**3GPP TSG RAN WG1 #104b-e R1-2103892**

**e-Meeting, April 12th – 20th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#3 for multi-beam enhancement: Round 2

**Document for:** Discussion and Decision

## Summary of companies’ inputs

### Issue 1 (Rel.17 unified TCI framework for intra-cell beam management)

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** |
| 1.3 | Switching between joint and separate DL/UL TCI   * Alt1. A UE can be dynamically indicated with either joint DL/UL TCI or separate DL/UL TCI * Alt2A. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via RRC signaling * Alt2B. A UE can be configured with either joint DL/UL TCI, separate DL/UL TCI, or both via RRC signaling * Alt3. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via MAC CE signaling | **Alt1 (17)**: Lenovo/MoM, Nokia/NSB, Spreadtrum, CATT, APT/FGI, Xiaomi, Sony, AT&T, Apple, MTK, ZTE, Futurewei, Convida, Intel  **Alt2A (6)**: Ericsson, NTT Docomo, LGE, NEC, Huawei, HiSi  **Alt2B (2)**: vivo, ZTE  **Alt3 (11)**: CMCC, Samsung, NTT Docomo, Huawei, HiSi, CATT, Xiaomi, Intel, Qualcomm, NEC, Convida. |
| 1.6 | Setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index): In addition to association with UL channel/RS,   * Alt1. The setting of (P0, alpha, closed loop index) is also associated with UL or (if applicable) joint TCI state * Alt2. The setting of (P0, alpha, closed loop index) is included with UL or (if applicable) joint TCI state * Alt3. The setting of (P0, alpha, closed loop index) is neither associated with nor included in UL or (if applicable) joint TCI state * Alt4. The setting of (P0, alpha, closed loop index) is determined as in Rel-16 without enhancement | **Alt1 (11)**: Lenovo, CMCC (PUCCH), Nokia/NSB, NTT Docomo, Spreadtrum, CATT, ZTE, OPPO (PUSCH, PUCCH), Qualcomm, Futurewei  **Alt2 (6)**: IDC, Samsung, Intel (at least PUCCH), Apple, Qualcomm, LGE  **Alt3 (5)**: Fraunhofer IIS/HHI, CMCC (PUSCH – SRI, SRS – SRSResourceSet), Ericsson (for P0 and alpha), Sony,  **Alt4 (5)**: vivo, OPPO (SRS), MTK, Huawei, HiSi |
| 1.7 | Path-loss measurement (PL RS):   * Alt1. PL-RS can be included in UL TCI state or (if applicable) joint TCI state.   + FFS: Whether it is always included or not. If not included, PL-RS is the periodic DL-RS used as a source RS for determining spatial TX filter or the PL RS used for the UL RS in UL or (if applicable) joint TCI state. * Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   + FFS: Exact association mechanism   + FFS: Whether it is always associated or not. If not associated, PL-RS is the periodic DL-RS used as a source RS for determining spatial TX filter or the PL RS used for the UL RS in UL or (if applicable) joint TCI state * Alt3. The periodic DL-RS used as a source RS for determining spatial TX filter can be used as PL-RS. In case the periodic DL-RS used as a source RS for determining spatial TX filter is not used as PL-RS, reuse Rel.16 procedure with the same signaling structure (MAC CE+SRI field in UL-related DCI) to indicate PL-RS for UL transmission with minimum enhancement (e.g. pertaining to the use for PUCCH, or using default PL-RS)   + PL-RS is not additionally configured in or associated to UL TCI state or (if applicable) joint TCI state * Alt4. UE calculates path-loss based on periodic DL RS configured as the source RS or a periodic QCL-Type-D/spatialRelationInfo source of the source RS in UL TCI state or (if applicable) joint TCI state   + FFS: Whether UE can calculate path-loss based on DL periodic RS for path-loss calculation for UL RS in the UL TCI | **Alt1 (10)**: IDC, Fraunhofer IIS/HHI, Ericsson (if UL RS in TCI state), NTT Docomo, OPPO, Intel (at least PUCCH), Qualcomm, AT&T, LGE  **Alt2 (14)**: Lenovo/MoM, CMCC, NTT Docomo, Huawei, HiSi, Spreadtrum, CATT, ZTE, MTK, Futurewei, Sony, Nokia/NSB  **Alt3 (1)**: vivo  **Alt4 (3)**: Ericsson (if DL RS in TCI state), Samsung, Apple, |

**From round 1:**

**Table 2**

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| **Proposal 1.2**: On Rel.17 unified TCI framework, in RAN1#105-e, further discuss to down-select or combine from the following two alternatives for switching between joint and separate DL/UL TCI (note: the text below is based on the agreed description in RAN1#104-e):   * Alt1. A UE can be dynamically indicated with either joint DL/UL TCI or separate DL/UL TCI among the activated TCI states   + Details on dynamic indication are FFS * Alt3. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via MAC CE signaling   + Details on how this is signaled in relation to TCI activation are FFS   FFS: The support for joint DL/UL TCI and/or separate DL/UL TCI in terms of UE capability  FFS: Functionality/mode corresponding to either joint DL/UL TCI, separate DL/UL TCI, or dynamically switching between joint and separate is enabled by RRC  **(New) Proposal 1.4**: On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework, for each of PUSCH, PUCCH, and SRS, in RAN1#105-e, strive to down-select or combine from the following alternatives:   * Alt1. The setting of (P0, alpha, closed loop index) is also associated with UL or (if applicable) joint TCI state * Alt2. The setting of (P0, alpha, closed loop index) is included with UL or (if applicable) joint TCI state * Alt4. The setting of (P0, alpha, closed loop index) is determined as in Rel-16 without enhancement * Note: It has been agreed that the setting of (P0, alpha, closed loop index) is associated with UL channel or UL RS (therefore the setting is channel- and signal-specific)   In RAN1#105-e, for each of the PUSCH, PUCCH, and SRS, if no consensus can be reached among the above 3 alternatives, the setting of (P0, alpha, closed loop index) will neither be associated with nor included in UL or (if applicable) joint TCI state.  **Proposal 1.5**: On Rel.17 unified TCI framework, in RAN1#105-e, further discuss to down select or combine from the following two alternatives for PL-RS (note: the text below is based on the agreed description in RAN1#104-e):   * Alt1. PL-RS can be included in UL TCI state or (if applicable) joint TCI state. * Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   + FFS: Exact association mechanism * Depending on the final outcome, FFS on exact association mechanism and whether to support a unified mechanism for the setting of (P0, alpha, closed loop index) and PL-RS, if PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   The support of the above PL-RS (the outcome of the above down selection or combining) is a UE optional feature.   * If not supported, or if a UE is configured with neither PL-RS in UL/joint TCI state nor the association between PL-RS and UL/joint TCI state, the UE estimates path-loss based on the periodic DL-RS provided as a source RS for determining spatial TX filter [or the PL-RS used for the UL RS provided as a source RS for determining spatial TX filter] in UL or (if applicable) joint TCI state   + [FFS: How to select between the periodic DL-RS and the PL-RS used for the UL RS] * FFS: maximum number of active PL-RS per band   The above behavior is optionally supported by the UE for Rel-17 unified TCI framework. |

