**3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-220XXXX**

**Electronic Meeting, Jan. 17th – 25th, 2022**

**Agenda item:** 6.19.3

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [101-bis-e][219] NR\_feMIMO\_RRM

**Document for:** Information

# Introduction

This e-mail discussion summary captured the discussions for Rel-17 FeMIMO RRM in RAN4 #101-bis-e meeting.

In RAN4 101-e meeting, two WFs were approved.

* **WF on FeMIMO RRM impact for unified TCI** was approved in R4-2120320; and
* **WF on FeMIMO RRM requirements for inter-cell beam management** was approved in R4-2120321.

In addition, two coming LS from RAN1 would be discussed.

In this e-mail discussion, the following topics are arranged based on agenda items.

* Topic #1: Unified TCI (6.19.3.1)
* Topic #2: Inter-cell beam management (6.19.3.2)
* Topic #3: Other RRM requirements (6.19.3.3)

Based on the e-mail discussions, WF (s) is expected to collect the meeting agreements for future discussions and CRs.

# Topic #1: Unified TCI

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4- 2200182 | MediaTek Inc | Proposal 1: To define the PL-RS switching delay requirement only when PL-RS and associated RS with spatial relation are the same RS.Observation 1: In R17 unified TCI state framework, for the unknown PL-RS, no switching delay requirement will be defined.Proposal 2: No requirement when the PL-RS or associated RS with spatial relation is unknown.Observation 2: For DCI based TCI state switch, the target PL-RS is maintained. For MAC CE TCI state based, the target PL-RS may be maintained or non-maintained.Proposal 3: For DCI based switch, DCI based UL TCI state switching requirements can be re-used for PL-RS switching delay, i.e., Y symbol.Proposal 4: For MAC CE based switch, the PL-RS switching delay requirement should consider the maintained and non-maintained cases.Proposal 5: For MAC-CE based UL TCI switch in separate UL/DL mode for serving cell, the delay requirement for known case is THARQ + $3N\_{slot}^{subframe,µ}$ + NM\*$\left⌈( T\_{first\\_target-PL-RS}+ 4\*T\_{target\\_PL-RS} + 2ms)/NR slot length\right⌉$, where NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.Proposal 6: For the MAC-CE/DCI based TCI-pair indication in separate UL/DL TCI states switch, the UL/DL state switch delay requirements can reuse the UL/DL delay requirement defined in separate TCI mode, respectively.Proposal 7: For MAC-CE based joint UL/DL TCI states switch, to define a total switching delay requirement for known case and delay the requirement is $T\_{HARQ}+3N\_{slot}^{subframe,μ}+max(NM×\left⌈T\_{first\\_target\\_PL-RS}+4×T\_{Target\\_PL-RS}+2ms/NR slot length\right⌉,TO\_{k}×\left⌈(T\_{first-SSB}+T\_{SSB-proc})/NR slot length\right⌉)$.Proposal 8: For DCI based switch, the new TCI state should be applied starting from the first slot that is at least Y symbols after the last symbol of the PUCCH containing ACK corresponding to DCI indication.Proposal 9: For common TCI switching delay for CA case, reuse the delay requirement as the TCI state switching for single CC, with the clarification that the first slot to apply the new TCI state is determined on the CC with the smallest SCS among the CCs which applying the beam indication.Proposal 10: For known non-serving cell, re-use serving cell's R17 MAC-CE/DCI based unified TCI switching delay requirements. |
| R4-2200277 | Apple | Known ConditionProposal #1: Re-use the existing known conditions for associated DL-RS for joint and separate DL/UL TCI for MAC CE and DCI based switch.Proposal #2: Define switching delay for UL TCI state associated with DL-RS based on command decoding time and whether the target TCI state is * Known or unknown
* Associated PL-RS is maintained

MAC CE based switchProposal #3: Define MAC -CE based switching delay for UL TCI state associated with DL-RS as:THARQ + 3ms + NM\*(Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) for known TCITHARQ + 3ms + TL1-RSRP + (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) for unknown TCI*Observation #1: For joint TCI state switch referring to DL and UL switching delay to define joint TCI switch delay would count common processing delays in DL and UL twice, making the delay much longer than necessary.*Proposal #4: Define a total switching delay for joint TCI state switching requirements. Proposal #5: Define joint TCI state switching delay from the slot switching command is received until UE can receive DL channel or transmit UL channel with target TCI state, whichever is later. Proposal #6: Define MAC CE based joint TCI state switch for known TCI state as: THARQ + 3ms + max{TOk\*(Tfirst-SSB + TSSB-proc) , NM\*( Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms)}Proposal #7: Define MAC-CE based switching delay requirements for unknown joint TCI state as:THARQ + 3ms + TL1-RSRP +max{TOuk\*(Tfirst-SSB+ TSSB-proc) , (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms)}Proposal #8: Define DCI based TCI state switching requirements for joint and separate DL and UL TCI.DCI based switchProposal #9: Define requirements for DCI based joint or separate DL/UL TCI state switching for known target TCI, TCI in active TCI list and maintained PL-RS. Proposal #10: Define DCI based joint or separate DL/UL TCI state switching delay as TACK +Y for known TCI state. TCI state switch associated with different PCI*Observation #2: The TCI state switch associated with different PCI would be either separate DL or joint TCI.* Proposal #11: Define TCI state switching requirements associated with different PCI for separate DL and joint TCI only. Proposal #12: Components of delay for TCI state switching associated with different PCI are (1) MAC-CE decoding or DCI processing time, (2) Time acquisition delay if target TCI was not in active TCI list monitored by UE, (3) Time for RX beam acquisition if target TCI state is unknown, (5) Time for Active BWP switch.Proposal #13: Discuss and define interruption requirements for TCI state switch associated with different PCI.  |
| R4-2200593 | ZTE Corporation | Proposal 1: The targets of Option 1 and Option 2 are same, considering Option 1 is aligned with RAN1’s conclusion and in line with RAN4’s definition habit, we prefer Option 1.Proposal 2: For joint TCI switch, for the case of different SCS between PDSCH/PDCCH and PUSCH/PUCCH/SRS, it should be determined which SCS is used to count Y. Proposal 3: For separate TCI switch with a pair of DL TCI and UL TCI, whether the case of only one of the two target TCI states is known allowed, which should be determined.Proposal 4: Considering for applying the unified TCI state in intra-band CA case, still reuse the existing known condition is enough, not need to update the known condition.Proposal 5: For simplicity, using Option 2 for both joint mode and separate mode can be tradeoff. Proposal 6: For separate mode with DL and UL TCI state switch delay, we also prefer to using Option 2.Proposal 7: Considering the PL-RS switch is not as frequently as UL TCI state switch, and actually UE can always maintain target PL-RS, we prefer Option 2 for the case of separate UL TCI state switch. Proposal 8: Based on the assumption that UE can always maintain the target PL-RS for the case of UL TCI state switch triggering PL-RS switch, we support re-using the UL TCI state switching requirements as PL-RS switching requirements. |
| R4-2200602 | vivo | Observation 1 The switching of TCIstate/SpatialRelation/PL-RS in R15/R16 does not necessarily cause interruption.Proposal 1 The requirements for UL TCI switching delay and requirements for PL-RS update delay are specified as two separate delay. For PL-RS activation delay, only specify requirements when PL-RSs are known.Proposal 2 RAN4 works on the PL-RS update delay requirements only for the case where PL-RS is identical to the spatial relation RS in the UL TCI, unless RAN1 reaches further conclusions on other cases.Proposal 3 If a MAC CE activates only one separate UL TCI, R16 MAC CE based spatial relation info update requirements can be reused for R17 MAC-CE based UL TCI state switch, for both known case and unknown case, and R16 MAC CE based PL-RS requirements can be reused for R17 PL-RS update delay caused by UL TCI switch.Observation 2 In R17 separate TCI, for MAC-CE based TCI state list updates, one MAC CE can update a list with mixed UL TCIs and DL TCIs.Proposal 4 RAN4 specify MAC CE based TCI state list update requirements comprising UL TCI list update delay, DL TCI list update delay, and the potential maintained PL-RS list update delay.Proposal 5 If the TCI state list update include both DL TCIs and UL TCIs, the endpoint of the TCI state switching delay is the later one between DL TCI switching delay and UL TCI switching delay.Proposal 6 If there is at least one unknown DL or UL TCI in the TCI list being activated, the requirement for TCI state list update delay follow the respective unknown case, i.e. extra delay for the respective L1-RSRP measurement is considered.Proposal 7 If a MAC CE activates only one joint TCI, the delay for TCI state switch and the delay for associated PL-RS update are separately specified, and the TCI switch delay comprises the overall delay for UE to apply the sync assumption, Rx spatial filter and Tx Spatial filter.Proposal 8 For MAC CE based joint TCI state list update, only specify requirements for the case when all TCI states are known.Proposal 9 For DCI-based joint TCI and separate TCI state switching in both single carrier case and CA case, the switching delay follows RAN1 agreements on beam application time.Proposal 10 Specify requirements for common TCI state switching delay in CA scenario, i.e. the switching delay between the TCI states whose QCL-D or UL TX filter is determined by a source RS in one of the CCs, while QCL-A or QCL-C is still determined by the RS in each CC.Proposal 11 Specify per-CC known status for the common TCI state.Proposal 12-1 For MAC-CE based common TCI state or common TCI state list update delay, if all TCI-CC pairs are known, UE follows the requirements of common TCI switch delay for known case, which is identical to single CC MAC CE based TCI state or TCI state list update delay for the known case.Proposal 12-2 For MAC-CE based common TCI state or TCI state list update delay, if any TCI-CC pair is unknown, and the total number of unknown TCI-CC pairs is within UE capability ‘beamManagementSSB-CSI-RS’, UE follows the requirements of common TCI switch delay for unknown case, which is identical to single CC MAC CE based TCI state or TCI state list update delay for the unknown case.Proposal 12-3 For MAC-CE based common TCI state or TCI state list update delay, if the total number of unknown TCI-CC pairs exceeds the UE capability ‘beamManagementSSB-CSI-RS’, no RRM requirements are defined.Proposal 13 RAN4 starts discussion on the RRM requirements for the addition of the ‘cell with different PCI’, while legacy requirements for MAC-CE based SCell activation can be used as baseline.Proposal 14 For MAC-CE based TCI state activation, if the TCI state being activated belongs to a cell with different PCI, UE need to check whether the ‘cell with different PCI’ is known before checking whether the TCI state is known.Proposal 15 For the known condition for the ‘cell with different PCI’, the known condition for deactivated SCell can be reused, except that the measurement period for ‘cell with different PCI’ should be the SMTC period for the intra-frequency L3 measurements.Observation 3 The L3 measurement periodicity considered for the activation requirements in ‘cell with different PCI’ can be much shorter than that for SCell activationObservation 4 How does network know whether UE has successfully switched the TCI to a ‘cell with different PCI’ not is still unclear based RAN1/RAN2 conclusions.Observation 5 Interruption is considered in intra-frequency DAPS HO due to the baseband and RF adjustments for the activation of another cell.Proposal 16 For MAC-CE based TCI state activation, if the TCI state being activated belongs to a cell with different PCI, and no TCI in the active TCI list is associated to this PCI, the TCI state switching delay need to comprise the time for activation of ‘cell with different PCI’, in which whether an interruption window is required needs further discussion in RAN4.Proposal 17 RRM Requirements for inter-cell BM under CA scenario are deprioritized in R17, and can be delayed to R18 if no enough time. |
| R4-2200642 | CMCC | Proposal 1: for MAC-CE based UL TCI switching in separate TCI mode for serving cell, for the case that a PL-RS is included in UL TCI state or joint TCI state, the existing requirements can be reused, which means the existing MAC-CE based pathloss reference signal switch delay requirements can be reused, but the terminology of UL spatial relation need to be updated by UL TCI state.Proposal 2: for MAC-CE based UL TCI switching in separate TCI mode for serving cell, for the case that a PL-RS is associated with UL TCI state or joint TCI state, UL TCI switching delay requirements and pathloss reference signal switching delay requirements can be specified separately, and the existing requirements can be reused. Proposal 3: For MAC-CE based DL/UL TCI switching delay in Joint TCI mode for serving cell, it is proposed to define the DL switching delay requirements and UL switching delay requirements separately.Proposal 4: For DCI based TCI state switching (joint or UL TCI), the delay requirements can be defined based on RAN1 agreements of Y symbols. Observation 1: according to existing spec, when the UL spatial relation info switch for PUCCH changes both the associated DL RS and pucch-PathlossReferenceRS with the same MAC-CE activation, and if both the DL RS and pucch-PathlossReferenceRS are known, the UE shall be able to transmit PUCCH with the target UL spatial relation after the delay specified for known pathloss reference signal switch.Observation 2: for the unknown case, either the associated DL RS for uplink spatial relation switching or pucch-PathlossReferenceRS are unknown, according to existing spec, a longer switching delay is allowed, which means there are no detailed requirements.Observation 3: for MAC-CE based UL TCI switching in separate TCI mode for serving cell, the case that a PL-RS is included in UL TCI state or joint TCI state is similar like the scenario specified in existing spec that both the associated DL RS for UL spatial relation info and pucch-PathlossReferenceRS are configured with the same MAC-CE activation. |
| R4-2200649 | Nokia, Nokia Shanghai Bell | **PL-RS switching delay requirement** **Proposal 1 :** Regarding how to capture the support of the PL-RS switching to non-serving cell in the spec : - Add non-serving cell support in TS.38133 chapter *8.14 PL-RS activation requirement*.  *The requirements in this clause apply for pathloss reference signal activated or updated on serving cell or [a cell configured with a different PCI] in MR-DC or standalone NR in clause 7.1.1 in TS 38.213.* - The requirement in *‘8.14.3 MAC-CE based pathloss reference signal switch delay’* can be reused.**Proposal 2 :** Review known conditions for supporting switching to non-serving cell in *“8.14.2 Known conditions for pathloss reference signal.”* (ex : add a condition of when a cell with a different PCI is configured with association of SSB indices and PCI indices.) **Active TCI switching delay to serving cell** **Proposal 3 :** MAC-CE based TCI switching delay does not have difference for a serving cell and non-serving cell.**Proposal 4 :** DCI based TCI switching delay does not have difference for serving cell and non-serving cell.**Switching delay for separate TCI/ Joint TCI****Observation 1 :** Unified TCI feature is the TCI switching framework in Rel-17. In physical layer operation, actual TCI switching is executed as DL TCI switching or UL TCI switching under Rel-17 unified TCI framework. **Proposal 5 :** For joint TCI, DL and UL requirements can be applicable respectively. ( also for a pair of DL and UL separate TCI )* For DL scheduling, the UE shall be able to receive PDCCH/PDSCH with the new target DL TCI state in the joint TCI at the first slot that is after a required DL switching delay in 8.10
* For UL scheduling, the UE shall be able to transmit PUCCH/PUSCH/SRS with the new target UL TCI state in the joint TCI at the first slot that is after a required UL switching delay in 8.12

