impacts can be further studied after completing core part. |
| Ericsson | What we mean here is there is no use if we compromise accuracy while we trying to improve e.g., measurement period related aspects. We think this can be taken as a baseline rule. |
| Apple | More discussion is needed. |
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**Issue 1-1-2-8: Applicability of new requirements to different QCL types**

* Proposals
  + Option 1: RAN4 to discuss whether the new requirements will also be applicable when QCL type D is configured together with QCL type A and QCL type C
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Ericsson | We can further study it |
| Apple | More discussion is needed. |
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**Issue 1-1-2-9: Requirements applicability for serving cells**

* Proposals
  + Option 1: Defining new improved requirements for serving cells (PCell, PSCell, and SCells, whichever are relevant for each such requirement) as well as for non-serving cells.
* Recommended WF
  + Further collect views. Proponent would need to clarify the proposal, especially on how multiple serving cells are taken into account by considering single carrier operation as discussed in Issue 1-1-2-1.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | It seems there are multiple places where we have a similar topic/issue. Please do not repeat this. |
| Huawei | RAN4 focus on investigating RRM impacts firstly. |
| Ericsson | We think this is mTRP scenario, hence proposal is reasonable. |
| Apple | We can focus on single carrier for now. |
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**Issue 1-1-2-10: RS signals that shall remain detectable during measurement period**

* Proposals
  + Option 1: In an improved RRM requirement relying on a certain QCL relationship (QCL type D), not only the target signal but also the associated signal in the QCL information shall remain detectable during the entire measurement period.
* Recommended WF
  + Further collect views. Proponent may further elaborate the proposal.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Do not fully get the point of Option 1. |
| Huawei | The “RRM requirement relying on a certain QCL relationship” is not clear to us. |
| Ericsson | What we mean is if the target RS configured with reference RS as QCL source, we think reference RS also should be detectable through out the measurement period. As companies commented for some other issues, this may be early stage for detailed discussion. This can be discussed at later meetings. |
| Apple | Such side conditions can be discussed later. |
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**Issue 1-1-3: Feasibility/necessity of enhancing requirements for L1 measurements**

* Proposals
  + Option 1: FFS whether Following L1 measurements related requirements are enhanced in the multi-Rx chain DL reception WI
    - L1-RSRP measurement
    - BFD/CBD
    - RLM
    - L1-SINR
    - TCI state switching with dual TCI
    - Scheduling/measurement restrictions
  + Option 2: FFS whether Following L1 measurements related requirements are enhanced in the multi-Rx chain DL reception WI
    - L1-RSRP measurement
    - BFD/CBD
    - L1-SINR
    - TCI state switching with dual TCI
    - Scheduling/measurement restrictions
* Recommended WF
  + Agree on option 1 with the understanding that RLM requirements enhancement are not for specifying TRP specific requirements.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Do not support any yet. Not clearly how much this wording “enhanced” is aiming for. |
| Huawei | It is too early to conclude on which type of RRM requirements can be enhanced. |
| Ericsson | We support the proposal 1 in general. These are the requirements we discussed in Rel-17 FeMIMO WI, with dual RX chain we think at least these requirements will be impacted or can be enhanced. |
| Apple | With FFS, Option 1 is OK. |
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**Issue 1-1-4: Feasibility/necessity of enhancing requirements for L3 measurements**