**Table 3**

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| **Current state of proposal 1.4 and rationale for the new proposal 1.4:**  At least the following companies repeatedly stated that they cannot accept FL proposal 1.4 in round 0/1 (based on Alt1, i.e. the majority view): Ericsson (Alt3 for all), IDC (Alt2 for all), Intel (Alt2 for all), OPPO (SRS), Samsung (Alt2 for all), vivo (PUSCH, SRS).  It has been agreed in RAN1#104-e that “(t)he setting of (P0, alpha, closed loop index) is at least associated with UL channel or UL RS”. This is equivalent to saying that the setting is channel- and signal-specific (PUSCH, PUCCH, and SRS have separate settings).  The problem raised in down-selecting among Alt1, 2, 3, and 4 (to be finalized in RAN1#104b-e) can be reformulated as follows: In addition to the agreement that the setting of (P0, alpha, closed loop index) is associated with UL channel or UL RS (specific for each of PUSCH, PUCCH, and SRS), is association between such setting and UL TCI state needed?   * Note that Alt1, Alt2, and (to some extent) Alt4 propose some form of association between the said setting and UL TCI state (“UL beam”). Inclusion (Alt2/4) is a special case (perhaps the strongest form) of association. Alt3, on the other hand, states that the agreement is already sufficient, i.e. there is no need for associating the setting with UL TCI state. * Therefore, if no consensus can be reached among Alt1/2/4, Alt3 is automatically the outcome since no association scheme between the UL PC parameter setting and UL TCI state can be agreed.   From Table 1 and the discussion thus far, although the majority of companies prefer to add some form of association between the setting and the UL TCI state (Alt1+2+4 proponents), consensus cannot be reached despite the majority view of Alt1. Therefore, to respect the majority (one more chance) while trying to ensure timely (despite already missing an established deadline) completion of Issue 1, a new FL proposal 1.4 was made (see above). The proponents of Alt1/2/4 are encouraged to discuss offline and strive for consensus by RAN1#105-e. If such an attempt fails, Alt3 will be the outcome. |