( Reuse the current DL and UL TCI switching requirements )**Proposal 6 :** For a pair of DL and UL separate TCI switching requirements, the same requirement statements in Proposal 4 can be applicable.**Beam application time (BAT) for ‘indicated TCI’****Observation 2 :** The first slot to apply the **‘indicated TCI’** is at least Y symbols after the last symbol of the acknowledgment of the joint or separate DL/UL beam indication. The legacy DCI-based TCI switching delay requirement cannot be reused for the indicated TCI switching. **Proposal 7 :** Capture the statement below as a requirement for the indicated TCI switching delay to consider ‘Y symbol’ (= $BeamAppTime\\_r17$ symbols)  - *A UE shall be able to receive PDSCH with target TCI state of the serving cell [or non-serving cell] on which TCI state switch occurs at the first slot that is at least* $BeamAppTime\\_r17$ *symbols after the last symbol of the PUCCH with HARQ-ACK information.***Wording of “non-serving cell”****Proposal 8 :** Wording of “non-serving cell” needs to be aligned with RAN1/2 spec. TS38.214 uses wording as *“SS/PBCH block having a PCI different from the PCI of the serving cell”* rather than directly mention ‘a cell’. |
| R4-2200787 | Intel Corporation | Observation 1: If PL-RS is included in UL TCI state, PL-RS and associated RS in UL TCI state are identical. They will be known or unknown at the same time.Proposal 1: If PL-RS is included in UL TCI state and the TCI state is known, MAC-CE based uplink spatial relation switching delay requirements can be re-used for UL TCI switching delay.Proposal 2: If PL-RS is included in the UL TCI state and the TCI state is unknown, the delay requirement for UL TCI switching delay is:n+ THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP+$ \left⌈\frac{ 5\*T\_{target\\_PL-RS} + 2ms}{NR slot length}\right⌉$Observation 2: If PL-RS is associated with UL TCI state, PL-RS and associated RS in UL TCI are QCL-typeD. They will be known or unknown at the same time.Proposal 3: When PL-RS is associated with UL TCI sate and PL-RS is activated in the same MAC-CE with UL TCI state switching, if TCI state is known, legacy MAC-CE based uplink spatial relation switching delay requirements can be re-used.Proposal 4: If associated DL RSandPathloss Reference RSare unknown, the delay requirement is the same as the case when PL-RS is included in UL TCI state and the TCI state is unknown.Proposal 5: If PL-RS is associated with UL TCI state and PL-RS is not activated in the same MAC-CE with UL TCI state switching, the legacy MAC-CE based uplink spatial relation switching delay requirement for known case and unknown case can be re-used for UL TCI state switching.Proposal 6: MAC-CE based UL TCI switching delay will apply for PUCCH, aperiodic SRS, semi-persistent SRS and periodic SRS.Proposal 7: For MAC-CE based TCI state-pair indication, the TCI state switching delay requirement can be defined for UL TCI and DL TCI switching respectively.Proposal 8: UL TCI state switching requirements can be re-used for PL-RS switching delay if UL TCI state switching can trigger PL-RS switch.Proposal 9: Re-use the DL/UL TCI state switching delay respectively for joint TCI case.Proposal 10: For CA, DCI-based TCI switching delay is determined based on the carrier with the smallest SCS among the carrier(s).Proposal 11: For inter-cell TCI state switching, only define requirement for known TCI state case.Proposal 12: For inter-cell TCI state switching, define requirement when the BW of inter-cell is within the active BWP of the serving cell and the SCS are the same.Proposal 13: System information of inter-cell will be assumed to be known when defining delay requirement for TCI state switching for inter-cell.Observation 3: For uplink spatial info switch, no DL timing tracking is need since DL timing is unchanged.Observation 4: For UL TCI switching for inter-cell, DL timing of inter-cell may change and UE may need to perform DL timing tracking for Uplink if DL timing of inter-cell is not maintained. Observation 5: For UL TCI switching for inter-cell, UE may need to track DL timing for PL-RS if DL timing of inter-cell is not maintained. Proposal 14: For inter-cell UL TCI state switching, further discuss whether DL timing tracking for inter-cell is needed.Proposal 15: For inter-cell UL TCI state switching, further discuss whether there is any timing offset assumption.Proposal 16: Modify “non-serving cell” to “TRP with different PCI”. |
| R4-2201363 | Samsung | Proposal 1: RAN4 agreed the specification structure for switching delay requirements for unified TCI in RAN4 101bis meeting taking the above suggestions into account Proposal 2: Specify the PL-RS switching delay for known and maintained condition by specifying requirements as same delay requirements as UL TCI switching delay requirements, e.g., *slot n+ THARQ +* $3N\_{slot}^{subframe,µ}$for MACE-CE based PL-RS switching delay Proposal 3: For joint TCI with both uplink TCI and downlink TCI update case, separated delay requirements for downlink and uplink is applied.Proposal 5: It is suggested to apply known condition in current specification for both serving cell and non-serving cell TCI switch delay requirements. Proposal 6: Apply the existing TCI switch delay and spatial relation switch delay for intra-frequency non-serving cell downlink TCI and uplink TCI switch delay  |
| R4-2201384 | Ericsson | Proposal 1: RAN4 to agree that when a DCI based TCI state switch command is received at UE at slot n, and sends ACK at slot n+TACK, it should be able to receive on the new beam at n+TACK+ TBAT. Where TBAT is signalled by gNB based on the UE capability.Proposal 2: For CA cross-carrier scheduling, RAN4 to agree that, when a DCI based TCI state switch command is received at slot n, and sends ACK at slot n+TACK, it should be able to receive on the new beam at n+TACK+ TBAT. Where TBAT is signalled by the gNB based on the UE capability and the slot and beam application time are based on the carrier with smallest SCS.Proposal 3: Rel-16 MAC-CE based TCI state switching requirements to be reused for unified joint TCI state switching based on MAC-CE.Proposal 4: RAN4 to agree that when a DCI based TCI state switch command is received at UE at slot n, and sends ACK at slot n+TACK, it should be able to receive on the new beam at n+TACK+ TBAT. Where TBAT is signalled by gNB based on the UE capability. Proposal 5: For CA cross-carrier scheduling, RAN4 to agree that, when a DCI based TCI state switch command is received at slot n, and sends ACK at slot n+TACK, it should be able to receive on the new beam at n+TACK+ TBAT. Where TBAT is signalled by the gNB based on the UE capability and the slot and beam application time are based on the carrier with smallest SCS.Proposal 6: Rel-16 MAC-CE based TCI state switching requirements to be reused for unified separate TCI state switching based on MAC-CE. Proposal 7: Requirements for PL-RS update under TCI framework shall use the separate UL TCI state switch requirements/joint TCI state switch requirements. Proposal 8: RAN4 to agree that TCI switch delay requirements for target TCI is associated with non-serving cell should be same as target TCI is associated with serving cell.  |
| R4-2201616 | Huawei, HiSilicon | Proposal 1: The following TCI state switching delay requirements needs to be defined for R17 unified TCI framework.* MAC-CE based DL TCI state switching delay
* MAC-CE based UL TCI state switching delay
* DCI based DL TCI state switching delay
* DCI based UL TCI state switching delay