* Proposals
  + Option 1: Following L3 measurements related requirements are enhanced in the multi-Rx chain DL reception WI
    - RRM measurement requirements for RRC-IDLE state and for RRC\_INACTIVE state.
    - Handover to FR2-1 unknown cell
    - FR2-1 unknown SCell activation
    - FR2-1 unknown PSCell addition and release
    - For L3 measurement in connected mode, including all the existing scenarios (intra-frequency measurements without MG, intra-frequency measurements with MG, inter-frequency measurement with MG, inter-frequency measurement without MG).
  + Option 1a: Following L3 measurements related requirements are enhanced in the multi-Rx chain DL reception WI
    - Handover to FR2-1 unknown cell
    - FR2-1 unknown SCell activation
    - FR2-1 unknown PSCell addition and release
    - For L3 measurement in connected mode, including all the existing scenarios (intra-frequency measurements without MG, intra-frequency measurements with MG, inter-frequency measurement with MG, inter-frequency measurement without MG).
  + Option 2a: Not to enhance L3 measurement requirement in R18 multi-panel WI.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 2a.  Let’s do not extend the scope beyond the original scope and repeat the same question in multiple places. |
| Huawei | Support option 2a.  The impacts on L3 measurements due to enhancements on L1 measurements can be studied. But there is no need to enhance L3 measurements due to RSs with different QCL-typeD. |
| Ericsson | In FeMIMO WI though it is about the MIMO, we had to discuss L3-RSRP and L1-RSRP assumptions. Since they share some of the measurement occasions, we think RAN4 need to discuss L3 measurements impacts may be due to enhanced measurement occasions for L1-RSRP. |
| Apple | Our view is let’s identify the need and use cases of L3 measurement enhancements. |
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**Issue 1-1-5: Receive time difference**

* Proposals
  + Option 1: The timing difference between different panels is at least within one CP. FFS whether to define requirements with timing difference larger than one CP.
  + Option 1a: The condition of receive timing difference between different directions with different TCI of QCL type-D shall take CP length as baseline.
  + Option 1b: Receive time difference for configured different QCL Type D RSs is within CP. FFS receive time difference for configured different QCL Type D RSs is larger than CP.
  + Option 1c: If we define cases where ∆τ > CP then we define a total MRTD budget, where ∆τ = TAE + ∆propagation and ∆τ < MRTD. This way TAE and ∆propagation can be balanced as terms, within the total MRTD budget.
  + Option 1d:
    - Option a: If keep the assumption of single FFT as in Rel-17, the receive timing difference between different directions should be not larger the CP length. But the legacy MRTD under inter-band CA is much larger than CP length for FR2-1, which is beyond UE capability.
    - Option b: If UE is capable of supporting two FFTs for different TRP or panel/RF chain reception, the restriction of not larger the CP length can be ignored, so re-using the legacy requirement for inter-band CA is fine.
  + Option 2: The receive timing difference between different directions is within CP
  + Option 2a: Check whether it is available that the maximum receive timing difference between the DL transmission from two TRPs is within CP according to RAN2 specification.
  + Option 3: Given that independent RF and BB processing is of necessity to support two distinct AoAs, no restriction on MRTD between different directions (different QCL Type D RSs) should be provided
  + Option 4: Study UE RX capability receiving extended MRTD based on non-collocated mTRP deployment scenario.
  + Option 5: Clarify the scope of this item and discuss whether existing spec can be modified for multi Rx chain UE or not under the clarified scope for receive timing difference between different directions.
* Recommended WF
  + Further collect views.
  + Since views are quite diverse, moderator would encourage companies to provide views by taking all the 1st round comments into consideration.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Do not support anything.  We are not sure even within-CP is okay if we take UL into consideration. To our understanding, the major target scenario of the WI is for a UE capable of receiving one PDSCH with one CW from two geographically separated TRPs while transmitting UL one specific TRP at a time. As the UE will apply one TA to UL transmission whichever TRP is scheduled for the transmission. Therefore, the max Rx time different here is not just about whether UE can deal with the Rx time different or not. The impact on UL should also have to be taken into consideration. |
| Huawei | This issue can be further studied, and there is no need to conclude on it during this meeting cycle. |
| Ericsson | We can further study this. |
| Apple | We are OK to further discuss it, including the point raised by QC. |
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**Issue 1-1-6: UE capabilities**

*Since proposals for Issue 1-1-6 are focusing on different aspects of UE capabilities, it is further split as follows for efficient discussion.*