Table 4 Additional inputs: issue 1

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| Mod V00 | Proposal 1.2: The text is stable but Ericsson and IDC voiced opposition (too early). MTK has attempted to address the concern. **Any view?**  *Ericsson: Do not support. This is somewhat premature: it would seem reasonably clear how the NW would signal a joint TCI state to the UE (one DCI codepoint corresponds to one joint TCI state, and if the codepoint is indicated, the UE would switch to that new joint TCI state). But we have not agreed on how separate DL/UL TCI would be signalled, so we don’t see how we can discuss switching between them. Suggest that we first agree on how to signal separate DL/UL TCI.*  *IDC: We agree with Ericsson that agreeing this proposal is premature. Hope to have the agreement after having more details on unified TCI framework.*  *MTK: Response to Ericsson: To our understanding, this proposal is just a down-selection from a previous agreement. In the previous agreement, some alternatives support a semi-statically configuration between joint DL/UL TCI and separate DL/UL TCI. In this proposal, the semi-static mechanism is ruled out, and dynamic switching is supported (either by DCI or MAC-CE). We think this is the intention of this proposal. Regarding how to signal separate DL/UL TCI, we agree that it is necessary to be discussed, but it would be the next level design. The two alternatives in this proposal just provide the directions how we can design the signaling.*  New proposal 1.4: Please check Table 2 for the rationale of the new proposal 1.4. **Any view?**  Proposal 1.5: Two pending issues:   * The cyan text (PL-RS for UL RS as an option): **Any view (and reason)?**   + Propose to keep: Fraunhofer IIS/HHI   + Propose to remove: ZTE, Qualcomm (complicate implementation by rules for possible combinations), MTK (new behavior with potential issues), OPPO * Proposal from Futurewei to replace the “default” scheme: **Any view (and reason)?**   + Support current “default” scheme:   + Support Futurewei’s “default” scheme: |
| **Company** | **Input** |
| MediaTek | New proposal 1.4: Support |
| Vivo | For proposal 1.4: Alt4. can be re-labeled as Alt 3?  Proposal 1.5: Two pending issues:   * The cyan text (PL-RS for UL RS as an option): **Any view (and reason)?**   + Propose to keep: Fraunhofer IIS/HHI   + Propose to remove: ZTE, Qualcomm (complicate implementation by rules for possible combinations), MTK (new behavior with potential issues), OPPO , vivo * Proposal from Futurewei to replace the “default” scheme: **Any view (and reason)?**   + Support current “default” scheme: vivo   + Support Futurewei’s “default” scheme: |
| Apple | Proposal 1.2: we are ok to defer the decision. But so far we have not seen any issue for dynamic switching between different types of TCI.  Proposal 1.4: OK with current version  Proposal 1.5:   * PL-RS for UL RS: we do not have strong preference * To replace “default scheme”: we support current scheme. We failed to see how R16 power control framework + R17 unified TCI can work. R16 PC is based on spatialRelation which would be taken instead of by unified TCI. |
| Fraunhofer IIS/HHI | Proposal 1.4: Support  Proposal 1.5  To the question from Qualcomm "What about the UL RS also has no PL RS?": In our understanding, Rel. 15/16 covers the possibilities for the absence of configured PL RS and default PL RS is assigned in various cases. So, when an explicitly assigned PL RS for the UL RS is not provided, the default PL RS is taken.  And, as mentioned earlier, the method merely copies/borrows the PL RS from an UL RS and does not activate one. Hence, there is no issue with the number of PL RSs activated with this proposal.  Moreover, the use of PL RS of an UL signal (PUCCH/SRS) for other UL transmissions is not unprecedented.  From TS 38.213:  ------------- Start of relevant part TS 38.213 -------------  is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index for the active DL BWP, as described in Clause 12, of carrier of serving cell  …   * If the PUSCH transmission is scheduled by DCI format 0\_0, and if the UE is provided a spatial setting by PUCCH-SpatialRelationInfo for a PUCCH resource with a lowest index for active UL BWP of each carrier and serving cell , as described in Clause 9.2.2, the UE uses the same RS resource index as for a PUCCH transmission in the PUCCH resource with the lowest index * If the PUSCH transmission is not scheduled by DCI format 0\_0, and if the UE is provided *enableDefaultBeamPL-ForSRS* and is not provided *PUSCH-PathlossReferenceRS* and *PUSCH-PathlossReferenceRS-r16,* the UE uses the same RS resource index as for an SRS resource set with an SRS resource associated with the PUSCH transmission   ------------------ End of relevant part -----------------  We therefore believe that this proposal is within the possibilities of implementation.  The default scheme without the blue highlight provides the PL RS only when the UL/joint TCI state provides a periodic DL RS as spatial source. This proposal in blue highlight extends it to the case when an UL RS is provided as a spatial source in the UL/joint TCI state and gives it broader usage.  And, we support the current default scheme with the PL RS for UL RS part. |
| Ericsson | **Proposal 1.2:** Thanks for the explanation: it is indeed so that Proposal 1.2 aims at down-selecting. The problem is that there is not enough information available for us to do the down-selection, since it depends on how the separate DL/UL TCI states are signalled in “isolation”. Similar to Apple, we feel that with the most reasonable way to signal separate DL/UL TCI states, Alt1 is inherently supported. Then RRC signalling also has merits, in case the UE only supports joint DL/UL TCI states, we want to handle UE capabilities during RRC reconfiguration and not during MAC CE activation. We were hoping that we could develop a common understanding on how separate DL/UL TCI states are signalled before agreeing on how to switch, if such switching is at all needed. Hence, we are not OK to remove Alt2A.  **Proposal 1.4:** Support  **Proposal 1.5:** Essentially OK. This part [or the PL-RS used for the UL RS provided as a source RS for determining spatial TX filter] sounds circular: this would require that there is PL RS defined for that UL RS, and there is no guarantee for that. But it is anyway in brackets. |