Proposal 2: The same DL TCI state switching delay requirements are applied when the target DL TCI state is indicated by a DL TCI state, a joint TCI state or a TCI pair.Proposal 3: The same UL TCI state switching delay requirements are applied when the target UL TCI state is indicated by a UL TCI state, a joint TCI state or a TCI pair.Proposal 4: The TCI state switching delay requirements for R17 unified TCI can be defined as follows:

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| --- | --- | --- | --- |
| ***Requirement Type*** | ***Known/Unknown*** | ***Switching Delay*** | ***Applicable cases*** |
| *MAC-CE based DL TCI state switching* | *known* | *THARQ +* $3N\_{slot}^{subframe,µ}$*+* *TOk\*(Tfirst-SSB + TSSB-proc)* | *DL TCI, joint TCI or TCI pair* |
| *Unknown* | *THARQ +*$3N\_{slot}^{subframe,µ}$ *+ TL1-RSRP +**TOuk\*(Tfirst-SSB+ TSSB-proc)* |
| *MAC-CE based DL TCI state switching* | *known* | *THARQ +* $3N\_{slot}^{subframe,µ}$*+ 1* | *UL TCI, joint TCI or TCI pair* |
| *Unknown* | *THARQ +*$3N\_{slot}^{subframe,µ}$ *+ TL1-RSRP +1* |
| *DCI based DL TCI state switching* | *Known only* | *THARQ + Y symbol* | *DL TCI, joint TCI or TCI pair* |
| *DCI based UL TCI state switching* | *Known only* | *THARQ + Y symbol* | *UL TCI, joint TCI or TCI pair* |

Proposal 5: For R17 unified TCI, the same DL/UL TCI state switching delay requirements are applied when the associated SSB for target TCI is with the serving cell PCI or with PCI different from the serving cell.Proposal 6: When the UE needs to update a PL-RS which is included in or associated with the UL/joint TCI state by DCI, the DCI based UL state switching delay can be reused as PL-RS switching delay. |

## Open issues summary

Please note that some proposals (issues) might be omitted by purpose as they are deprioritized in the 1st round discussion or out of the scope of [219].

### Sub-topic 1-1: Specification Structures of Unified TCI

**Issue 1-1-1 The Spec structures of Unified TCI State Switching Delay**

* Proposals
	+ Proposal 1: RAN4 agreed the specification structure for switching delay requirements for unified TCI in RAN4 101bis meeting, e.g. (Samsung)

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| 8.10.15 Active downlink TCI state switching delay for unified TCI  8.10.15.1 Introduction  8.10.15.2 Know condition for downlink TCI state  8.10.15.3 MAC-CE based downlink TCI state switch delay  8.10.15.4 DCI based downlink TCI state switch delay  8.10.15.5 Active downlink TCI state list update delay 8.10.16 Active uplink TCI state switching delay for unified TCI  8.10.16.1 Introduction  8.10.16.2 Know condition for uplink TCI state  8.10.16.3 MAC-CE based uplink TCI state switch delay  8.10.16.4 DCI based uplink TCI state switch delay  8.10.16.5 Active uplink TCI state list update delay  |

* + Proposal 2: Separate section for the requirement of joint UL and DL TCI case
	+ Proposal 3: Separate section for the requirement of PL-RS switching delay
	+ Proposal 4: Separate section for the requirement of separate TCI list update delay (vivo)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 1-2 Switching delay requirements for unified TCI associated with SC

**Issue 1-2-1 Define DCI based DL and UL TCI state switching delay as**

* Proposals
	+ Option 1: the delay requirements can be defined based on RAN1 agreements (CMCC, Samsung)
	+ Option 2: TACK +Y ( Huawei)
		- Option 2a: Specify which SCS is used to count Y if that of DL and UL are different (ZTE)
		- Option 2b: Define switching delay requirement of DCI based unified TCI state switching for cases that joint and separate TCI, known TCI, TCI I in active TCI list and maintained PL-RS. (Apple)
	+ Option 3: Y symbols (MTK)
	+ Option 3a: *‘Y symbols’* delay is about *beam application time (BAT)* that cannot reuse legacy DCI-based TCI state switch delay requirement. Define a switching requirement as RAN1 agreement. (Nokia)
		- *A UE shall be able to receive PDSCH with target TCI state of the serving cell [or non-serving cell] on which TCI state switch occurs at the first slot that is at least* $BeamAppTime\\_r17$ *symbols after the last symbol of the PUCCH with HARQ-ACK information.*
	+ Option 4: UE sends ACK at slot n+TACK, receive on the new beam at n+TACK+ TBAT. Where TBAT is signalled by the gNB based on the UE capability. (Ericsson)
	+ Option 5: Define DCI based DL and UL TCI state switching delay also for CA case (vivo)
		- Option 5a: For CA, DCI-based TCI switching delay is determined based on the carrier with the smallest SCS among the carrier(s). (Intel, Ericsson)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-2-2 Define MAC-CE based UL TCI state switching delay in separate UL/DL mode as**

* **Proposals**
	+ Option 1: For serving cell, for known case, i.e., PL-RS and associated RS with spatial relation are known (MTK)
		- THARQ + $3N\_{slot}^{subframe,µ}$ + NM\* $\left⌈( T\_{first\\_target-PL-RS}+ 4\*T\_{target\\_PL-RS} + 2ms)/NR slot length\right⌉$, where NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.
		- For unknown case, i.e., PL-RS or associated RS with spatial relation is unknown , no requirement is applied.
	+ Option 2: for UL TCI state associated with DL-RS as following for both known and unknow TCI state and associated PL-RS is maintained (Apple):
		- THARQ + 3ms + NM\*(Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) for known TCI
		- THARQ + 3ms + TL1-RSRP + (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) for unknown TCI
	+ Option 3: Reuse the existing MAC-CE based uplink spatial relation switching delay requirements for known and unknown case (ZTE, vivo, Samsung, Huawei, Nokia)
	+ Option 4: (Intel)
		- If PL-RS is included in UL TCI state, reuse uplink spatial relation switching delay requirements for known case and n+ THARQ + $3N\_{slot}^{subframe,µ}$+ TL1-RSRP+$ \left⌈\frac{ 5\*T\_{target\\_PL-RS} + 2ms}{NR slot length}\right⌉$ for unknown case.
		- When PL-RS is associated with UL TCI sate and PL-RS is activated in the same MAC-CE with UL TCI state switching, if TCI state is known, legacy MAC-CE based uplink spatial relation switching delay requirements can be re-used.
		- If associated DL RS and Pathloss Reference RS are unknown, the delay requirement is the same as the case when PL-RS is included in UL TCI state and the TCI state is unknown.
		- If PL-RS is associated with UL TCI state and PL-RS is not activated in the same MAC-CE with UL TCI state switching, the legacy MAC-CE based uplink spatial relation switching delay requirement for known case and unknown case can be re-used for UL TCI state switching.
	+ Option 5: If PL-RS is included in UL TCI state, reuse the existing MAC-CE based pathloss reference signal switch delay requirements; If PL-RS is associated with UL or joint TCI, then resue existing requirement. (CMCC)
* **Recommended WF**
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-2-3 Define MAC-CE based joint UL and DL TCI state switching delay as**

* Proposals
	+ Option 1: No extra requirement needed for Joint TCI mode, DL and UL requirements can be applicable respectively. (Samsung, CMCC, Ericsson, Intel, Huawei, Nokia)
	+ Option 2: Define a total switching delay for joint TCI state switching requirements and define the requirement from the slot switching command is received until UE can receive DL channel or transmit UL channel with target TCI state, whichever is later. (Apple, vivo, MTK)
		- Option 2a: (Apple)
			* THARQ + 3ms + max{TOk\*(Tfirst-SSB + TSSB-proc) , NM\*( Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms)} for known joint TCI state
			* THARQ + 3ms + TL1-RSRP +max{TOuk\*(Tfirst-SSB+ TSSB-proc) , (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms)} for unknown joint TCI state
		- Option 2b: (vivo)
			* Define a total switching delay for joint TCI state switching requirements as existing DL requirement
		- Option 2c: (MTK)
			* For known case, i.e., PL-RS and associated RS with spatial relation are known: the delay requirement is$T\_{HARQ}+3N\_{slot}^{subframe,μ}+max(NM×\left⌈T\_{first\\_target\\_PL-RS}+4×T\_{Target\\_PL-RS}+2ms/NR slot length\right⌉,TO\_{k}×\left⌈(T\_{first-SSB}+T\_{SSB-proc})/NR slot length\right⌉)$**.**
			* For unknown case, i.e., PL-RS or associated RS with spatial relation is unknown, no reuqirement is applied.
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-2-4 Define MAC-CE based TCI state-pair indication requirement**

* **Proposals**
	+ Option 1:
		- the TCI state switching delay requirement can be defined for UL TCI and DL TCI switching respectively. (Intel, MTK, Huawei, Nokia)
	+ Option 2:
		- RAN4 specify MAC CE based TCI state list update requirements comprising UL TCI list update delay, DL TCI list update delay, and the potential maintained PL-RS list update delay.
		- If the TCI state list update include both DL TCIs and UL TCIs, the endpoint of the TCI state switching delay is the later one between DL TCI switching delay and UL TCI switching delay. (vivo)