**Issue 1-1-6-1: UE capability of simultaneous reception of measured RS and data**

* Proposals
  + Option 1: Consider simultaneous reception of L1/L3 measured RS and data if UE supports simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.
  + Option 2: Consider simultaneous reception of L1 measured RS and data if UE supports simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.
  + Option 3: For scenario 2 (two RX beams used for different cells) with multi-RX chain capability, UE can receive PDCCH/PDSCH/TRS/CSI-RS for CQI (one beam) and on SSB symbols (another beam) to be measured
  + Option 4: RAN4 to discuss if additional UE capability for indicating supporting of simultaneous reception with different QCL type D RS and PDSCH/PDCCH is needed.
  + Option 5: UE is not required to simultaneous reception on both L1/L3-measured RS and data if L1/L3-measured RS and data are from different directions with different QCL TypeD RSs.
* Recommended WF
  + Is Option 2 agreeable? In addition, if option 4 to define new UE capability is agreeable.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Do not support anything yet in this meeting. |
| Huawei | This issue can be further studied, and there is no need to conclude on it during this meeting cycle. |
| Ericsson | We are OK to further study this. |
| Apple | We can discuss UE capability later. |
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**Issue 1-1-6-2: Clarification/understanding on existing UE capabilitiy *simultaneousRxDataSSB-DiffNumerology***

* Proposals
  + Option 1: Clarify whether UE can perform SSB based measurement using multi-antenna panels when UE supports *simultaneousReceptionDiffTypeD*.
  + Option 2: The existing *simultaneousRxDataSSB-DiffNumerology* IE can be re-used for FR2
  + Option 3: RAN4 shall not introduce new, but reuse Rel-16 UE capability IE *simultaneousReceptionDiffTypeD-r16*, to indicate enhanced FR2-1 UEs supporting simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier.
  + Option 4: It is assumed that UE is capable of supporting simultaneous reception from two different directions with two different QCL type D RSs.
* Recommended WF
  + Companies is encouraged to provide understanding on existing UE capability *simultaneousRxDataSSB-DiffNumerology*. In addition, how this UE capability is used in this WI, e.g., if use cases for existing UE capability can be extended.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Are we the group that has to clarify the capability? |
| Apple | Further discussion is needed. |
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**Issue 1-1-6-3: UE behaviour and capability of handling Rx signal level difference between two channels**

* Proposals
  + Option 1: Study UE behaviours and capability of multiple RX chains regarding handling Rx signal level difference between two channels.
  + Option 2: Discuss in RF session
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Do not need to consider the issue. If the Rx power at one panel is much different from that on the other panel, anyway it would be hard to expect a 4-layer MIMO. |
| Huawei | Option 2. The power imbalance between different TRP/panels need to be discussed in RF session. |
| Ericsson | We do not think this issue has to be discussed. If companies pointing to this something like power difference discussed during DAPS, we would like to point that it is different than DAPS. |
| Apple | RF session will consider it when specifying the new EIS spherical coverage requirement. |
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**Issue 1-1-6-4: UE capability for L3 measurement enhancement for UE supporting multi-Rx chain simultaneous reception**

* Proposals
  + Option 1: A new capability, different from simultaneousReceptionDiffTypeD-r16 or other L1 measurement related UE capability, should be introduced for L3 measurement delay reduction for UE supporting multi-Rx chain simultaneous reception.
  + Option 2: Same UE capability as for L1 measurement
* Recommended WF
  + Depending on issue 1-1-4. Interested companies further provide views on this issue.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not this separately. L3 measurement related topics are, if we are not wrong, present in other issue items too. |
| Huawei | Whether L3 measurements need to be enhanced is still FFS. |
| Ericsson | Can be FFS |
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**Issue 1-1-7: UE architectures**

* Proposals
  + Option 1: The scope of a RX chain architecture includes possible implementations and UE capabilities as below:
    - Multiple Antenna panel
    - Multiple Antenna panel + AGC
    - Multiple Antenna panel + AGC + front-end (time and frequency sync)
    - Multiple Antenna panel + AGC + front-end + Demod/RRM
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | More discussion is needed. |
| Huawei | The assumptions for antenna panel, AGC and front-end need be discussed in RF session. |
| Ericsson | Not sure RRM is the session to discuss this. We think requirements should be architecture independent. |
| Apple | RF session will look at it. |
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**Issue 1-1-8: Beam management**

* Proposals
  + P1: RAN4 can consider two options for beam management for UE with multiple RX chains
    - Option-(i) Reuse independent beam management concept (IBM) from Inter-band CA study
    - Option-(ii) define panel or RX chain specific behaviors with RX panel control signal for DL
  + P2: Study independent beam managements for different QCL-D sources with multiple TRPs, and also study other QCL channel property impacts of {average gain, delay shift and doppler shift} for multi-RX chain requirements.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Let’s do not discuss if nothing has changed from the first round. |
| Huawei | RAN4 focus on the impacts on L1-RSRP measurement requirments. |
| Ericsson | Can be further studied. |
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**Issue 1-1-9: Dependent on RF conclusions**