| ZTE | Proposal 1.2: We do not have strong preference for making decision this meeting or next one.  Proposal 1.4: Thanks so much for the FL’s great efforts. If we prefer to defer this discussion, we are fine. But, the last note is confusing: if above three alternatives is not agreed, then the setting of (P0, alpha, closed loop index) will neither be associated with nor included in UL or (if applicable) joint TCI state. Then what’s the fall-back solution in the table? Could any proponent clarify how Alt3 can operate for PUCCH, for instance? The same comment is to Alt4.  If not clear solution, we suggest to remove Alt 4 and the last note, directly.    Proposal 1.5: We suggest to remove the PL-RS for UL RS (cyan) and make the implicit solution clearly. Meanwhile, we support current “default” scheme.  @Fraunhofer IIS/HHI, you may have some misunderstanding between the Rel-16 default beam and Rel-17 unified TCI solution.   * For Rel-16, we need to define the default spatial relation for PUCCH and SRS, and then handle PL-RS determination for PUSCH using the above paragraphs you mentioned. * But, for Rel-17 unified TCI state, we directly provide spatial relation to PUSCH, besides PUCCH and SRS. We do not need to this complicated logic chain.   As you see, SRS for CB/NCB should use the the periodic DL-RS provided as a source RS for determining spatial TX filter, and then based on your suggestion, the PUSCH also need to use the same PL-RS for SRS. It is circular as Ericsson mentioned. |
| Nokia | Proposal 1.2: perhaps it helps if we reiterate our statement from the previous round. Dynamic indication of either joint DL/UL TCI or separate DL/UL TCI can be provided e.g. following Rel16 principles by defining a TCI codepoint that may have own entries for both DL and UL TCI. In each TCI codepoint there can be either DL TCI, UL TCI or both. MAC activation command would then be used to map up to L (e.g. 8) combinations of one or two TCI states to the codepoints and DCI based indication would select one of the activated codepoints. To support multiple indicated DL and UL TCI states, i.e. M > 1 and N > 1, the activation of the TCI state combinations could be per coresetPoolIndex and if configured there could be up to two coresetPoolIndices and thus also M and N could be up to 2.  New Proposal 1.4:  We don’t understand how Rel-15/16 power control scheme can work with unified TCI framework. Should P0 & alpha to be associated to SRI which is not valid as UL spatial Tx filter information anymore? Or should P0& alpha be configured for each of SRS resource set while S*patialRelationinfo* for SRS can be dynamically update by TCI?  Proposal 1.5:  We do not support selection between DL-RS as QCL source and PL-RS configured for UL. PL-RS configured for UL RS can work only when it is the only valid RS.   * If not supported, or if a UE is configured with neither PL-RS in UL/joint TCI state nor the association between PL-RS and UL/joint TCI state, the UE estimates path-loss based on the periodic DL-RS provided as a source RS for determining spatial TX filter   + If QCL source RS is configured as UL RS, then UE estimates path-loss based bnbnbnbnbn on ~~[or~~ the PL-RS used for the UL RS provided as a source RS for determining spatial TX filter~~]~~ in UL or (if applicable) joint TCI state   ~~[FFS: How to select between the periodic DL-RS and the PL-RS used for the UL RS]~~ |
| Fraunhofer IIS/HHI | **Proposal 1.5:** Thanks to ZTE and Ericsson for the comments. I included the default PL RS for PUSCH in Rel-16 as examples for precedence in using PL RS of other UL signals. For clarity regarding the PL RS availability for the UL RS (separate from the default assumptions in Rel-16) and the choice of the PL RS in different circumstances as mentioned by Nokia and Huawei, we suggest the following changes:   * If not supported, or if a UE is configured with neither PL-RS in UL/joint TCI state nor the association between PL-RS and UL/joint TCI state, the UE estimates path-loss based on the periodic DL-RS provided as a source RS for determining spatial TX filter or the PL-RS used for the UL RS provided as a source RS for determining spatial TX filter in UL or (if applicable) joint TCI state   + If the source RS provided by the UL/joint TCI state for determining spatial TX filter is a periodic DL-RS then the periodic DL-RS is chosen and if the source RS provided by the UL/joint TCI state for determining spatial TX filter is a UL RS, the PL-RS used for the UL RS is chosen.   + Note: The UL RS in the UL/joint TCI state, in this case, is provided a PL RS via explicit RRC or MAC-CE signaling. |
| CAT | **Proposal 1.2:**  Fine with the proposal.  New proposal 1.4: Support  Proposal 1.5: Support . OK to keep the cyan text in bracket. |
| OPPO | New Proposal 1.4: Support. In our understanding, if none of those 3 alts is agreed, then the setting {P0, alpha, closed loop index} is only associated with UL channel or RS, which is what we agreed in 104 meeting.  Proposal 1.5: We share the same views as ZTE and prefer to remove the PL-RS for UL RS part. We shall avoid any complicated UE ‘default behavior’ rules, which is a lesson learnt from previous version. |
| Samsung | Proposal 1.4: We are fine with the new proposal 1.4,  Some technical points for later discussion (after proposal 1.4 is agreed):   1. We would like to get some clarifications on Alt4 regarding how it fits into the unified TCI Framework. The legacy power control framework uses the SRI to determine the p0-PUSCH-AlphaSet-Id for PUSCH. For PUCCH the spatial relation info is used. In the unified TCI framework, the SRI and spatial relation info are no longer there. How does the UE determine the power control parameters from the joint/UL TCI state with Alt4. 2. It seems that the difference between Alt1 and Alt2 is whether to associate or include the power control parameters with the TCI state. This is mainly a signaling issue, and can be left to RAN2 to decide how to efficiently signal power control parameters that are linked to the TCI states. 3. As the FL rightly pointed out in the last we agreed that the “setting of (P0, alpha, closed loop index) is at least associated with UL channel or UL RS”. If we additionally agree that the “setting of (P0, alpha, closed loop index) is associated with the joint/UL TCI state”, a follow up question would be how to associated the PC parameters jointly with UL channel/signal and TCI state. We see at least two ways for the joint association:    1. In the TCI state, the PC parameters are separately repeated or associated for each UL channel/signal. We see this increasing the signaling overhead.    2. In the TCI state, the PC parameters are common across all UL channels/signals. The PC parameter is then derived as a function of the UL channel/signal and UL TCI state. For example, P0 for PUSCH can be a sum of P0(PUSCH) + P0(TCI state). This saves signaling overhead. 4. Alt 1.3 this will be a regression from Rel. 15/16. One benefit of having PC parameters depend on the TCI state is to control the interference in certain beam directions.   Proposal 1.5: In general, we are supportive of the proposal. |