### Sub-topic 1-3 Switching delay requirements for unified TCI associated with NSC

**Issue 1-3-1 Define TCI state switching delay (associated with different PCI) as**

* Proposals
	+ Option 1: Components of delay are (1) MAC-CE decoding or DCI processing time, (2) Time acquisition delay if target TCI was not in active TCI list monitored by UE, (3) Time for RX beam acquisition if target TCI state is unknown, (5) Time for Active BWP switch. (Apple)
	+ Option 2: discussion on the RRM requirements for the addition of the ‘cell with different PCI’, while legacy requirements for MAC-CE based SCell activation can be used as baseline. And check whether the ‘cell with different PCI’ is known by the known condition for deactivated Scell.(vivo)
	+ Option 3: MAC-CE based and DCI based TCI switching delay does not have difference for a serving cell and non-serving cell. (Nokia, Ericsson)
	+ Option 4: only define requirement for known TCI state case, and the BW of inter-cell is within the active BWP of the serving cell and the SCS are the same; System information of inter-cell will be assumed to be known; For inter-cell UL TCI state switching, further discuss whether DL timing tracking for inter-cell is needed and whether there is any timing offset assumption. (Intel)
	+ Option 5: Apply the existing TCI switch delay and spatial relation switch delay for intra-frequency non-serving cell downlink TCI and uplink TCI switch delay. (Samsung)
	+ Option 6: For R17 unified TCI, the same DL/UL TCI state switching delay requirements are applied when the associated SSB for target TCI is with the serving cell PCI or with PCI different from the serving cell. (Huawei)
	+ Option 7: For known non-serving cell, re-use serving cell's R17 MAC-CE/DCI based unified TCI switching delay requirements.(MTK)
	+ Option 8: apply known condition in current specification for both serving cell and non-serving cell TCI switch delay requirements. (Samsung, ZTE, Nokia)
	+ Option 9: Define switching delay requirement of TCI state associated with NSC for cases that separate DL TCI and joint TCI only. (Apple)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-3-2 Whether introduce the interruption requirement due to TCI state switch associated with different PCI**

* Proposals
	+ Option 1: Yes (Apple)
	+ Option 2: Needs further discussion in RAN4. (vivo)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-3-3 The wording of “non-serving cell”**

* Proposals
	+ Option 1: Wording of “non-serving cell” needs to be aligned with RAN1/2 spec. TS38.214 uses wording as “SS/PBCH block having a PCI different from the PCI of the serving cell” rather than directly mention ‘a cell’. (Nokia)
	+ Option 2: Modify “non-serving cell” to “TRP with different PCI”. (Intel)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 1-4 Delay requirements for TCI switching in CA case

**Issue 1-4-1 The requirements for common TCI state switching delay in CA scenario**

* Proposals
	+ Option 1: Specify the requirement, i.e. the switching delay between the TCI states whose QCL-D or UL TX filter is determined by a source RS in one of the CCs, while QCL-A or QCL-C is still determined by the RS in each CC. (vivo)
	+ Option 2: delay requirement as the TCI state switching for single CC, with the clarification that the first slot to apply the new TCI state is determined on the CC with the smallest SCS among the CCs which applying the beam indication. (MTK)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-4-2 Known condition in CA scenario**

* Proposals
	+ Option 1: Specify per-CC known status for the common TCI state. And if the total number of unknown TCI-CC pairs exceeds the UE capability ‘beamManagementSSB-CSI-RS’, no RRM requirements are defined. (vivo)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 1-5 Requirements for PL-RS switching delay indicated by unified TCI

**Issue 1-5-1 Scenarios for defining PL-RS switching requirement**

* **Proposals**
	+ Option 1: To define the PL-RS switching delay requirement only when PL-RS is identical to the spatial relation RS in the UL TCI. (MTK, vivo)
	+ Option 2: If the PL-RS or associated RS with spatial relation is unknown, no switching delay requirement will be defined. (MTK)
	+ Option 3: For PL-RS activation delay, only specify requirements when PL-RSs are known. (vivo)
* **Recommended WF**
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-5-2 Whether the PL-RS maintained in unified TCI framework**

* **Proposals**
	+ Option 1: For DCI based TCI state switch, the target PL-RS is maintained. (MTK)
	+ Option 1a: For MAC CE TCI state based, the target PL-RS may be maintained or non-maintained. (MTK, Nokia)
	+ Option 2: UE can always maintain the target PL-RS for the case of UL TCI state switch triggering PL-RS switch (ZTE)
	+ Option 3: No maintained or non-maintained question for unified TCI framework
* **Recommended WF**
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-5-3 Define MAC-CE based PL-RS switching delay requirements**

* **Proposals**
	+ Option 1: re-using the UL TCI state switching requirements as PL-RS switching requirements. (ZTE, Samsung, Nokia) if UL TCI state switching can trigger PL-RS switch (Intel)
	+ Option 2: The requirements for UL TCI switching delay and requirements for PL-RS update delay are specified as two separate delay. (vivo, CMCC)
* **Recommended WF**
	+ Collect companies’ view for these proposals in 1st round

**Issue 1-5-4 Define DCI based PL-RS switching delay as**

* **Proposals**
	+ Option 1: For DCI based switch, DCI based UL TCI state switching requirements can be re-used for PL-RS switching delay, i.e., Y symbol. (MTK, Huawei)
* **Recommended WF**
	+ Collect companies’ view for these proposals in 1st round

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| xxx | Sub topic 1-1 Specification Structures of Unified TCITBASub topic 1-2 Switching delay requirements for unified TCI associated with SCTBASub topic 1-3 Switching delay requirements for unified TCI associated with NSCTBASub topic 1-4 Delay requirements for TCI switching in CA caseTBASub topic 1-5 Requirements for PL-RS switching delay indicated by unified TCITBA |
|  |  |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
|  |  |

## Discussion on 2nd round (if applicable)

# Topic #2: Inter-cell beam management

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2200183 | MediaTek Inc | Proposal 1: UE is not required to perform the L1-RSRP measurement on the unknown non-serving cell.Proposal 2: For the measurement behaviour for non-serving cell in FR1, L1 measurements for non-serving cell can be performed within or outside SMTC.Proposal 3: For the measurement behaviour for non-serving cell in FR2, L1 measurements for non-serving cell are assumed to be performed outside SMTC.Proposal 4: For the unknown non-serving cell, no delay requirement of the L1-RSRP measurement will be defined.Proposal 5: For the known non-serving cell, the existing R15/R16 delay requirement of the L1-RSRP measurement can be reused.Proposal 6: For inter-cell beam management/multiple TRP, to define the requirement with the condition of the timing offset between serving cell and non-serving cell is within one CP.Proposal 7: For inter-cell beam management/multiple TRP, to take one FFT as assumption to define the L1-RSRP measurement requirement.Proposal 8: For inter-cell beam management/multiple TRP, UE Rx beam assumptions for L1 and L3 measurement are same as legacy, i.e., fine beam and rough beam will be applied for L1 and L3 measurement, respectively. |
| R4-2200278 | Apple Inc. | L1-RSRP Measurements for inter-cell beam managementProposal #1: The L1-RSRP measurement requirements on cell with different PCI are applicable to inter-cell beam management and inter-cell multi-TRP.Proposal #2: Define known cell condition for L1-RSRP as In FR1 the cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds.In FR2 the cell is known if, during the last 5 seconds –* the UE has sent a valid measurement report for the cell with different PCI and
* One of the SSBs measured from the cell with different PCI being configured remains detectable

Otherwise, the cell is unknown.Proposal #3: Define SSB based L1-RSRP measurement period for known cell with different PCI similar to existing serving cell requirements. Proposal #4: For unknown cell, the L1-RSRP measurement period is extended by the time needed for intra-frequency cell identification and measurement. Proposal #5: Define Measurement restriction on SSB based L1-RSRP measurements for cell with different PCI, if the SSB from cell with different PCI is on the same OFDM symbol as SSB or CSI-RS from serving cell for other L1 measurements.Proposal #6: Define scheduling availability for UE performing L1-RSRP measurement on cell with different PCI. Proposal #7: RAN4 defines requirements for *Nmax*=1 only. Timing offset and FFT assumption*Observation #1: Inter-cell beam management and inter-cell multi-TRP framework are under the assumption that UE receives signals from serving and cell with different PCI with single FFT with timing offset assumption < CP.**Observation #2: Inter-cell multi-TRP assumes dedicated and non-dedicated signals to be received from serving and cell with different PCI with single FFT and with timing offset < CP.**Observation #3: For inter-cell beam management, if timing offset > CP is allowed additional scheduling restriction is needed for L1-RSRP measurement and dedicated channel reception from cell with different PCI.* Proposal #8: L1-RSRP measurements for cell with different PCI should be restricted to single FFT operation and timing offset assumption within CP. Rx beam and Measurement behavior assumption*Observation #4: UE knows the SSB time location of cells with different PCI configured for L1-RSRP measurement.**Observation #5: If L1-RSRP measurement is restricted to SMTC the measurement period would be much longer.* *Observation #6: UE is expected to use fine beam for L1-RSRP measurement on cells with different PCI as it is for* *beam management and beam indication.* Proposal #9: Do not restrict L1-RSRP measurement on cells with different PCI to SMTC. Proposal #10: Define requirements for L1-RSRP measurements on cell with different PCI with similar assumptions (for e.g., RX beam) as L1 measurements on serving cell. Proposal #11: Further discuss reply LS to RAN1. |
| R4-2200594 | ZTE Corporation | Proposal 1: Not re-use the existing known/unknown condition of Handover, enhance a new known/unknown condition based on L1 measurement for NSC.Proposal 2: For MAC CE based TCI state switch for NSC, re-use existing MAC CE based requirements.Proposal 3: For DCI based TCI sate switch for NSC, re-use the corresponding requirements for serving cell.Proposal 4: In order to guarantee sufficient flexibility for L1 SSB configuration of NSC as similar as serving cell, which should not be limited by the configuration of SMTC and MG.Proposal 5: Re-using the existing collision handling in legacy Rel-16 to resolve the possible collision between L1 SSB used for NSC measurement and SMTC/MG.Proposal 6: For inter-cell BM, since one FFT applied for both serving cell and NSC is preferred, so if simultaneous RX with such different QCL sources is needed, then the timing offset requirement is needed so as to guarantee the timing offset between serving cell and NSC is within CP. |
| R4-2200603 | vivo | Proposal 1 R17 RAN4 RRM requirements for inter-cell BM should be forward compatible to R18 L1/L2-centric mobility.Proposal 2 Based on recent progress, it is suggested not to restrict the assumption of timing difference between the serving cell and a cell with different PCI to be less than CP.Proposal 3 Inter-cell L1-RSRP measurements can be used by network in making decisions on whether to activate the TCI associated to the cell with different PCI, and therefore it is not necessary to restrict assumptions that UE only perform L1 measurements on the known cells.Proposal 4 For inter-cell L1-RSRP measurement requirements, including measurement restrictions and scheduling restrictions, FR1 and FR2 are discussed separately assuming different UE behaviour, similar to the case of R15/16 intra-cell L1-RSRP measurements.Proposal 5 Except cell identification and measurements performed in SMTC, single FFT assumption should be the baseline UE behaviour assumption in specifying R17 inter-cell L1-RSRP measurement requirements.Proposal 6 RAN4 only works for SSB-based inter-cell L1-RSRP measurement requirements in R17.Proposal 7 For FR1, before a TCI state associated to the cell with different PCI is activated, for single-FFT UE, UE is only required to perform inter-cell L1-RSRP measurements within SMTC.Observation 1 In R15/16, for UEs capable of tracking more than 1 TCIs, the timing difference between tracked TCIs is assumed to be less than CP.Proposal 8 After a TCI state associated to the cell with different PCI is activated, for UEs capable of tracking more than 1 TCIs, a baseline UE is only able to track TCIs with timing difference less than CP, and RAN4 can further discuss whether to specify UE capability for those who are able to track TCIs with timing difference larger than CP.Observation 2 If a UE is only able to track TCIs with timing difference less than CP, but the actual timing difference between active TCIs from different cells is larger than CP, UE performance degradation can be expected, except the L3/L1 RSRP measurement performance within SMTCs.Proposal 9 RAN4 separates the discussion on inter-cell L1-RSRP measurement requirements into 2 cases, * Case I: the L1-RSRP measurements performed before a TCI associated to the cell with different PCI is activated
* Case II: the L1-RSRP measurements performed after a TCI associated to the cell with different PCI is activated