* Proposals
  + Option 1: RRM requirement of simultaneous DL reception from different directions shall be defined based on applicable conditions/architecture to be concluded in UE RF session.
  + Option 2: RRM requirements discussion and RF discussion are in parallel.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | The overall transceiver architecture needs to be first studied in RF. In case any conflict between sessions (RF and RRM) RRM should not proceed with work based on kind of RRM-only assumptions. |
| Huawei | We are fine with option 1 generally. |
| Ericsson | We think option 2 and if any issue is identified, we can revisit that issue. |
| Apple | Option 1 is fine. |
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#### Sub-topic 1-2: L1 measurements related

**Issue 1-2-1: Scenarios for L1 measurement requirements enhancements**

* Proposals
  + Option 1: R16 intra-cell mTRP, i.e., reception on two TRPs from one cell at a time, as a start point.
  + Option 2:
    - R16 intra-cell mTRP, i.e., reception on two TRPs from one cell at a time, as a start point.
    - Discuss R17 inter-cell BM/mTRP after the requirement of single serving cell is concluded
  + Option 3: Both intra-cell m-TRP operation scenario and inter-cell m-TRP operation scenario should be supported. The discussion can be going in parallel.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 1. It is anyway what the group has to consider no matter what. |
| Huawei | Option 1, FFS inter-cell case. |
| Ericsson | Option 3. |
| Apple | We can start with Option 1. |
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**Issue 1-2-2: General part for L1 measurement requirements enhancements**

*Since proposals for Issue 1-2-2 are focusing on different aspects of general part for L1 measurement requirements, it is further split as follows for efficient discussion.*

**Issue 1-2-2-1: Simultaneous reception of two different QCL-Type D RSs for L1 measurement**

* Proposals
  + Option 1: For the case when both different QCL-Type D RSs are received by two different UE Rx panels at a time, no measurement restriction and scheduling availability are needed because of beamforming conflict.
  + Option 2: For the case when two different QCL-Type D RSs are received by same UE Rx panel at a time, the legacy R15/R16 requirement (e.g., measurement restriction and scheduling availability) should be reused.
  + Option 3: UE is assumed to perform simultaneous data receptions with different beam directions or perform simultaneous L1 measurements with different beam directions.
  + Option 4: Simultaneous DL reception of same or different type of RSs from different directions is supported for defining L1 measurement requirements to support multi-TRP operation.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Ericsson | We can further study details in future meetings. |
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**Issue 1-2-2-2: whether measured RS samples can be reduced for L1 measurement delay in case of FR2 multi-Rx reception**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + Further collect views. Proponent is encouraged to elaborate the proposal with more details.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
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**Issue 1-2-2-3: Features for L1 measurement requirements enhancement**

* Proposals
  + Option 1: The study for L1-RSRP/RLM/BFD/CBD measurements for Reporting under CCA, for RedCap and for satellite access should be discussed later based on the normal case agreements.
  + Option 2: The study for L1-RSRP/RLM/BFD/CBD measurements for Reporting under CCA, for RedCap, for satellite access, and for a cell with different PCI from serving cell should be discussed later based on the normal case agreements.
  + Option 3: Deprioritize joint feature of multi-Rx chain DL reception and other features.
* Recommended WF
  + Further collect views and justifications.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Option 3. We don’t even have to discuss this. Clearly out of scope. |
| Huawei | Option 3. |
| Ericsson | If the Inter-cell BM is used in any of the said features, we do not see the reason why we need to limit the use case. Having said that this can be discussed later also. |
| Apple | Option 3 is reasonable. |
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**Issue 1-2-3: L1-RSRP measurement requirements enhancement**

*Since proposals for Issue 1-2-3 are focusing on different aspects for L1-RSRP measurement requirements, it is further split as follows for efficient discussion.*