### Issue 2 (L1/L2-centric inter-cell mobility)

Table 5 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | Support CSI-RS associated with/configured for non-serving cell(s) as a measurement RS  Note: Supporting this implies the support of Rel-15 CSI-RSRP as beam metric/reporting | CSI-RS for mobility/RRM associated with NSC:   * **Yes (6)**: Huawei, HiSi, ZTE, CATT, Sony, LGE * **No (7)**: Samsung, Nokia/NSB, OPPO, MTK, Xiaomi, Qualcomm   CSI-RS for BM configured for NSC:   * **Yes (8)**: Ericsson, Nokia/NSB, APT/FGI, Futurewei, Huawei, HiSi * **No (4)**: Samsung, OPPO, MTK, Xiaomi,   CSI-RS for tracking (TRS) configured for NSC:   * **Yes (4)**: Nokia/NSB, IDC (add PCI in TRS), Futurewei * **No (5)**: OPPO, MTK, Xiaomi, Huawei, HiSi |
| 2.5 | Can beam reporting associated with non-serving cell(s) be mixed with that with serving-cell in one reporting instance? | **Yes (14)**: vivo, Ericsson, Samsung, Spreadtrum, CATT, Intel, LGE, Apple, MTK, APT/FGI, Sony, ZTE (Up to config.), Futurewei, Xiaomi, NTT Docomo, Huawei. HiSi (up to configuration)  **No (3)**: ASUSTeK, Nokia/NSB |
| 2.9 | Support for event-triggered (UE-initiated) inter-cell SS-RSRP reporting | **Yes (14)**: Huawei, HiSi, Qualcomm, Sony, Apple, Samsung, Xiaomi, ASUSTeK, IDC (inter-cell BFR), ZTE, Lenovo/MoM, Futurewei, CATT  **No (3)**: Ericsson, Nokia/NSB |
| 2.10 | Timing assumption (e.g. time of arrival and time of the measurement) for measurement of non-serving cell measurement RS | TA/TAG of SC and configured NSC(s) shall be the **same**: Xiaomi  TA/TAG of SC and configured NSC(s) can be **different**: vivo (UE can report), Intel, Apple (with PDCCH ordered NSC PRACH, no TAG), Qualcomm, CATT (TA difference is configured), APT/FGI, Sony, ZTE, Futurewei, Huawei, HiSi, LG, Ericsson |

From round 1, the previous proposal 2.1 is split into three:

**Table 6**

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| **Proposal 2.1**: On Rel.17 multi-beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP,   * On the value of K (defined in RAN1#104-e as the number of beam qualities associated at least with non-serving cell(s) can be reported in a single CSI reporting instance),   + FFS: the supported maximum value(s) of K, select from {4, 8, 16}   + FFS: whether the maximum value of K is a UE capability * [Periodic,] semi-persistent, and aperiodic measurement/reporting are supported. * For aperiodic reporting, in one reporting instance, depending on NW configuration, beam(s) associated with a non-serving cell can be mixed with that associated with serving-cell   + FFS: How to report the K beams and corresponding qualities if the Tx power among the non-serving cell and with serving-cell is not the same   + Note: The supported numbers of non-serving cells (in terms of measurement/reporting) have not yet been decided. The above description doesn’t imply only one non-serving cell is allowed to be configured for measurement. Nor does this imply that only one non-serving cell is allowed in one reporting instance. * [For L1-RSRP measurement and at least aperiodic reporting, support MAC CE based dynamic activation/deactivation of a subset of higher-layer-configured (for measurement) measurement for non-serving cell SSBs, e.g., additionally activated non-serving cell information for SSBs to be measured, or activated non-serving cell SSBs ]   **Proposal 2.2**: On Rel.17 multi-beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP, in addition to NW-initiated measurement/reporting, event-based (UE-initiated) measurement/reporting without CSI request from the NW is supported   * FFS: Definition of triggering event * Treated with lower priority |

Table 7 Additional inputs: issue 2

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| Mod V00 | Proposal 2.1: Please share your view on the following issues:   * Grey (max K values): **any other proposals for candidate max K values?** * Cyan (periodic): MTK proposed to keep **periodic FFS (do not see the need for NSC measurement/reporting). Any view (agree, disagree - reasoning)?** * Purple (activation): Ericsson raised concern that it is “too early”. **Any view (agree, disagree - reasoning)?**   Proposal 2.2: Given the majority view, this proposal may have a chance. Some companies voiced some concerns (Ericsson, Nokia/NSB) on **the lack of event definition and benefits. Could the proponents elaborate on this and see if they can resolve the concern?** |
| **Company** | **Input** |
| vivo | Proposal 2.1: Please share your view on the following issues:   * Purple (activation): We would like to agree on such mechanism. It is expected number of NSC would be large. Fast selection of NSC for measurement would be important to make this feature more useful.   Proposal 2.2: We are fine with it as low priority. |
| Apple | Proposal 2.1:   * Max K: we are fine with {4, 8} if we have UE capability. We can live with 16 if there is majority’s support * Periodic: we are ok to support periodic report, and we assume there would be a UE capability at least for SP report * Activation: this was agreed as FFS in last meeting, we do not know why it is “too early”.   Proposal 2.2: we can add more details if companies have concern.   * FFS: Definition of triggering event, e.g. L1-RSRP from a non-serving cell SSB is higher than maximum L1-RSRP measured from serving cell SSB plus a threshold, or reuse legacy BFD, CBD and BFR procedure where the candidate beam can be a non-serving cell SSB. |
| Ericsson | We reiterate that there is little point in defining advanced measurements on L1 before beam indication to non-serving cells is supported, since L1 measurements end up in the DU, whereas RRC is in the CU.  Overall, we are OK to focus on semi-persistent and aperiodic. On the other hand, the specification effort to include also periodic reporting is negligible – so it would seem unnecessary to exclude it.  On the activation of measurements, it is unclear if this is different from the aperiodic triggering states, where this activation possibility already exists. We also note there is a parallel discussion on the number of non-serving cells to support. Before we have agreed how many non-serving cells can be reported, we cannot say that the number of cells is too large.  For P2.2, we would be ok to extend BFR to situations where candidates are non-serving SSBs. We are more concerned about general events. |
| ZTE | Proposal 2.1:   * Grey (max K values): 16 is suggested, and we are also fine with UE capability as what we did for normal beam reporting. * Cyan (periodic): We do not have strong preference, but slightly prefer to support **periodic reporting.** * Purple (activation): Support.   + We share the same views with Apple. To reply Ericsson’s comment, we think that the candidate non-serving cells should be very large in RRC level, like 32 or 64 neighboring cells as we did for RRM. But, after having the L3 reporting, we think that the available NSC for L1/L2 measurement may be limited, like 1 or 2. Therefore, the MAC-CE activation for NSC information, like PCI, for measurement seems to be very necessary.   Proposal 2.2: It seems that event-driven reporting has been highlighted in first R17 RAN1 meeting. The benefits are summarized as follows, according to our best knowledge:   * Compared with NW-initialized beam measurement/reporting, the latency of event-based (UE-initiated) measurement/reporting should be smaller because the UE can initiate the L1 reporting for a neighboring cell by trigger event without waiting for the signaling from gNB. * Then, we think that the latency reduction for TL1-RSRP as specified in RAN4 may be performed well based on this event-driven method. It is due to the fact that if the UE provide this reporting of NSC beam(s), and the corresponding Rx beam can be stored in UE side automatically. As a result, the UE do not need to do any UE Rx beam refinement. But for former, if the UE do not store any information, the gNB still need to preform UE Rx beam refinement (e.g., waiting for at least 8 SSB periods according to RAN4) * Finally, the UE reports the L1 reporting on demand which will save power of UE as BFR and UL/DL resource.   BTW, could any companies provide already RAN1 agreement clarifying that **NW-initialized beam reporting has been supported for L1/L2 inter-cell mobility**? If not, we suggest that NW-initialized beam reporting should be treated as low priority. |
| Nokia | 2.1: We cannot see a reason to prevent NW configuration to have same reporting time types for NSC as for serving cell (periodic,S-P, aperiodic)  2.2: In our view, there should be first discussion/proposal which events would be supported/benefits before agreeing that UE event-based triggering of reporting is supported. |
| CATT | Support the proposal in its current format.   * Cyan (periodic): we are OK to support it. * Purple: Support MAC-CE based activation, due to reasons articulated by vivo. |
| OPPO | Regarding the max of K: we are ok with {4, 8} with UE capability and prefer not to have 16. Do not see motivation for 16.  Regarding [Periodic,]: we prefer not to support it. The target non-serving cell could change and thus frequent RRC reconfiguration would be needed.  Regarding the Purple: we can support if the purpose of that is to only select one NSC for measurement. We do not see the use case for requesting UE to measure > 1 MSC at the same time. The L1 measurement is used to prepare the TCI state for the target non-serving cell in inter-cell mobility, which is only one. The UE does see and measure multiple cells in L3 measurement and that is used to select/determine the target cell for mobility. Therefore, when the UE measures the L1-RSRP, the target cell is already determined.  Re proposal 2.2: It looks like the NW-initialized beam reporting is not agreed yet. Suggest to remove the word “in addition to”, we are ok to support both modes. And regarding the defining triggering event, we prefer not to list detailed exampled. Specially, we do not think it is proper to extend to BFR. BFR involves some automatic beam switch. If NSC is included in BFR, does that mean the UE handover to the new cell during BFR? |
| Samsung | Proposal 2.1: We would like to keep periodic without square brackets. The UE can be configured to periodically report SC and NSC measurements in the same report. If there is no NSC with a quality above a threshold, the report would only include SC measurements.  For the third bullet, we see no reason to limit just to aperiodic reporting, we suggest:   * At least for aperiodic reporting, in one reporting instance, depending on NW configuration, beam(s) associated with a non-serving cell can be mixed with that associated with serving-cell   + FFS: whether this applies to periodic and semi-persistent reporting   For the last bullet highlighted in pink we can accept with following clarifications:   * For L1-RSRP measurement and at least aperiodic reporting, support MAC CE based dynamic activation/deactivation of a subset of higher-layer-configured (for measurement) measurement for non-serving cell SSBs, e.g., additionally activated non-serving cell information for SSBs to be measured, or activated non-serving cell SSBs   + FFS: Dynamic (MAC CE and/or DCI) activation for semi-persistent   + FFS: RRC configuration for periodic |

### Issue 4 (MP-UE)

The following text is almost stable from Round 1:

**Table 11**

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| **Proposal 4.1**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, for CSI/beam measurement/reporting, down select and/or modify from the following candidates:   * Opt1-1: A panel entity is referring to reported CSI-RS and/or SSB resource index in a beam reporting instance   + The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index is indicated to NW   + FFS: Detailed design of the correspondence including the conveyed information   + Note: the correspondence between a CSI-RS and/or SSB resource index and a panel entity is determined by the UE (analogous to Rel-15/16) * Opt1-2: A panel entity is referring to a new panel ID within CSI/beam reporting configuration or reports   + FFS: Detailed design of the new panel ID including the information conveyed by the new panel ID   + Note: The association between the new panel ID and the panel entity is determined by the UE * Opt1-3: No additional specification support * The duration in which the above panel entity reference is valid and the respective setting are FFS * Note: “panel entity” is only used for discussion purpose |

Table 12 Additional inputs: issue 4

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| Mod V00 | The text of proposal 4.1 is almost stable. There was one input from vivo at the end of the round 1 (see above). **Are the proponents of Opt1-1 ok with vivo’s suggestion? Please comment.**  *Vivo: The reason is that the alignment between UE and NW could be through different signaling. The panel for CSI measurement could be indicated from NW based on some UE side MPE report or active panel status report.*  ***Proposal 4.1****: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,*   * *For CSI/beam measurement/reporting, down select and/or modify from the following candidates:*   + *Opt1-1: A panel entity is referring to reported CSI-RS and/or SSB resource index in a beam reporting instance*   *The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index is ~~indicated~~ aligned with ~~to~~ NW through indication.* |
| **Company** | **Input** |
| MediaTek | We are not fine with the rewording. As mentioned previously, the mapping between panel entity and CSI-RS resource for measurement/reporting shall be controlled by UE as agreed in the last meeting. Furthermore, the rewording conflicts with the note in Opt1-1.   * + Note: the correspondence between a CSI-RS and/or SSB resource index and a panel entity is determined by the UE (analogous to Rel-15/16) |
| Vivo | To MediaTek, the indication is not against the note. For example, UE can indicate the panels that can be used to the network firstly. Then the network may trigger corresponding measurement/reporting in specific panels. The correspondence is always controlled by the UE. |
| Apple | If the indication means NW signaling like panel indication, we share the same concern as what MTK mentioned. Based on vivo’s comment, we think it can be as follows:  *The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index is ~~indicated~~ aligned with ~~to~~ NW through beam reporting framework ~~indication~~.*  In addition, is it possible to converge to opt1-1. Opt1-2 is confusing to us, especially for “reporting configuration or reports” in the main-bullet. If it is configuration, does it mean UE has to fix a panel to receive corresponding RS in the reportConfig? Then it seems it is not aligned with the agreement MTK mentioned. |
| Ericsson | We would have preferred that beam indication/scheduling would have been described before the measurements, but we realize that this may not be possible. For the May meeting, it would be appreciated if companies could also explain how the panel entity would be used in scheduling, and what the benefit would be.  Also, we share Apple’s view that it would be preferable to combine opt1-1 and opt1-2: the difference feels mostly semantic. |
| ZTE | Thanks so much for discussion. To be honest, it is very difficult for me to follow the logic of these discussion ^\_^. If my understanding is correct, MTK/Apple and vivo are discussing two different stories.   * “is indicated to NW” or “*~~indicated~~ aligned with ~~to~~ NW through beam reporting framework ~~indication~~*”, it means that we would like to enhance the format of beam reporting. Panel ID or other panel-related information, like panel state, should be provided by the UE in a reporting instance. * “*~~indicated~~ aligned with ~~to~~ NW through indication*” seems to say that, if the gNB have the above reporting information about UE panel, what the gNB shall do for the next? Like panel ID can be associated with reporting setting?   If so, we think that two different Alternatives should be provided. Then, Alt1-2 can be removed? I am not sure whether/which companies still prefer this alternative. |
| Nokia | Proposal 4.1: it is OK, from our side we are for Opt 1-3 and it would help the discussion to see the reasons behind options 1-1 and 1-2, hence to solve the FFS.  As response to MeditaTek, we wonder whether Opt 1-3 is neither O.K. |
| CATT | Fine with the proposal. |
| OPPO | We do not agree with the comments of “*The panel for CSI measurement could be indicated from NW based on some UE side MPE report or active panel status report*” by vivo. As we agreed in last meeting, the mapping between panel entity and RS is controlled by the UE. The gNB does not control that. Therefore, the system does not indicate or command the UE to use which panel. What the NW do is trigger beam measurement and reporting and the UE would use proper panel/beam to measure each DL RS. After that, when the NW indicates one RS through UL TCI, the UE will use the corresponding panel/Rx beam for UL transmission.  The wording in Opt1-2 also confuse us by the wording “reporting configuration”. Does it means the gNB can control the UE panel through reporting configuration. If so, that does not align with the previous agreement of that the mapping to panel entity is controlled by the UE. |
| Samsung | We are fine with the current wording of proposal 4.1. We would like to update the first sub-bullet of Opt1-1 as follows:   * + The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index and/or resource set index is indicated to NW   We would like to include the possibility of the UE indication a correspondence between a panel entity and a resource set. |

### Issue 5 (MPE mitigation)

Table 13 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** |
| 5.1 | Whether to support at least one the following:   * {Rel.16 P-MPR based (beam/panel-level)} + {A}, where A is either Opt1A, Opt1B, Opt1C, or Opt1D:   + Option 1A: Virtual PHR or a modified version associated with each activated UL TCI or, if applicable, joint TCI   + Option 1B: {SSBRI(s)/CRI(s) and/or panel indication}   + Option 1C: {SSBRI(s)/CRI(s) and/or panel indication} + virtual PHR or a modified version associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)   + Option 1D: No additional reporting quantity * {SSBRI(s)/CRI(s) and/or panel indication} + {A}, where A is either Opt2A, Opt2B, Opt2A+ Opt2B, or Option 2C   + Option 2A: L1-RSRP [L1-SINR] or a modified version that accounts for MPE effect associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)   + Option 2B: Virtual PHR or a modified version associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)   + Option 2C: No additional reporting quantity | Rel-16 P-MPR based:   * **Option 1A (6)**: Nokia/NSB, NTT Docomo, OPPO, Lenovo/MoM * **Option 1B (2)**: Sony, Intel * **Option 1C (3)**: ZTE, Apple, Qualcomm * **Option 1D (6)**: vivo, Spreadtrum, MTK, Xiaomi, Huawei, HiSi   SSBRI/CRI-based:   * **Option 2A (8)**: CMCC, Ericsson (*UL-RSRP = L1-RSRP – PDL + PUL*), Samsung (modified RSRP), NTT Docomo, CATT (scaled RSRP), MTK, Sony, LGE * **Option 2B (4)**: CATT, ZTE, Convida, Qualcomm * **Option 2A+2B** (in one report) (3): Nokia/NSB, Apple * **Option 2C (2)**: Spreadtrum, Xiaomi * **Other option**(s): IDC (TCI state group indication + gNB confirmation) |
| 5.4 | Reporting mechanism | **UE-initiated (event-triggered) without NW triggering via CSI request (9):** Sony, Qualcomm, Samsung, Nokia/NSB (BFR like), ZTE, Huawei, HiSi, NTT Docomo  **NW triggering via CSI request (just as the regular A-CSI) (5):** Spreadtrum, MTK, Ericsson, NTT Docomo, Qualcomm |

The following text is almost stable from Round 1:

**Table 14**

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| **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, in RAN1#104b-e, further discuss to down-select at least one or combine from the following options:   * Opt 1A. {Rel.16 P-MPR based (beam/panel-level)} + Virtual PHR or a modified version   + The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.   + FFS: how to determine the virtual PHR or the modified version. * Opt 1D. {Rel.16 P-MPR based (beam/panel-level)} * Opt 2A. {SSBRI(s)/CRI(s) and/or panel indication} + L1-RSRP [L1-SINR] or a modified version that accounts for MPE effect associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)   + FFS: How panel-level L1-RSRP [L1-SINR] is reported if L1-RSRP [L1-SINR] is associated with panel   + FFS: Whether/how to account for MPE effect in L1-RSRP [L1-SINR] report, e.g. by using scaled L1-RSRP [L1-SINR]   + FFS: Whether/how to enhance existing beam reporting format to support Option 2A   + FFS: When multiple SSBRIs/CRIs and their corresponding metrics are reported in the same reporting instance, whether to allow mixture between the SSBRI(s)/CRI(s)) intended for MPE mitigation and for DL beam reporting   + [Note: If Opt2A is selected and there is no consensus on a modified L1-RSRP definition, at least the Rel-15 L1-RSRP definition is reused and virtual PHR may be added]   FFS: If gNB confirmation of MPE-based UE reporting is supported  FFS: If differential report is supported when multiple UL beams are reported in the same report  **Proposal 5.2**: On Rel.17 enhancements to facilitate MPE mitigation, in addition to NW-initiated, the supported UE reporting scheme is UE-initiated (event-triggered, without CSI request)   * FFS: Definition of triggering event |

Table 15 Additional inputs: issue 5

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| Mod V00 | Proposal 5.1: The wording is stable except for the Note. Some companies mentioned whether it is better to keep, remove, or revise the Note. From FL perspective, the Note is just fine the way it is. **Please share your inputs if any**. Otherwise I will consider this acceptable.  Proposal 5.2: The wording is stable. Some companies suggest to make NW-initiated FFS while some other companies can agree to this proposal only when NW-initiated is also supported. So having both is a good compromise. **Is the current wording acceptable as is** (please do not repeat making NW-initiated FFS – there are enough supporters)? |
| **Company** | **Input** |
| MediaTek | Proposal 5.1: We are fine without the note under Opt2A.  Proposal 5.2: Okay to this proposal. Both should be supported and each may correspond to one of the solutions identified in Proposal 5.1. |
| vivo | We would like to update Proposal 5.2 as following:  **Proposal 5.2**: On Rel.17 enhancements to facilitate MPE mitigation, ~~in addition to NW-initiated,~~ the supported UE reporting scheme is UE-initiated (event-triggered, without CSI request)  FFS: Definition of triggering event |
| Apple | Proposal 5.1: Either to keep the note or remove it is ok to us.  Proposal 5.2: Support. We think it can be similar to PHR report, which can be triggered based on an event. |
| Ericsson | Proposal 5.1: Support Proposal 5.2: Do not support. As we understand it, if opt1A/1D is agreed, the reporting will be event-driven. If opt2A is agreed, the reporting may be NW-initiated (our preference) or event-driven. Hence, the type of reporting must be discussed in conjunction with the other details of the report. Could we include this in P5.1:  **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, in RAN1#104b-e, further discuss to down-select at least one or combine from the following options:   * Opt 1A. {Rel.16 P-MPR based (beam/panel-level)} + Virtual PHR or a modified version   + The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.   + FFS: how to determine the virtual PHR or the modified version.   + The reporting would reuse the event-driven mechanisms from the Rel-16 P-MPR reporting. * Opt 1D. {Rel.16 P-MPR based (beam/panel-level)}   + The reporting would reuse the event-driven mechanisms from the Rel-16 P-MPR reporting * Opt 2A. {SSBRI(s)/CRI(s) and/or panel indication} + L1-RSRP [L1-SINR] or a modified version that accounts for MPE effect associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)   + FFS: How panel-level L1-RSRP [L1-SINR] is reported if L1-RSRP [L1-SINR] is associated with panel   + FFS: Whether/how to account for MPE effect in L1-RSRP [L1-SINR] report, e.g. by using scaled L1-RSRP [L1-SINR]   + FFS: Whether/how to enhance existing beam reporting format to support Option 2A   + FFS: When multiple SSBRIs/CRIs and their corresponding metrics are reported in the same reporting instance, whether to allow mixture between the SSBRI(s)/CRI(s)) intended for MPE mitigation and for DL beam reporting   + [Note: If Opt2A is selected and there is no consensus on a modified L1-RSRP definition, at least the Rel-15 L1-RSRP definition is reused and virtual PHR may be added]   + FFS if the reporting is event-based and/or NW-controlled   FFS: If gNB confirmation of MPE-based UE reporting is supported  FFS: If differential report is supported when multiple UL beams are reported in the same report  We reiterate that event-driven reporting has never been described in RAN1 specifications (RAN1 specifications are state-less), and it would seem to us that introduction of event-driven mechanisms would be described in RAN2 specs. |
| ZTE | Proposal 5.1: We can support the note under Opt 2A. Frankly speaking, if we really prefer to have NW-initialized solution, the note under Opt 2A seems to be more realistic rather than a new/weird definition of UL-RSRP that can be well done by the already virtual PHR as some companied mentioned in their contribution.  Proposal 5.2: Support, although we much more prefer to vivo’s suggestion. BTW, Ericsson’s suggestion sounds good, and we can live with this.   * A minor comments for Ericsson’s proposal: as you see that we can ‘combine’ in the main bullet, so we are wondering whether triggering mechanism can be combined. So, we may have a new bullet rather than a sub-bullet to clarify the possible reporting mechanism of each alternatives as suggestion. |
| Nokia | We are O.K. with the note. |
| OPPO | Proposal 5.1: the Note looks very strange to us. The note actually proposes another Alt, instead of clarify something. We can be ok with one of the following two options:   1. change the Note to another Opt for down-selection. 2. Or delete the note.   Proposal 5.2: In our view, if 1A or 1D is agreed at last, then NW-initiated would not be needed. So, it might be too early to decide that now. Maybe we can postpone the discussion to after we settle down the issue in 5. |
| Samsung | Proposal 5.1: We don’t support the note under Opt2A, it is premature to agree to now. Including virtual PHR mixes Alt2A and Alt2B, this is a new alternative we don’t support.  We would like to get some clarifications on the second from last FFS: “If gNB confirmation of MPE-based UE reporting is supported”, does this refer to the gNB acknowledging an MPE report? If yes, maybe we can reword as: “FFS: If gNB acknowledges MPE report from UE”  Proposal 5.2: We accept for progress. |

# References

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| --- | --- | --- | --- |
| 1 | R1-2103830 | Moderator summary for offline discussion on multi-beam enhancement: SSB and SRS as QCL Type-D source RS | Moderator (Samsung) |
| 2 | R1-2103220 | Moderator summary for multi-beam enhancement | Moderator (Samsung) |
| 3 | R1-2103854 | Moderator summary#2 for multi-beam enhancement: Round 1 | Moderator (Samsung) |