Observation 3 For FR1, if SSB-based inter-cell L1 measurements are performed within SMTC, scheduling restrictions defined for L3 measurements can be re-used, and no need to define measurement restrictions for such L1 measurements.Proposal 10 For FR1, the inter-cell L1-RSRP measurement requirements assuming UE only performs L1 measurements within SMTCs are at least specified in R17 feMIMO WI, i.e. L1 measurements within SMTCs are 1st priority over other cases of UE measurement behaviour assumption.Observation 4 For FR1, if SSB-based inter-cell L1 measurements are performed outside SMTCs, more scheduling restrictions and measurement restrictions outside SMTCs can be expected, if * network cannot ensure that timing difference from different cells is less than CP, and
* SSB has a different subcarrier spacing than PDSCH/PDCCH/CSI-RS, and
* UE does not support ‘simultaneousRxDataSSB-DiffNumerology’.

Observation 5 For FR1, if SSB-based L1 measurements are performed outside SMTCs, RAN4 may need to further specify applicability of core/performance requirements, or scheduling/measurement restrictions, if* network cannot ensure that timing difference from different cells is less than CP, and
* one of the following conditions are met
	+ Condition 1:
		- SSB has a different subcarrier spacing than PDSCH/PDCCH/CSI-RS, and
		- UE does not support ‘simultaneousRxDataSSB-DiffNumerology’.
	+ Condition 2:
		- SSB has the same subcarrier spacing as PDSCH/PDCCH/CSI-RS, and
		- UE is only capable of Single-FFT

Observation 6 According to RAN1 LS, RRM measurement requirements are not impacted by L1-RSRP measurements on RSs with a PCI different from serving cell.Proposal 12 For FR2, before a TCI state associated to the cell with different PCI is activated, UE is only required to perform inter-cell L1-RSRP measurements within SMTC assuming the same set of Rx beams for L3 measurements is re-used, and requirements are only applicable if ‘timeRestrictionForChannelMeasurement’ is not configured.Proposal 13 For FR2, after a TCI state associated to the cell with different PCI is activated, * + if the SSB for the cell with different PCIs are not fully overlapped with SMTC, the SSB-based inter-cell measurement share the same requirements as the legacy L1-RSRP measurement for one serving cell.
		- RAN4 can further discuss whether to allow larger beam sweeping factor if serving cell SSB and the SSB for the cell with different PCIs are fully overlapped in time domain.
			* If larger beam sweeping factor is allowed for the case when serving cell SSB and the SSB for the cell with different PCIs are fully overlapped in time domain, then UE is required to prioritize L1-RSRP measurements to the original serving cell for the case when serving cell SSBs and the SSBs for the cell with different PCIs are partially overlapped in time domain
	+ if the SSB for the cell with different PCIs are fully overlapped with SMTC, inter-cell L1-RSRP measurements requirements are specified assuming the same set of Rx beams for L3 measurements is re-used, and requirements are only applicable if ‘timeRestrictionForChannelMeasurement’ is not configured.

Proposal 14 Clarify the understanding of beam sweep factor N from RAN4 perspective, for SSB-based L1-RSRP measurements, as following in the reply LS,‘UE is only required to meet the L1-RSRP measurement accuracy requirements after N samples.’  |
| R4-2200643 | CMCC | Proposal 1: for the requirements on number of cells (the number of PCIs different from the serving cell for measurement/reporting), it is not preferred to only consider Nmax = 1. Proposal 2: for the definition on requirements on number of cells (the number of PCIs different from the serving cell for measurement/reporting), it is proposed to refer to the Nmax, which was agreed in RAN1. Proposal 3: for FR1 L1-RSRP measurement of non-serving cell, it is proposed to follow the principle in Rel-15/16 that the FR1 L1-RSRP measurement of non-serving cell can be performed within SMTC or outside SMTC. And L3 and L1 measurements can be performed at the same timeProposal 4: for FR2 L1-RSRP measurement of non-serving cell, it is proposed to follow the principle in Rel-15/16 that the FR2 L1-RSRP measurement of non-serving cell is performed outside SMTC.Observation 1: according to RAN1 agreements, Nmax is up to UE capability and the candidate value of Nmax is {1, 2, 3, 7}.Observation 2: for the requirements on number of cells, only consider Nmax = 1 cannot guarantee the performance of UE which is capable of Nmax > 1.Observation 3: For FR1 L1-RSRP measurement of serving cell, the location of configured SSB resource for L1-RSRP can be within SMTC or outside SMTC.  |
| R4-2200650 | Nokia, Nokia Shanghai Bell | **Known cell condition for L1 measurement****Proposal 1 :** For L1-RSRP measurement on non-serving cell, a UE has sent at least L3-RSRP report within a given time and acquired initial sync by detecting PSSS from the non-serving cell.**Proposal 2 :** a UE should be configured with association information of the non-serving cell PCI and SSB to support L1 RSRP measurement on non-serving cell.**Proposal 3 :** SSB of a non-serving cell has the same center frequency, SCS, SFN offset in the same active BWP with a serving cell in Rel-17. Also, SSB time domain position can be also known. - If SSB time domain position is not given, a UE can search the non-serving cell using the SSB association information.**Proposal 4:** Assuming L3-RSRP on non-serving cell has been measured and reported to a serving cell before L1-RSRP measurement trial on non-serving cell, the serving cell can evaluate if quality of signal is good enough to measure L1-RSRP based on L3-RSRP value. ( FFS on a threshold value).**Timing offset assumptions between non-serving cell and serving cell****Proposal 5 :** If a UE is not support simultaneous RX and if the RX timing difference between non-serving cell and serving cell is assumed within CP length, there is no strong motivation to introduce the limitation of known conditions of non-serving cell.**Measurement accuracy & period for serving cell L1-RSRP****Proposal 6 :** If a UE does not support simultaneous RX, measurement accuracy for serving cell L1-RSRP can be reused for L1-RSRP measurement for non-serving cell.**Proposal 7** : If a UE does not support simultaneous RX, and if SSB from serving cell and non-serving overlap over time, the UE should be able to sequentially measure L1-RSRP on SSB from serving and from non-serving cell.* The current measurement period for L1-RSRP can be scaled by a scaling factor.
* FFS : How to apply a scaling factor (including considering inside or outside of SMTC window discussion)

**RX scheduling restriction due to SSB overlapping****Proposal 8 :** If a UE does not support simultaneous RX and if SSB from a cell and other DL signal from another cell overlap in time, RAN4 studies to set RX scheduling restriction of a UE. 1. Overlap between L1 measurement on a cell and another cell
2. Overlap between L1 measurement on a cell and L3 measurement on another cell
3. Overlap between L1 measurement on a cell and PDCCH/PDSCH reception from another cell

**Proposal 9:** Assuming RX scheduling restriction and measurement conditions proposed above, SMTC window is not essentially required for L1-RSRP measurement on non-serving cell. - Also, a UE is not mandated to measure L1-RSRP measurement outside of SMTC window. |
| R4-2200788 | Intel Corporation | Observation 1: There is no conclusion about timing offset assumption between serving cell and TRP with different PCI in RAN1.Observation 2: For FR2, if different RX beams are assumed for L1 and L3 measurement of neighbor cell, more accurate beam quality measurement can be achieved and shorter measurement delay is expected for inter-cell beam measurement. However, measurement delay for L1 serving cell will be impacted and extended.Observation 3: For FR2, if same RX beam is assumed for L1 and L3 measurement of neighbor cell, L1 serving cell measurement will not be delayed. However, beam quality measurement may not be accurate and measurement delay may be longer for inter-cell beam measurement. Proposal 1: Both SSBs inside and outside SMTC can be used for L1-RSRP measurement for inter-cell. RX beam sweeping factor can be further reduced. Proposal 2: If L1-RSRP measurement for inter-cell is performed inside SMTC, it will use the same RX beam of L3 measurement. If L1-RSRP measurement of neighbor cell is performed outside SMTC, different RX can be used.Observation 4: SSB location, index and PCI information will be provided by high layer.Proposal 3: For inter-cell L1-RSRP measurement, single shot is considered as the baseline for defining measurement period and don’t consider timeRestrictionForChannelMeasurement. Proposal 4: For FR2, if SSBs outside SMTC and MG are used for inter-cell L1-RSRP measurement. It will be shared with L1 measurements of serving cell. A sharing factor X is further introduced on top of P factor.Proposal 5: For FR2, when SMTC and SSB for inter-cell L1-RSRP are fully overlapped, no requirement for NSC L1-RSRP measurement is expected or clarify that performance degradation is expected.Proposal 6: If a cell is known, the total measurement delay for inter-cell beam measurement will only consider the delay for inter-cell L1-RSRP measurements.Proposal 7: If a cell is unknown, the total measurement delay will consider extra cell searching time and SSB index acquiring time. Proposal 8: If the cell is unknown, one SSB sample can be used for cell search time.Proposal 9: If the cell is unknown, further discuss extra time needed for SSB index acquiring.Proposal 10: if NW configure UE to measure L1-RSRP for multiple TRPs with different PCIs, UE will perform the measurement in sequential method.Proposal 11: The reply LS will depend on the discussion about whether L1-RSRP for inter-cell beam measurement can be performed outside SMTC or not. |
| R4-2201385 | Ericsson | Proposal 1: RAN4 to support L1-RSRP measurement on NMAX+1 TRPs. Proposal 2: When SSB from different PCI overlap, UE should be able to measure them at the same time if following conditions are met. * Received SSB are within the active BWP
* Received time difference between the SSB of different PCI is within the CP