**Issue 1-2-3-1: Aspects for L1-RSRP measurement requirements enhancement**

* Proposals
  + Option 1: FFS whether L1-RSRP measurement requirements can be enhanced on following aspects
    - Beam sweeping factor *N*
    - Sharing factor *Psharing factor* for both SSB based measurement and CSI-RS based measurement
    - Measurement restrictions for both SSB based and CSI-RS based L1-RSRP
    - Scheduling restrictions for both SSB based and CSI-RS based L1-RSRP
* Recommended WF
  + Agree on option 1.
  + Note: other aspects to enhance for L1-RSRP measurements requirements are not precluded.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | FFS whether the above aspects can be enhanced. |
| Ericsson | We think above aspects can be studied for enhanced requirements. |
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**Issue 1-2-3-2: impacts on sharing factors PSC and PCDP when UE is performing simultaneous L1-RSRP measurements on two RSs from different TRPs**

* Proposals
  + Option 1: Study the conditions when UE is able to perform simultaneous L1-RSRP measurements on two RSs from different TRPs, and investigate the impacts on sharing factors PSC and PCDP.
* Recommended WF
  + Agree on option 1 if possible.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Ericsson | FFS |
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**Issue 1-2-3-3: SSB based L1-RSRP measurement period**

* Proposals
  + Option 1: L1-RSRP measurement period: SSB-only based L1-RSRP measurement reporting does not benefit from QCL type D information.
* Recommended WF
  + Further collect views. Clarification/justification for the proposal are encouraged.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | Can’t even understand what this is about. |
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**Issue 1-2-3-4: Requirements enhancement for inter-cell L1-RSRP measurement**

* Proposals
  + Option 1: Requirements for inter-cell L1-RSRP measurement are enhanced for UE supporting multi-Rx chain simultaneous reception.
* Recommended WF
  + Further collect views. Agree on option 1 if possible.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | No. Why inter-cell? Let’s do not repeat more or less same issue that is mentioned in other Issue items. |
| Huawei | RAN4 needs to study intra-cell case firstly. |
| Ericsson | As said earlier we can study intra-cell and inter-cell in parallel. |
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**Issue 1-2-3-5: Number of cells with PCI different from serving cells for inter-cell BM**

* Proposals
  + Option 1: Number of cells with PCI different from serving cells are further discussed for UE supporting multi-Rx chain simultaneous reception and the max number of cells is 8.
* Recommended WF
  + Further collect views and more options.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | No! again, why do we repeat the same discussion. If recall correctly, there are issues about whether to consider intra-cell vs. inter-cell. |
| Huawei | FFS inter-cell case. |
| Ericsson | This is same capability considered for inter-cell BM. We think this can be reused. We are fine to keep this FFS. |
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**Issue 1-2-4: L1-SINR measurement requirements enhancement**

* Proposals
  + Option 1: FFS whether L1-SINR measurement requirements can be enhanced on following aspects
    - Beam sweeping factor *N*
    - Sharing factor *Psharing factor* for both SSB based measurement and CSI-RS based measurement
* Recommended WF
  + Agree on option 1.
  + Note: Other aspects to enhance for L1-SINR measurements requirements are not precluded.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | FFS whether the above aspects can be enhanced. |
| Ericsson | FFS |
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**Issue 1-2-5: BFD/CBD measurement requirements enhancement**

*Since proposals for Issue 1-2-5 are focusing on different aspects for BFD/CBD measurement requirements, it is further split as follows for efficient discussion.*

**Issue 1-2-5-1: Aspects for BFD/CBD measurement requirements enhancement**

* Proposals
  + Option 1: FFS whether BFD/CBD measurement requirements can be enhanced on following aspects
    - Beam sweeping factor *N*
    - Sharing factor *Psharing factor* for both SSB based and CSI-RS based BFD/CBD
    - Measurement restrictions for both SSB based and CSI-RS based BFD/CBD
    - Scheduling restrictions for both SSB based and CSI-RS based BFD/CBD
    - The scaling factor PTRP for TRP specific requirements
* Recommended WF
  + Agree on option 1.
  + Note: Other aspects to enhance for BFD/CBD measurements requirements are not precluded.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | FFS whether the above aspects can be enhanced. |
| Ericsson | Support the proposal as these requirements are defined as part of inter-cell BM and we think they can be enhanced with multi-RX chain- |
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**Issue 1-2-5-2: Simultaneous BFD/CBD measurements on two RSs from different resource sets**