Proposal 3: RAN4 to agree that the non-serving TRPs, whose timing offset w.r.t reference TRP is less than CP to be measured at the same time. If the timing offset of the non-serving TRPs w.r.t reference TRP are more than CP, they are to be measured in TDM fashion. Where reference TRP refers to serving TRP and additional serving TRP.Proposal 4: RAN4 to agree on the assumption that two independent FFT and RF chain are used for inter-cell beam management.Proposal 5: RAN4 to agree that UE measures all the non-serving cell TRPs whose timing offset is within CP from the reference cell TRP at the same time and other TRPs whose timing offset is more than CP in TDM fashion. Where reference cell TRP is serving TRP or additional serving TRP.Proposal 6: RAN4 to agree that same RX beam can be used for L1-RSRP and L3-RSRP computation for non-serving cell inter-cell beam management in Rel-17.Proposal 7: L1-RSRP measurements for inter-cell beam management to be based on SSB only for non-serving cell inter-cell beam management in Rel-17. Proposal 8: RAN4 to re-use HO and SCell known/unknown definitions for inter-cell beam management. |
| R4-2201617 | Huawei, HiSilicon | Proposal 1: The Rx beam assumption for L1-RSRP measurements based on SSB with PCI different from the serving cell can be same as that for L1-RSRP measurements based on SSB with serving cell PCI.Proposal 2: For the timing offset between serving cell TRP and the TRP with different PCI, it is suggested to reuse R16 timing offset assumption for multi-TRP transmissions, i.e. timing offset within CP length.Proposal 3: For L1-RSRP measurements based on SSB with different PCI, the existing SSB based L1-RSRP measurement requirements in R15/R16 can be reused as baseline.Proposal 4: For SSB based L1-RSRP measurements in R17, it is suggested to introduce the measurement restrictions between SSB with serving cell PCI and SSB with PCI different from the serving cell.Proposal 5: For SSB based L1-RSRP measurements in R17, it is suggested to introduce the measurement restrictions between SSB with serving cell PCI and SSB with PCI different from the serving cell.Proposal 6: It is suggested that the existing cell detectable conditions used in SMTC based intra-frequency measurements can be reused as the known cell condition for non-serving cell SSB configured for L1-RSRP measurements. |
| R4-2201960 | Samsung | Proposal 1: RAN4 agreed the specification structure for L1-RSRP measurement requirements for configured SSB with PCI different from serving cell in RAN4 101bis meeting taking the above suggestions into accountProposal 2: Existing condition for detected intra-frequency cell can be reused for known condition for L1-RSRP for SSBs with different PCI Proposal 3: For unknown SSB with different PCI, RAN4 can further discuss whether to introduce additional delay performance for L1-RSRP. Proposal 4, Existing serving cell L3 measurement behaviour in FR1 and L1 measurement requirements in FR2 can be used as baseline for L1-RSRP measurement for SSB with different PCI fully overlapped with SMTC. Proposal 5: RAN4 can further discuss the case when SSB with different PCI not fully overlapped with SMTC by taking the scheduling restriction, measurement restriction, timing difference assumption and Rx beam assumption into account.  |

## Open issues summary

Please note that some proposals (issues) might be omitted by purpose as they are deprioritized in the 1st round discussion or out of the scope of [219].

### Sub-topic 2-1: Specification Structures for Inter-cell L1-RSRP Measurement

*Sub-topic description:*

**Issue 2-1-1 Specification Structures for Inter-cell L1-RSRP Measurement**

* Proposals
	+ Proposal 1: Spec structure as following (Samsung)

|  |
| --- |
| 9.12 L1-RSRP measurements for configured SSB with PCI different from serving cell9.12.1 Introduction 9.12.2 Requirement applicability 9.12.3 Measurement reporting requirements 9.12.4 L1-RSRP measurement requirements9.12.5 Measurement restriction 9.12.6 Scheduling availability  |

### Sub-topic 2-2: Requirements for inter-cell L1-RSRP measurement

*Sub-topic description:*

**Issue 2-2-1 Applicability rules for inter-cell L1-RSRP measurement requirement**

* Proposals
	+ Proposal 1: UE is not required to perform the L1-RSRP measurement on the unknown non-serving cell and no delay requirement will be defined. (MTK)
	+ Proposal 2: Requirements applicable to inter-cell beam management and inter-cell multi-TRP. (Apple)
	+ Proposal 3: Do not restrict UE only perform L1 measurements on the known cells. (vivo)
	+ Proposal 4: Separates the discussion for 2 cases: performed [before / after] a TCI associated to the cell with different PCI is activated (vivo)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 2-2-2 Assumptions for defining inter-cell L1-RSRP measurement requirement**

* Proposals
	+ Proposal 1: The timing offset between SC and NSC is within one CP and take one FFT as the assumption. (MTK, Apple, vivo, Huawei), and similar assumptions (for e.g., RX beam) as L1 measurements on serving cell. (Apple)
	+ Proposal 2: Fine beam and rough beam will be applied for L1 and L3 measurement, respectively. (MTK)
	+ Proposal 3: Single shot is considered as the baseline for defining measurement period and don’t consider *timeRestrictionForChannelMeasurement*. (Intel)
	+ Proposal 4: If the timing offset of the non-serving TRPs w.r.t reference TRP is within CP, they are to be measured at the same time. If the timing offset of the non-serving TRPs w.r.t reference TRP are more than CP, they are to be measured in TDM fashion. (Ericsson)
	+ Proposal 5: The same RX beam can be used for L1-RSRP and L3-RSRP. (Ericsson)
	+ Proposal 6: The same Rx beam assumption for SC and NSC (Huawei)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 2-2-3 Known NSC condition for L1-RSRP measurement**

* Proposals
	+ Proposal 1: Define known cell condition for L1-RSRP as (Apple)

|  |
| --- |
| In FR1 the cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds.In FR2 the cell is known if, during the last 5 seconds –* the UE has sent a valid measurement report for the cell with different PCI and
* One of the SSBs measured from the cell with different PCI being configured remains detectable
 |

* + Proposal 2: (Nokia)

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| For L1-RSRP measurement on non-serving cell, a UE has sent at least L3-RSRP report within a given time and acquired initial sync by detecting PSSS from the non-serving cell. UE should be configured with association information of NSC PCI. SSB of a non-serving cell has the same center frequency, SCS, SFN offset in Rel-17. Also, SSB time domain position can be also known.  - If SSB time domain position is not given, a UE can search the non-serving cell using the SSB association information. Assuming L3-RSRP on non-serving cell has been measured and reported to a serving cell before L1-RSRP measurement trial on non-serving cell, the serving cell can evaluate if quality of signal is good enough to measure L1-RSRP based on L3-RSRP value. ( FFS on a threshold value). |

* + Proposal 3: Re-use HO and SCell known/unknown definitions(Ericsson)
	+ Proposal 4: existing cell detectable conditions used in SMTC based intra-frequency measurements can be reused as the known cell condition (Huawei, Samsung)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 2-2-4 Define delay requirement for inter-cell L1-RSRP measurement**

* Proposals
	+ Proposal 1: For the known non-serving cell, the existing R15/R16 delay requirement can be reused. (MTK) as the baseline (Huawei).
	+ Proposal 1a: Existing serving cell L3 measurement behaviour in FR1 and L1 measurement requirements in FR2 can be used as baseline within SMTC. (Samsung)
	+ Proposal 2: Define SSB based L1-RSRP measurement period for known cell with different PCI similar to existing serving cell requirements. For unknown cell, period is extended by the time needed for intra-frequency cell identification and measurement. RAN4 defines requirements for *Nmax*=1 only. (Apple)
	+ Proposal 3: It is not preferred to only consider Nmax = 1; it can refer to RAN1 agreement. (CMCC)
	+ Proposal 4: if SSB from serving cell and non-serving overlap over time, the current measurement period for L1-RSRP can be scaled by a scaling factor. (Nokia)
	+ Proposal 5: If a cell is unknown, the total measurement delay will consider extra cell searching time and SSB index acquiring time; one SSB sample can be used for cell search time (Intel)
	+ Proposal 6: RAN4 to support L1-RSRP measurement on NMAX+1 TRPs (Ericsson)
	+ Proposal 7: For unknown SSB with different PCI, RAN4 can further discuss whether to introduce additional delay performance for L1-RSRP.
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 2-3: L1-RSRP measurement behaviour for non-serving cell

*Sub-topic description:*

**Issue 2-3-1 Where to perform inter-cell L1-RSRP measurement from NSC in FR1**

* Proposals
	+ Proposal 1: Both within and outside SMTC (MTK, Apple, CMCC, Intel)
	+ Proposal 2: Before a TCI state associated to the cell with different PCI is activated for single-FFT UE, only required to perform within SMTC. And for R17 within SMTCs are 1st priority. (vivo)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 2-3-2 Where to perform inter-cell L1-RSRP measurement from NSC in FR2**

* Proposals
	+ Proposal 1: Outside SMTC only (MTK, CMCC)
	+ Proposal 2: Both within and outside SMTC (Apple) RX beam sweeping factor can be further reduced. (Intel)
	+ Proposal 3: The same as FR1 vivo’s proposal assuming the same set of Rx beams for L3 measurements is re-used, and requirements are only applicable if ‘timeRestrictionForChannelMeasurement’ is not configured. (vivo)
	+ Proposal 4: Assuming RX scheduling restriction and measurement conditions, SMTC window is not essentially required for L1-RSRP measurement on non-serving cell.
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

**Issue 2-3-3 When inter-cell L1-RSRP measurement** **overlapping with other UE behaviours**

* Proposals
	+ Proposal 1: Define Measurement restriction if the SSB from NSC on the same OFDM symbol from serving cell and define scheduling availability for UE performing L1-RSRP measurement on cell with different PCI. (Apple)
	+ Proposal 2: if SSB from a cell and other DL signal from another cell overlap in time, set RX scheduling restriction of a UE. (Nokia)
	+ Proposal 3: A sharing factor X is further introduced on top of P factor for FR2 introduced. (Intel)
	+ Proposal 4: UE should be able to measure them at the same time if following conditions are met:1 Received SSB are within the active BWP; 2 Received time difference between the SSB of different PCI is within the CP.
	+ Proposal 5: introduce the measurement restrictions between SSB with serving cell PCI and SSB with PCI different from the serving cell. (Huawei)
	+ Proposal 6: Larger beam sweeping factor if SC and NSC SSBs fully overlapped in time; prioritize SC L1-RSRP measurements if SC and NSC SSBs partially overlapped in time. (vivo)
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 2-4: Reply on RAN1 LS R1-2112762

*Sub-topic description:*

**Issue 2-4-1 Reply on RAN1 LS L1-RSRP measurement behaviour when SSBs associated with different PCIs overlap**

* Proposals
	+ Proposal 1: Discuss the proposed reply LS (Apple)

|  |
| --- |
| For FR1, when the SSB from cell with different PCI for L1-RSRP measurement is in the same OFDM symbol as SSB from serving cell for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure SSB from both serving and cell with different PCI without any restriction.For FR2, when the SSB from cell with different PCI for L1-RSRP measurement on one CC is in the same OFDM symbol as CSI-RS or SSB from serving cell for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for L1-RSRP measurement and CSI-RS. Longer measurement period for SSB based L1-RSRP measurement is expected, and no requirements are defined. Similar measurement restriction will apply if SSBs from one than one cell with different PCI overlaps in the same symbols in FR2.For FR2 if the UE is capable of simultaneous reception with different QCL Type D, then it can measure SSB from 2 cells simultaneously if they overlap.  |

* + Proposal 2: Clarify the understanding of beam sweep factor N “UE is only required to meet the L1-RSRP measurement accuracy requirements after N samples”. (vivo)
	+ Proposal 3: The reply LS will depend on the discussion about whether L1-RSRP for inter-cell beam measurement can be performed outside SMTC or not. (Intel)
	+ Proposal 4 (Ericsson):
	+ When SSB from different PCI overlap for L1-RSRP measurements, UE should be able to measure them at the same time if following conditions are met.
		- Received SSB are within the active BWP
		- Received time difference between the SSB of different PCI is within CP
	+ Proposal 5 (Nokia)
* RAN4 develops UE requirements for at least *Nmax* = 1, where *Nmax* is the maximum number of RRC configured PCIs different from the serving cell for measurement/reporting.
	+ RAN4 will further study to specify the requirements for other *N\_max* value taking RAN1 decision into account
* RAN4 is discussing to introduce separate UE requirements of two types of UE reception capabilities and requirements in Rel-17.
* A UE not supporting simultaneous reception from different QCL-type-D sources **sequentially** measures one SSB and another.
* A UE supporting simultaneous reception from two (or multiple) different QCL-type-D sources can **simultaneously** measure L1 RSRP on the overlapping SSBs.
	+ - Due to lack of Rel-17 TU, the Rel-17 requirement study on simultaneous reception continues in Rel-18 WI phase. RAN4 will define requirement applicability to Rel-17 from Rel-18.
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #2-1** | *Tentative agreements:*TBA*Candidate options:*TBA*Recommendations for 2nd round:*TBA |

## Discussion on 2nd round (if applicable)

# Topic #3: Other RRM requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2200184](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2117440.zip) | MediaTek Inc. | **Proposal 1: For TRP specific BFR, for both FR1 and FR2, to introduce a new scaling factor PTRP to extend the evaluation period of BFD and CBD for multiple TRPs.****Proposal 2: RAN4 should further check the need of the QCL definition for UL TCI state.****Observation 1: In RF session, simultaneous reception channel/RS with different QCL type-D in R17 is being discussed.****Proposal 3: In R17, no RRM requirements are specified for simultaneous reception channel/RS with different QCL type D.***Moderator note: Simultaneous reception should be moved to AI 6.19.1 for discussion*  |
| [R4-2200279](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118021.zip) | Apple Inc. | **QCL Definition***Observation #1: Currently the definition of QCL is only applicable to PDSCH and PDCCH.* Proposal #2: Update TCI chain definition to include SRS and for PUCCH/PUSCH**.****TRP specific BFR***Observation #2: In FR2 if UE doesn’t support simultaneous reception with multi-panel and BFD-RS / CBD-RS from TRPs are not TDMed, BFD and CBD requirements need to be enhanced.*Proposal #3: Introduce sharing factor for BFD and CBD evaluation period in FR2 when BFD-RS or CBD-RS are received simultaneously from 2 TRP. **BFD for HST Enhancements**Proposal #4: For a CORESET with two activated TCI states, two RS indexes are included in $\overbar{q}\_{0} $(as two BFD RS resources) for implicit BFD. |
| [R4-2200535](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118101.zip) | Intel Corporation | **Proposal 1: For Rel-17, TCI chain needs to be defined for DL/UL TCI state separately.****Proposal 2: For DL TCI chain, SSB associated with a different PCID is added as a source RS.****Proposal 3: DL TCI chain can apply for separate DL TCI state or joint TCI state switching.****Proposal 4: For UL TCI chain,** **SSB, SRS or CSI-RS will be considered as source RS in the UL TCI chain. the number of Reference Signals in the chain is no more than 4.** **Proposal 5: For TRP-specific BFD, delay requirement is defined assuming that UE will perform BFD in TDM manner.****Proposal 6: For TRP-specific BFD, measurement delay will be scaled by the number of BFD-RS sets.****Proposal 7: For a CORESET with two activated TCI states, UE evaluates the RLM/BFD based on single hypothetical PDCCH BLER for the CORESET.** |
| [R4-2200604](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118260.zip) | vivo | **Observation 1 In R17, UL TCIs are only applicable to UL signals/channels, and UL RSs can not be used as source RSs of DL TCIs or joint TCIs.****Proposal 1 Applicability of QCL needs not to be updated in R17 feMIMO WI.****Proposal 2 RAN4 to work on RLM/BFD requirements for the case PDCCH with two TCI states in FR1 HST-SFN scenario.****Observation 2 Compared to R15/16 BFD-RSs, different use case is assumed for the BFD-RSs when one CORESET is configured with two TCI states in HST-SFN scenario.**Text Proposal 1: TS 38.133 Clause 8.1.1If a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', on the [RLM-RS pair], the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout and Qin for the purpose of monitoring downlink radio link quality of the cell. Otherwise, on each RLM-RS resource, the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout and Qin for the purpose of monitoring downlink radio link quality of the cell.Text Proposal 2: TS 38.133 Clause 8.5.1If a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', on the [BFD-RS pair] , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of assessing downlink radio link quality of the serving cell beams. Otherwise, on each RS resource configuration in the set , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of ~~accessing~~ assessing downlink radio link quality of the serving cell beams. **Proposal 3 Adopt Text proposal 1 and Text proposal 2 for clarifications on BFD and RLM requirements in R17 HST-SFN scenario, and inform RAN1 about the above change in the reply LS.****Proposal 4 Ask RAN1 for confirmation on whether the term ‘RLM-RS pair’ can used for the RLM case.****Proposal 5 In R17 feMIMO WI, simultaneous transmission or reception based on 2 active UE panels is not considered for RRM requirements, and the enhancements of related RRM requirements can be considered in R18 FR2 related RAN4-led WI.****Proposal 6 RRM requirements for TRP-specific BFR should be specified for FR1 in R17.****Proposal 7 For the CC configured with TRP-specific BFR, introduce scaling factor PTRP = 2 to the following period requirements*** **SSB-based BFD**
* **CSI-RS-based BFD**
* **SSB-based CBD**
* **CSI-RS-based CBD**
 |
| [R4-2200651](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118758.zip) | Nokia, Nokia Shanghai Bell | **Observation 1 :** The FR2 UE feature with simultaneous RX can extract full benefits both single cell and mTRP deployment. RAN1 is discussing the UE feature as one of key solutions to overcome FR2 blocking issue since Rel-16. **Proposal 1** : RAN4 does not conclude if no RRM requirements will be specified for simultaneous reception channel/RS with different QCL type D in Rel-17 feMIMO WI.**Proposal 2 :** The study on the simultaneous RX can be postponed to Rel-18 WI phase and continued under a Rel-18 WI. Requirement applicability to Rel-17 UE should be defined after introducing the requirements.**BFR/CBD/BFRQ requirements****Proposal 3 :** Study BFR requirements for the two cases below : (i) to receive and evaluate sequentially BFD-RS from multiple TRP. (ii) to receive and evaluate only one BFD-RS, when a serving cell beam failure is detected.**Proposal 4:** consider optionally setting measurement priority over a BFD-RS set. This helps quick BFR for a prioritized cell (i.e. serving cell) or when BFD-RS from all TRPs fail at the same time. **Proposal 5:** If a UE receives sequentially BFD-RS from multiple TRPs and if the number of BFD-RS included in the two BFD-RS sets (k=0,1) is more than 2 or higher, consider to apply scaling\_factor\_BFD to TEvaluate\_BFD\_SSB evaluation period. (FFS on scaling\_factor\_BFD values)**Proposal 6:** If a UE receives sequentially BFD-RS from multiple TRPs and if the number of BFD-RS included in the two BFD-RS sets (k=0,1) is more than 2 or higher, consider applying scaling\_factor\_CBD to TEvaluate\_CBD evaluation period. (FFS on scaling\_factor\_CBD values)**Proposal 7 :** In this case (ii) in Proposal 3 that a UE receive and evaluate only one BFD-RS with measurement priority, reuse a current requirement for a single cell (i.e. not to apply the scaling factors to the evaluation period requirements) **Proposal 8 :** If a FR2 UE does not support simultaneous reception, the following scheduling restriction applies due to beam detection ( in *8.5.8.3 Scheduling availability of UE performing L1-RSRP measurement on FR2)**- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, CSI-RS for tracking or CSI-RS for CQI on reference symbols to be measured for candidate beam detection.***Proposal 9 :** Adopt baseline from the BFRQ requirements in TS38.133 8.5.9.2, and studies further details depending on a recovery target cell and the evaluation period above. * How to treat two PUCCH-SR resource/SR configurations for T1 calculation.
* How to apply a scaling factor in TEvaluate\_CBD calculation for T2 calculation.

**UE supporting simultaneous reception from different QCL-type-D sources****Proposal 10 :** Introduce separate UE requirements of two types of UE reception capability in Rel-17(i) A UE not supporting simultaneous reception from different QCL-type-D sources(ii) A UE supporting simultaneous reception from two (or multiple) different QCL-type-D sources**Proposal 11 :** RAN4 studies if the UE processing capabilities below can be supported for simultaneous reception in a single carrier1. One RX chain for L1 measurement, another RX chain for L1 measurement
2. One RX chain for L1 measurement, another RX chain for L3 measurement
3. One RX chain for L3 (or L1) measurement, another RX chain for PDCCH monitoring/decoding
4. One RX chain for L3 (or L1) measurement, another RX chain for PDSCH decoding

**Proposal 12 :** Clarify UE beamforming capability for simultaneous reception requirement discussion : - Option-1 : Simultaneous reception capability is equal to UE RX capability with multiple RX panel from two different AoAs. - Option-2 : It is RAN4 understanding that simultaneous reception includes UE beamforming capabilities using a wide beam or two narrow beams regardless of the number of RX panels.**RAN1 LS R1-2112762 reply discussion****Proposal 13 :** RAN4 make a reply LS draft as belowRAN4 is working on UE supports for Rel-17 enhancements for inter-cell beam management and inter-cell mTRP* RAN4 develops UE requirements for at least *Nmax* = 1, where *Nmax* is the maximum number of RRC configured PCIs different from the serving cell for measurement/reporting.
	+ RAN4 will further study to specify the requirements for other *N\_max* value taking RAN1 decision into account
* RAN4 is discussing to introduce separate UE requirements of two types of UE reception capability and requirements in Rel-17.
* A UE not supporting simultaneous reception from different QCL-type-D sources