* Proposals
  + Option 1: In R18, the enhancement on simultaneous BFD/CBD measurements on two RSs from different resource sets can be considered.
  + Option 2: In R18, RAN4 needs to study the conditions when UE is able to perform simultaneous BFD/CBD measurements on two RSs from different resource sets, and investigate the impacts on sharing factor PTRP.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Ericsson | We think both options are okay and we are fine to further study it. |
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**Issue 1-2-5-3: BFD/CBD measurement requirements enhancement for TRP specific link recovery**

* Proposals
  + Option 1: Requirements for TRP specific link recovery are enhanced for UE supporting multi-Rx chain simultaneous reception.
* Recommended WF
  + Further collect views. Agree on option 1 if possible.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Ericsson | Support it. As a general rule, the requirement defined in Rel-17 FeMIMO assuming single RX chain can be enhanced when UE supports multi-RX chain. |
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**Issue 1-2-6: RLM measurement requirements enhancement**

* Proposals
  + Option 1: FFS whether RLM measurement requirements can be enhanced on following aspects
    - Beam sweeping factor *N*
    - Sharing factor *Psharing factor* for both SSB based and CSI-RS based RLM
    - Measurement restrictions for both SSB based and CSI-RS based RLM
    - Scheduling restrictions for both SSB based and CSI-RS based RLM
* Recommended WF
  + Agree on option 1.
  + Note: Other aspects to enhance for RLM measurement requirements are not precluded.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | FFS whether the above aspects can be enhanced. |
| Ericsson | Can be FFS. |
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#### Sub-topic 1-3: TCI state switching

**Issue 1-3-1: General considerations for TCI related**

*Since proposals for Issue 1-3-1 are focusing on different general aspects for TCI state switching related requirements, it is further split as follows for efficient discussion.*

**Issue 1-3-1-1: Independent TCI switching for dual TCIs for multi-Rx chain UE**

* Proposals
  + Option 1: Each TCI switching per RX chain is assumed to be independent in aspect of TCI switching delay. RAN4 to study if Rel-17 TCI switching delay requirements can be applicable as Rel-18 UE requirements with multi-RX chains.
  + Option 2: RAN4 to study if a UE with multiple RX chains tracks time and frequency per TCI when dual TCIs are activated per RX chain.
  + Option 3: RAN4 to discuss the requirements for any change to the set of active TCI states used for simultaneous reception, e.g., active TCI state switching within this set.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | We are open to further investigate whether the TCI switching can be considered as independent and the corresponding conditions. It is too early to draw the conclusion on this. |
| Ericsson | We agree that details need to be looked into and in general all options can be further studied. |
| Apple | Further discussion is needed. |
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**Issue 1-3-1-2: TCI framework for dual TCIs**

* Proposals
  + Option 1: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.
  + Option 2: To define requirements for TCI switching delay with dual TCI, both R15/R16 TCI framework and R17 TCI framework, i.e., unified TCI, are considered for UE supporting multi-Rx chain simultaneous reception.
* Recommended WF
  + Further collect views. It may need coordination with R18 MIMO evo WI.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | Support option 1. Unified TCI is not jointly considered with mTRP in RAN1 and it will be considered in Rel-18 MIMO. Thus, this WI in RAN4 should base on R15/16 framework. |
| Ericsson | Option 2 |
| Apple | Further discussion is needed. |
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**Issue 1-3-1-3: Cases for defining dual TCI state switching requirements**

* Proposals
  + Option 1: Define dual TCI state switching requirements for following cases:
    - PDCCH non-SFN: Two MAC CE with one for each TCI state
    - PDCCH SFN: single MAC CE for two TCI states
    - PDSCH single DCI: single DCI for two TCI states
    - PDSCH multiple DCI: Two DCI with one for each TCI state
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | There are already items that need to be discussed/determined before this one, particularly about whether to consider multi-DCI. |
| Huawei | Open to further discuss the feasible/typical scenarios. |
| Ericsson | Can be FFS |
| Apple | Further discussion is needed. |
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**Issue 1-3-1-4: Inside-panel TCI state switching and cross-panel TCI state switching**

* Proposals
  + Option 1: Except for the consideration of reduction of Rx beam number, considering inside-panel TCI state switching and cross-panel TCI state switching are both possible, so additional panel/RF chain switching time should be considered within the TCI state switching latency for the case of cross-panel TCI state switching.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | More clarification is needed. From our understanding, whether it is an inside-panel or cross-panel TCI switching is transparent to gNB, then what is the definition/conditions for them. |
| Ericsson | Can be discussed RF session. |
| Apple | Further discussion is needed. |
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**Issue 1-3-1-5: Whether number of active TCI states can be larger than the UE capability for simultaneous reception**

* Proposals
  + Option 1: RAN4 to discuss whether there is an issue when the number of active TCI states is larger than the UE capability for simultaneous reception.
* Recommended WF
  + Further collect views. Proponent is encouraged to elaborate the proposal.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | Not fully understand the case. Is it possible that more than 2 TCI states are activated simultaneously? |
| Apple | Further discussion is needed. |
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**Issue 1-3-2: Known/unknown conditions for TCI state switching for multi-Rx chain**

* Proposals
  + P1: Study whether TCI state switching delay can be modified or not for multi Rx chain UE, e.g. how to evaluate known/unknown condition by using multi Rx chain, how to define TCI state change delay by the cases that dedicated Rx chain is used, partial Rx chains are used, or all Rx chains are used.
  + P1a: For MAC-CE based TCI state switch delay with unknown target TCI state, the reduction on switch delay requirements can be considered (i.e. consider the improvement of TL1-RSRP with multiple simultaneous reception)
  + P1b: For dual TCI state switching delay requirements, which scenarios of triggering, known/unknown TCI state and TCI association to different PCI could be considered and clarified.
  + P1c: Discuss the known conditions of dual TCI and discuss whether to define requirements for unknown dual TCI state switch.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | We are open to further discuss the proposals on known conditions. From our understanding, it may depend on the targeting scenario. If dual TCI switching is considering, then the known conditions shall cover dual TCI states, and additional conditions may be needed that these two TCI states are those UE can simultaneous receive with. |
| Ericsson | FFS |
| Apple | Further discussion is needed. |
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**Issue 1-3-3: Enhancement for TCI state switching delay requirements**

* Proposals
  + P1: For dual TCI state switch, the legacy TCI state switch delay requirement can be reused
  + P2: The new RRM requirements defined for simultaneous measurements and procedures on two chains need to apply, provided the corresponding active TCI states are configured and used for simultaneous reception during the measurement or evaluation period.
  + P3: The legacy TCI state switching delay requirement can apply for each RX beam.
* Recommended WF
  + Further collect views.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Qualcomm | FFS |
| Huawei | We are open to further discuss. It is too early to say legacy requirement can apply to each. |
| Ericsson | FFS |
| Apple | Further discussion is needed. |
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#### Sub-topic 1-4: L3 measurements related

*All the L3 measurements related proposals are depending on issue 1-1-4. There are different views on issue 1-1-4 in the 1st round and it seems not be easy to converge. No further discussion in the 2nd round on this sub-topic.*

**Issue 1-4-1: General part for L3 measurement requirements enhancements**

* Proposals
  + P1: In R18, it is suggested that the existing L3 measurements can be reused for FR2 UEs capable of simultaneous DL reception from different directions.
  + P2: Study whether measured RS samples can be reduced for L3 measurement delay in case of FR2 multi-Rx reception
  + P3: Cell detection and L3 measurement period, SSB-based:
    - No direct benefit from QCL type D information,
    - FFS: impact on CSSF.
  + P4: L3 measurement period, CSI-RS based: simultaneous measurements for signals with QCL type D can reduce the measurement period.
  + P5: Scaling factor for Rx beam sweeping for FR2-1 can be reduced by 2
    - FFS for HST scenario
  + P5a: The assumption of Rx beam number during cell identification/measurement can be reduced
  + P5b: Scaling factor of RX beam sweeping can be reduced with UE using its two RX beams for simultaneous measurement for one cell.
* Recommended WF
  + Discussion is held on in the 2nd round.