>> When there is overlap for L1-RSRP measurement for SSB associated with serving cell PCI and PCIs different from the serving cell PCI, the UE **sequentially** measures one SSB and another.* A UE supporting simultaneous reception from two (or multiple) different QCL-type-D sources

>> When there is overlap for L1-RSRP measurement for SSB associated with serving cell PCI and PCIs different from the serving cell PCI, the UE can **simultaneously** measure L1 RSRP.This is up to UE RX capability indication.* Due to lack of Rel-17 TU, the Rel-17 requirement study on simultaneous reception continues in Rel-18 WI phase.
 |
| [R4-2201387](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118840.zip) | Ericsson | Proposal 1: RAN4 to define requirements for TRP specific BFD, CBD and BFRQProposal 2: RAN4 to agree that BFD has to performed on 2 BFD-RS sets in m-TRP operation.Proposal 3: RAN4 to agree table 1 and table 2 as the evaluation period for SSB based BFD for each TRP in m-TRP operation. Table 1: Evaluation period of one SSB based BFD-RS set in m-TRP operation in FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms)  |
| no DRX | Max(50, Ceil(5 ´ P) ´ TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 ´ P) ´ Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 ´ P) ´ TDRX |
| Note: TSSB is the SSB periodicity of the SSB in the set . TDRX is the DRX cycle length. |

Table 2: Evaluation period of one SSB based BFD-RS set in m-TRP operation in FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms)  |
| no DRX | Max(50, Ceil(5 ´ P ´ N) ´ TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 ´ P ´ N) ´ Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 ´ P ´ N) ´ TDRX |
| Note: TSSB is the SSB periodicity of the SSB in the set . TDRX is the DRX cycle length. |

Proposal 4: RAN4 to agree table 3 and table 4 as the evaluation period for CSI-RS based BFD for each TRP in m-TRP operation. Table 3: Evalution period of one CSI-RS based BFD-RS set in m-TRP operation in FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms)  |
| no DRX | Max(50, [MBFD × P × PBFD] × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, [1.5 × MBFD × P × PBFD] × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | [MBFD × P × PBFD] × TDRX |
| Note: TCSI-RS is the periodicity of the CSI-RS resource in the set . TDRX is the DRX cycle length. |

Table 4: Evalution period of one CSI-RS based BFD-RS set in m-TRP operation in FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms)  |
| no DRX | Max(50, [MBFD × P × N × PBFD] × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, [1.5 × MBFD × P × N × PBFD] × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | [MBFD × P × N × PBFD] × TDRX |
| Note: TCSI-RS is the periodicity of the CSI-RS resource in the set . TDRX is the DRX cycle length. |

Proposal 5: RAN4 to agree that CBD has to performed on 2 CBD-RS sets in m-TRP operation.Proposal 6: RAN4 to agree table 5 and table 6 as the evaluation period for SSB based CBD for each TRP in m-TRP operation. Table 5: Evaluation period of one SSB based CBD-RS set in m-TRP operation of FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 ´ P ´ PCBD) ´ TSSB) |
| DRX cycle > 320ms | Ceil(3 ´ P ´ PCBD) ´ TDRX |
| Note: TSSB is the SSB periodicity of the SSB in the set . TDRX is the DRX cycle length. |

Table 6: Evaluation period of one SSB based CBD-RS set in m-TRP operation of FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 ´ P ´ N ´ PCBD) ´ TSSB) |
| DRX cycle > 320ms | Ceil(3 ´ P ´ N ´ PCBD) ´ TDRX |
| Note: TSSB is the SSB periodicity of the SSB in the set . TDRX is the DRX cycle length. |

Proposal 7: RAN4 to agree table 7 and table 8 as the evaluation period for CSI-RS based CBD for each TRP in m-TRP operation. Table 7: Evaluation period of one CSI-RS based CBD-RS set in m-TRP operation of FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluateC\_CBD\_CSI-RS (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. |

Table 8: Evaluation period of one CSI-RS based CBD-RS set in m-TRP operation of FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_CSI-RS (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × N × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × N × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. |

Proposal 8: RAN4 to agree that delay required from BFD on TRP to SR transmission on TRP for BFR procedure is given by T = T1 x Ceil((T2+D) /T1); Where:* T1 is equal to the periodicity of PUCCH configured with *schedulingRequestIDForBFR*.
* T2 = TEvaluate\_CBD is the evaluation period.

D is the UE Processing time and value of D is [2ms]. |
| [R4-2201618](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2119014.zip) | Huawei, HiSilicon | Proposal 1: In Rel-17, the requirements on applicability of QCL need to be updated for applicable to both DL and UL channel.Proposal 2: In Rel-17, it is suggested to define DL TCI chain and UL TCI chain respectively for unified TCI framework.Proposal 3: The existing definition of TCI chain in R15/R16 can be reused for DL TCL chain in R17.Proposal 4: In R17, a UL TCI chain* consists of an SSB, and one or more CSI-RS resources, and the TCI state of each reference signal includes another reference signal in the same TCI chain.

Or* consists of an SSB, and one or more SRS resources, and the TCI state of each reference signal includes another reference signal in the same TCI chain.

Or* consists of an SSB, and one or more CSI-RS resources, and one or more SRS resources, and the TCI state of each reference signal includes another reference signal in the same TCI chain.

Proposal 5: The existing BFD and CBD measurement requirements in R16 can be applied to the serving cell configured with TRP-specific BFR in R17. |

## Open issues summary

### Sub-topic 3-1: TRP specific BFR

Please note that some proposals (issues) might be omitted by purpose as they are deprioritized in the 1st round discussion or out of the scope of [219].

**Issue 3-1-1 Requirement for TRP specific Beam Failure Recovery**

* Proposals
	+ Proposal 1: for both FR1 and FR2, to introduce a new scaling factor PTRP to extend the evaluation period of BFD and CBD for multiple TRPs. (MTK)
	+ Proposal 2: Introduce sharing factor for BFD and CBD evaluation period in FR2 when BFD-RS or CBD-RS are received simultaneously from 2 TRP. (Apple, Nokia)
	+ Proposal 3: For TRP-specific BFD, delay requirement is defined assuming that UE will perform BFD in TDM manner; measurement delay will be scaled by the number of BFD-RS sets. (Intel)
	+ Proposal 4: RRM requirements for TRP-specific BFR should be specified for FR1 in R17. For the CC configured with TRP-specific BFR, introduce scaling factor PTRP = 2 to requirements SSB-based and CSI-RS based BFR. (vivo)
	+ Proposal 5: Study BFR requirements for the two cases: (i) to receive and evaluate sequentially BFD-RS from multiple TRP and (ii) to receive and evaluate only one BFD-RS when a serving cell beam failure is detected or when beam failure of all cells are detected at the same time (Nokia)
	+ Proposal 6: RAN4 to define requirements for TRP specific BFD, CBD and BFRQ and agree that BFD has to performed on 2 BFD-RS sets in m-TRP operation. Agree that CBD has to performed on 2 CBD-RS sets in m-TRP operation. Agree on detailed requirement Table in [R4-2201387](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118840.zip). (Erricsson)
	+ Proposal 7: RAN4 to agree that delay required from BFD on TRP to SR transmission on TRP for BFR procedure is given by T = T1 x Ceil((T2+D) /T1); Where:
		- T1 is equal to the periodicity of PUCCH configured with *schedulingRequestIDForBFR*.
		- T2 = TEvaluate\_CBD is the evaluation period.
		- D is the UE Processing time and value of D is [2ms].
	+ Proposal 8: The existing BFD and CBD measurement requirements in R16 can be applied to the serving cell configured with TRP-specific BFR in R17.
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 3-2: QCL definition

**Issue 3-2-1 QCL definition for UL TCI state**

* Proposals
	+ Proposal 1: RAN4 should further check the need of the QCL definition for UL TCI state. (MTK)
	+ Proposal 2: Update TCI chain definition to include SRS and for PUCCH/PUSCH. (Apple)
	+ Proposal 3: For DL TCI chain, SSB associated with a different PCID is added as a source RS. DL TCI chain can apply for separate DL TCI state or joint TCI state switching. (Intel)
	+ Proposal 4: For UL TCI chain, SSB, SRS or CSI-RS will be considered as source RS in the UL TCI chain. the number of Reference Signals in the chain is no more than 4. (Intel)
	+ Proposal 5: Applicability of QCL needs not to be updated in R17 feMIMO WI.
	+ Proposal 6: the requirements on applicability of QCL need to be updated for applicable to both DL and UL channel. The existing definition of TCI chain in R15/R16 can be reused for DL TCL chain in R17. A UL TCI chain (Huawei)
		- consists of an SSB, and one or more CSI-RS resources, and the TCI state of each reference signal includes another reference signal in the same TCI chain. Or
		- consists of an SSB, and one or more SRS resources, and the TCI state of each reference signal includes another reference signal in the same TCI chain. Or
		- consists of an SSB, and one or more CSI-RS resources, and one or more SRS resources, and the TCI state of each reference signal includes another reference signal in the same TCI chain.
* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

### Sub-topic 3-3: Reply on RAN1 LSs

**Issue 3-3-1 Reply on RAN1 LS BFR for CORESET with two activated TCI states** **R1-2112829**

* Proposals
	+ Proposal 1: For a CORESET with two activated TCI states, UE evaluates the RLM/BFD based on single hypothetical PDCCH BLER for the CORESET. (Intel, vivo)
	+ Proposal 2: For a CORESET with two activated TCI states, two RS indexes are included in $\overbar{q}\_{0} $(as two BFD RS resources) for implicit BFD. (Apple)
	+ Proposal 3: Adopt Text proposal 1 and Text proposal 2 for clarifications on BFD and RLM requirements in R17 HST-SFN scenario, and inform RAN1 about the above change in the reply LS. And ask RAN1 for confirmation on whether the term ‘RLM-RS pair’ can used for the RLM case. (vivo)

|  |
| --- |
| * Text Proposal 1: TS 38.133 Clause 8.1.1
* If a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', on the [RLM-RS pair], the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout and Qin for the purpose of monitoring downlink radio link quality of the cell. Otherwise, on each RLM-RS resource, the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout and Qin for the purpose of monitoring downlink radio link quality of the cell.
* Text Proposal 2: TS 38.133 Clause 8.5.1
* If a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', on the [BFD-RS pair] , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of assessing downlink radio link quality of the serving cell beams. Otherwise, on each RS resource configuration in the set , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of ~~accessing~~ assessing downlink radio link quality of the serving cell beams.
 |

* Recommended WF
	+ Collect companies’ view for these proposals in 1st round

## Companies views’ collection for 1st round

**Issue 3-3-1 Reply on RAN1 LS BFR for CORESET with two activated TCI states** **R1-2112829**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

## Summary for 1st round

|  |  |
| --- | --- |
|  | **Status summary**  |
|  |  |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
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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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
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Note:

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)