**Issue 1-4-2: How the requirements for L3 measurements in IDLE/INACTIVE mode are enhanced**

* Proposals
  + P1: For cell re-selection requirements, *N1* value is further studied.
* Recommended WF
  + Discussion is held on in the 2nd round.

**Issue 1-4-3: How the requirements for L3 measurements in CONNECTED mode are enhanced**

* Proposals
  + P1: For L3 measurement in connected mode, with multi-beam simultaneous reception, Mpss/sss, Mmeas and MSSB\_index can be reduced.
  + P2: Scaling factor Klayer1\_measurement for intra-frequency measurement/inter-frequency measurement without gap should be studied whether it can be removed or relaxed.
  + P3: In R18, the existing scheduling restriction requirements for L3 measurements can be reused for the UE supporting simultaneous DL reception from different direction in FR2.
* Recommended WF
  + Discussion is held on in the 2nd round.

## Summary for 2nd round

# Topic #2: Work plan

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2213053 | vivo, Qualcomm | Work plan for RRM requirement for NR FR2 multi-Rx chain DL reception |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1: work plan

*Sub-topic description: This sub-topic is intended for discussing work plan for the WI.*

**Issue 2-1-1: Work plan for FR2 multi-Rx RRM requirements**

* Proposals
  + Option 1: Agree on work plan for RRM requirements in R4-2213053
* Recommended WF
  + Agree on work plan for RRM requirements in R4-2213053.

## Discussion on 2nd round

### Sub-topic 2-1: work plan

*Sub-topic description: This sub-topic is intended for discussing work plan for the WI.*

**Issue 2-1-1: Work plan for FR2 multi-Rx RRM requirements**

* Proposals
  + Option 1: Agree on work plan for RRM requirements in R4-2213053
* Recommended WF
  + Agree on work plan for RRM requirements in R4-2213053.
* 2nd round Comment collection:

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| **Company** | **Comments** |
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## Summary for 2nd round

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  | WF on FR2 multi-Rx RRM | vivo |  |
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**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2211642 |  | Discussion on Rel-18 multi Rx pannel RRM | CATT | Noted |  |
| R4-2211768 |  | Views on FR2 multi Rx chain DL reception | NTT DOCOMO, INC. | Noted |  |
| R4-2211883 |  | RRM requirements for NR FR2 multi-Rx chain DL reception | Apple | Noted |  |
| R4-2211940 |  | Discussion on RRM requirements for simultaneous DL reception from different directions | CMCC | Noted |  |
| R4-2211978 |  | On multi-RX chain | Xiaomi | Noted |  |
| R4-2212062 |  | Initial discussion on RRM requirements for simultaneous DL reception from different directions | OPPO | Noted |  |
| R4-2212180 |  | Impacts on RRM to support FR2 multi-Rx chain DL reception from multi-TRP | Qualcomm Incorporated | Noted |  |
| R4-2212219 |  | Discussion on RRM for simultaneous DL reception from different directions | LG Electronics Inc. | Noted |  |
| R4-2212466 |  | Discussion on RRM requirements for simultaneous DL reception from different directions | Samsung | Noted |  |
| R4-2212512 |  | Discussion on simultaneous DL reception from different directions | MediaTek Inc. | Noted |  |
| R4-2212688 |  | Discussion on RRM requirements for FR2 multi-Rx chain reception | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2213053 |  | Work plan for RRM requirement for NR FR2 multi-Rx chain DL reception | vivo, Qualcomm | Return to |  |
| R4-2213054 |  | Discussion on RRM requirements for multi-chain DL reception | vivo | Noted |  |
| R4-2213289 |  | Discussion on RRM requirements for simultaneous DL reception from different directions | ZTE Corporation | Withdraw |  |
| R4-2213495 |  | Discussion on RRM impacts for R18 FR2 multi-Rx chain DL reception | Huawei, HiSilicon | Noted |  |
| R4-2213872 |  | Discussion on RRM requirements for simultaneous DL reception from different directions | ZTE Corporation | Noted |  |
| R4-2213957 |  | Discussion on general RRM issues for simultaneous DL reception from different directions | Ericsson | Noted |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

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| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | LS on … | ZZZ | Agreeable, Revised, Noted |  |
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Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents