**3GPP TSG RAN WG1 #106bis-e R1-2110549**

**e-Meeting, October 11th – 19th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#4 for multi-beam enhancement: ROUND 3

**Document for:** Discussion and Decision

## Introduction

In this summary, the term “item 1” refers to the first item in the Rel.17 NR FeMIMO WID, i.e. multi-beam enhancement:

|  |
| --- |
| 1. Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:    1. Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management for intra-cell and inter-cell scenarios to support higher UE speed and/or a larger number of configured TCI states:       1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA       2. Unified TCI framework for DL and UL beam indication       3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)       4. For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done). This includes L1-only measurement/reporting (i.e. no L3 impact) and beam indication associated with cell(s) with any Physical Cell ID(s)          1. The beam indication is based on Rel-17 unified TCI framework          2. The same beam measurement/reporting mechanism will be reused for inter-cell mTRP          3. This work shall only consider intra-DU and intra-frequency cases    2. Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection |

This summary includes the following:

* Observation and proposal
* Summary of current companies’ positions on each of the aspects within the category

## Summary of companies’ inputs

### Issue 1 (Rel.17 unified TCI framework – note: for intra-cell beam management unless otherwise noted)

Table 1 Summary: issue 1

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 1.1 | **Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, when a UE is configured with separate DL/UL TCI, the largest number of configured TCI states for DL TCI state update is 128 per BWP per CC, and the largest number of configured TCI states for UL TCI state update is 64 per BWP per CC   * Note: This doesn’t imply that UL TCI shares the same TCI state pool as or uses a different TCI state pool from joint DL/UL TCI   **FL Note**: This is the situation from the previous rounds  **Alt1**. The largest number of configured TCI states for DL TCI state update is 128 per BWP per CC, and the largest number of configured TCI states for UL TCI state update is 64 per BWP per CC   * **Support (16)**: NTT Docomo, Apple, Samsung, ZTE, Nokia/NSB (128 UL), Futurewei, LG (128 UL), Xiaomi, Fraunhofer IIS/HHI, Sony, Huawei, HiSilicon, Spreadtrum, MTK   **Alt2**. The total largest number of configured TCI states for DL TCI and UL TCI state update is 128 per BWP per CC   * **Support (8)**: NTT Docomo, Ericsson, Intel, Qualcomm, OPPO, vivo, Futurewei, Convida | **Support/fine**: NTT Docomo, Apple, Samsung, ZTE, [Nokia/NSB], Futurewei, [LG], Xiaomi, Fraunhofer IIS/HHI, Sony, Huawei, HiSilicon, Spreadtrum, MTK  **Concern**: Qualcomm (want 64 DL), OPPO (want 64 DL) |
| 1.2 | **Proposal 1.B.1:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL channels/signals that share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), the following option on source RSs and QCL-Types is also supported:   * Option 3: CSI-RS for CSI is configured for QCL-TypeA and QCL-TypeD source RS   **FL Note**: It was explained that the so-called “circular” issue is avoided in practice via NW implementation, i.e. NW will not configure the same CSI-RS for CSI both as source and target RSs. | **Support/fine (22)**: Convida, Huawei/HiSi, Ericsson, ZTE, CMCC, Samsung, Sony, Nokia/NSB, Qualcomm, Fraunhofer IIS/HHI, Futurewei, MTK, NTT Docomo, AT&T, Lenovo/MotM, Intel, Xiaomi, CATT  **Concern**: Apple, OPPO |
| 1.4 | **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL or UL channels/signals that can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH or dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update):   * That a DL channel/signal ~~[not]~~ sharing the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update) is configured via RRC. * That an UL channel/signal ~~[not]~~ sharing the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update) is configured via RRC.   FFS: Whether this configuration is per resource, per resource set, or per CORESET.  The details of this configuration is up to RAN2.  **FL Note:** Whether “not” is removed or kept seems immaterial as long as the respective RRC parameters employ correct range of values. That is, this should be up to RAN2. | **Support/fine (24)**: Convida, Ericsson, CMCC, Samsung, Sony, NTT Docomo, AT&T, Lenovo/MotM, Intel, Nokia/NSB, Qualcomm, LG (“not” removed), MTK, vivo, Futurewei (“not” removed), ZTE (“not” removed), Fraunhofer IIS/HHI (“not” removed), Xiaomi, Huawei, HiSilicon (“not” removed), CATT  **Concern**: Apple, OPPO |
| 1.5 | **Proposal 1.H**: On Rel.17 unified TCI framework, for the case when the setting of (P0, alpha, closed loop index) for PUSCH, PUCCH, and/or SRS are associated with UL or (if applicable) joint TCI state per BWP, for each of the PUSCH, PUCCH, and/or SRS, one individual setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC  **FL Note**: This is the situation from the previous rounds  **Alt1**. Support the following: for each of the PUSCH, PUCCH, and/or SRS, one individual setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC   * **Support/fine (13)**: Ericsson, vivo, Qualcomm, Intel, NTT Docomo, Nokia/NSB, Lenovo/MotM, ZTE (2nd preference), Spreadtrum, Apple, LG * **Concern**:   **Alt2**. Support the following: for each of PUSCH, PUCCH, and/or SRS, each of UL or (if applicable) joint TCI state is optionally associated with one of configured settings in a BWP via MAC-CE   * **Support/fine (11)**: ZTE, Samsung, Futurewei, MTK, Nokia/NSB, OPPO, Fraunhofer IIS/HHI, Huawei, HiSilicon * **Concern**: Ericsson, Apple, Intel, vivo, Spreadtrum   **FL Note:** RAN2 cannot decide for RAN1 whether the setting is configured via RRC or can be updated via MAC CE. Whether the additional flexibility from MAC CE is truly beneficial or not is not within RAN2 capability to assess.  Thus, if there is no consensus on this issue, the previous agreement on optionally associating UL PCP setting (other than PLRS) with UL or, if applicable, joint TCI state shall be reverted, i.e. the setting is not associated with UL or, if applicable, joint TCI state – simply because such association is an incomplete feature | **Support/fine**: Ericsson, vivo, Qualcomm, Intel, NTT Docomo, Nokia/NSB, Lenovo/MotM, ZTE, Spreadtrum, Apple, LG, CATT, Samsung  **Concern**: |
| 1.7 | **Proposal 1.G**: On path-loss measurement for Rel.17 unified TCI framework, at least for discussion purposes, when both PL-RS and spatial relation RS in the UL or (if applicable) joint TCI state are not the same [and they are not CSI-RS for BM with repetition ‘ON’], “beam alignment” also pertains to the following events:   * The PL-RS is identical to the QCL Type-D source RS or UL spatial relation RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS or UL spatial relation RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the QCL Type-D source RS of the spatial relation RS in the UL or (if applicable) joint TCI state   **FL Note:** Any additional event (bullet) doesn’t seem acceptable for a number of companies. Even the above, some still have concern | **Support/fine:** Apple, MTK, Convida, Lenovo/MotM, Qualcomm, Samsung, NTT Docomo, CMCC, Nokia/NSB, Futurewei, CATT, Intel (without last bullet from prev), Fraunhofer IIS/HHI  **Concern:** ZTE, vivo, Spreadtrum, OPPO (4th case not included), Ericsson (use case unclear), LG (5th case not included) |

Table 2 Additional inputs: issue 1

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 1** 2. **Share more inputs here if needed. For 1.4, share any response to Apple below**   **FL Note: BFR for unified TCI will be a main topic in the next meeting. Please prepare your Tdocs accordingly for RAN1#107-e** |
| Apple | 1.4: We think this needs some discussion. The first issue is SRS. If SRS does not share the indicated TCI, are we going to use spatialRelationInfo? The second issue is non-UE dedicated signal. So far we do not have definition about it, and the problem is that if non-UE dedicated signal does not share the indicated TCI, there is no legacy beam indication scheme in R16. The situation is even worse than SRS. Aperiodic CSI-RS may be easier, but there are still some problems, gNB is still able to indicate the beam by DCI, then would UE ignore it or not? Technically such RRC parameter is not helpful but it would take 10KB-25KB memory. One simple way may be to reserve one codepoint in trigger state to indicate the beam based on the shared TCI. |
| Samsung | **Proposal 1.A:** Support  **Proposal 1.B.1:** We are fine with the proposal for progress. But this is not an essential feature.  **Proposal 1.B.2:** We are fine with the direction of the proposal. However, the indication by RRC can be explicit or implicit. Example of implicit indication, is when a search space for non-UE-dedicated channel is configured to use the same CORESET of the search space of a UE-dedicated channel (e.g. USS). Therefore, we would like to update as follows:  **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL or UL channels/signals that can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH or dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update):   * That a DL channel/signal ~~[not]~~ sharing the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update) is ~~indicated~~ configured via RRC. * That an UL channel/signal ~~[not]~~ sharing the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update) is configured ~~indicated~~ via RRC.   FFS: Whether this configuration is per resource, per resource set, or per CORESET  Note: The details of this configuration is up to RAN2  [Mod: Good point. OK]  **Proposal 1.H:** This FL proposal (Alt1) is technically inferior than Alt2. The main issue with using RRC for the association rather than MAC CE is that it requires RRC reconfiguration to change PC settings and the association with the configured TCI states. This not only increases the reconfiguration time, but also the reconfiguration overhead associated with RRC reconfiguration (which ironically we tried to avoid in Rel-16 by using MAC-CE). It is ironic that the majority view is gravitated toward Alt1 simply because of “compromise spirit” in RAN1#106-e (mentioned by, e.g. vivo, Ericsson) rather than tangible technical merits.  Having said that, unlike those voicing ”concern” on Alt2 (for the aforementioned reason), we will not voice “concern” on the FL proposal – since this seems to be the best we can do in Rel-17. We will accept the proposal for progress. Perhaps in Rel-18 or later the group may realize (just as from Rel-15 to Rel-16) that we need to upgrade this feature with MAC CE.  [Mod: Thanks for being constructive despite your clearly articulated reservation (enough for a concern for sure) ☺]  **Proposal 1.G:** We are support this proposal, with the change mentioned in an earlier reply. Without this change, in our view, the proposal is incomplete.  **Proposal 1.G:** We support the principle of the proposal, but have a comment: If the spatial relation RS in the UL TCI state is SRS, SRS doesn’t have a QCL Type source RS, instead it has a spatial relation source RS. Therefore, we would like to update the first and third bullets to reflect this as follows (other the proposal is incomplete for that case):   * The PL-RS is identical to the QCL Type-D source RS or spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the QCL Type-D source RS or spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state   I illustrate this with a picture for better clarity    We don’t see the need for the text in square brackets in the main bullet.  [Mod: OK] |
| MediaTek | **1.A**: Support. However, we would like to clarify whether or not a TCI state configured for DL TCI update can be also configured for UL TCI update. If yes, in Alt1, the max number of configured TCI states for DL TCI update may be limited by 64.  [Mod: For separate DL/UL TCI, this may not always be the case in my understanding]  **1.B.1:** Support.  **1.B.2:** Support. We see using RRC to signal whether channels/signals share (or doesn't share) the indicated TCI state by Rel-17 MAC-CE/DCI-based beam indication will not cause additional issues. Instead, using dynamic signaling to signaling the applicability will cause larger implementation and spec impact.  According to previous agreements, only some of SRS (P/SP/AP SRS for CB, NCB, antenna switching and AP SRS for BM) can “optionally” share the indicated TCI state by Rel-17 MAC-CE/DCI-based beam indication. For other SRS that is not impacted by Rel-17 unified TCI, legacy spatial relation should be provided to our understanding. For non-UE-dedicated reception on a CORESET and the associated PDSCH, if DL reception on the CORESET/PDSCH doesn't share the indicated TCI state by Rel-17 MAC-CE/DCI-based beam indication (e.g., signaled by RRC for the corresponding CORESET), as agreed in previous meeting, Rel-15/16 MAC-CE-based beam indication will be used to indicate the TCI state to the corresponding CORESET.  **Agreement**  The following working assumption is confirmed with revision in RED.  On Rel.17 unified TCI framework, for any DL RS that does not share the same indicated Rel-17 TCI state(s) as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC, but can be configured as a target DL RS of a Rel-17 DL TCI (hence the Rel-17 DL TCI state pool), Rel-17 mechanism(s) which reuse the Rel-15/16 TCI state update signaling/configuration design(s) are used to update/configure such DL RS(s) with Rel-17 TCI state(s).   * Applies for both intra-cell and inter-cell beam indication   **1.G:** Support. We see the content in the brackets is needed. Otherwise, these sub-bullets still canoot gurunett the beam aligment since UE may chage the beam during the P3 BM procedure. |
| Qualcomm | For 1.A, do not support. 64 DL TCIs + 64 UL TCIs should be enough. Separate DL/UL TCIs are mostly used when MPE happens, and should not be optimized at the cost of more configured TCIs than joint TCI  [Mod: In Rel-15/16, when SRI is used for beam indication (analogous to separate DL/UL and UL TCI), we still have max 128 for DL TCI and max 64 for UL spatial relation. So your proposal seems to be a downgrade from Rel-15/16. Or do I miss something?]  Fine for the remaining proposals |
| OPPO | Re 1.A: Do not support. We share the same understanding as Qualcomm. Increasing the total number of TCI states is over-optiomization.  [Mod: See my comment to Qualcomm]  Re 1.B.1: this has been dicussed multiple rounds and it was removed from the email endorsement in last week. Why do we keep discussing it? Compnies have explained the problems/concerns about this proposal a few times.  [Mod: “Two” companies have explained but other companies don’t see the concerns as valid ☹]  Re 1.B.2: The issue of this proposal is it includes the channels and reference signal that shall always follow the same indicated Rel-17 TCI state.   * In UL, in our understanding, in UL, all the UL channels (PUCCH and PUSC) share the same indicated Rel-17 TCI state. So, we do not need to configure the UL channel. The SRS rescore set for PUSCH should always follow the indicated TCI state too because those SRS resources are used to provide reference for PUSCH transmission. If the UE applies different TCI state on PUSCH and the corresponding SRS resource for PUSCH transmission, can the system work? For UL, only the SRS resource for BM can be applied with the ‘common’ TCI state or separately indicated TCI state. * In DL: in our understanding for intra-cell BM, the non-UE dedicated PDCCH and associated PDSCH always follow the same indicated Rel-17 TCI state, as in our prevous agreement. For the CSI-RS resource for CSI, the gNB shall also apply the same indicated Rel-17 TCI state because the purpose of CSI-RS resource for CSI is to measure and provide CSI information for PDCCH/PDSCH transmission. If the UE measures CSI of channel being applied with different TCI state, how can the measured CSI be useful? Similarly, the CSI-RS for BM can be configurd to follow the indicated Rel-17 TCI state or separately indcaited TCI state because CSI-RS for BM is used to sweep the beams and find potentially good beam.   To summarise, we are fine to proposal on SRS for BM and CSI-RS for BM:  **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL or UL channels/signals that can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH or dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update):   * That a AP CSI-RS for BM ~~DL channel/signal~~ ~~[not]~~ sharing the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update) is indicated via RRC. * That an AP SRS for BM ~~UL channel/signal~~ ~~[not]~~ sharing the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update) is indicated via RRC.   FFS: Whether this configuration is per resource, per resource set, or per CORESET  [Mod: Your understanding for “non-UE-dedicated” is not according to the previous agreement as MTK pointed out which clearly says “can share” (not “always shares”) just as the agreements for CSI-RS and SRS. ]  Re 1.H: Actually, Alt1 and Alt2 do not contradict to each other. Alt1 says the association can be configured in RRC and Alt2 says the association can be updated by MAC CE. We might combine them in one proposal. The similar design happened in Rel-15/16: for instance, the PL-RS for SRS is configured in RRC and then in rel16, we introduced MAC CE-based updating and another example is association between SRI codepint and PC parameters for PUSCH: the associaton is configured in RRC and then in rel-16, we introduced using MAC CE to update the association.  Our concern on agreeing Alt1 only is later on we might have to dicuss using MAC CE to update the association again.  Re 1.G: Our 1st preference is to just define “beam alignment” by a general descrpption that is “PL-RS and spatial relation RS are QCLed with respect to Type D”, insteading of listing all the cases in details.  If we choose to list all the cases, we have give a exhaustive list, no missing one. The case we proposed to add is: “ The QCL Type-D RSs of PL-RS and the spatial relation RS have the same source RS for QCL-TypeD” . Any reason why this case can not be counted as beam alignment? Actually from some apect the first sub-bullet “• The PL-RS is identical to the QCL Type-D source RS of the spatial relation RS in the UL or (if applicable) joint TCI state” might not be beam alignment because the Rx beam on PL-RS is determined by the QCL-TypeD configured to the PL-RS, but not the PL-RS itself.  [Mod: I do sympathize with your point (very much valid). Unfortunately, as we have discussed since last meeting, the three are the only agreeable ones] |
| ZTE | For 1.A. Support. In our views, up to 64 DL TCI state is too limited for NW design and unacceptable for us. As you see, besides for TCI states for DMRS of PDSCH/PDCCH (e.g., TRS+CSI-RS for BM, w.r.t., TypeA+TypeD), we still need to additionally configure other TCI states for CSI-RS for CSI, tracking and BM (e.g., SSB w.r.t. TypeC+TypeD). In technical, we may not need to distinguish a UL TCI state from a DL TCI state in the separate case. While a TCI state is activated/indicated for UL, the UE assume that the corresponding QCL-TypeD RS or spatial relation RS is applied. That’s all.  For 1.B.1/2, 1.H: Support.  For 1.G: Not support, due to the same reason as we mentioned before. |
| Apple | 1.B.x: We already provided our concern in last round. It seems all of them have not been resolved.  [Mod: If you can point out which of your concerns haven’t been addressed (two companies tried to address above), it will help the discussion to be more productive and constructive]  1.H: We are fine in general. But we think this is for eMBB only. For URLLC, currently we have different designs.  [Mod: We already have an FFS for URLLC from last meeting. Still open.] |
| CATT | Proposal 1.B.1: Support  Proposal 1.B.2: Support. We fine to remove “not”.  Proposal 1.H: We support Alt2 for flexibility. For progress, we could also accept Alt1.  Proposal 1.G: Support |
| LG | Proposal 1.A: Support Alt1 but preferred to same number for UL TCI as DL TCI.  Proposal 1.B.2: Support the current proposal.  Proposal 1.G: We agree with Samsung that we should cover additional cases in which current spec supports. In addition to the cases that Samsung raised, as we explained multiple times, the spatial relation source RS of the spatial relation RS in the UL/joint TCI state can be an SRS resource when the spatial relation RS in the UL/joint TCI state is SRS, in which the (modified) three bullets cannot cover (Note that SRS cannot be PL RS!). We prefer to clarify the meaning of ‘beam alignment’ in this case in this meeting, but if companies need more time for this case, we could leave this case as FFS.  **Proposal 1.G**: On path-loss measurement for Rel.17 unified TCI framework, at least for discussion purposes, when both PL-RS and spatial relation RS in the UL or (if applicable) joint TCI state are not the same [and they are not CSI-RS for BM with repetition ‘ON’], “beam alignment” also pertains to the following events:   * The PL-RS is identical to the QCL Type-D source RS or spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the QCL Type-D source RS or spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state * FFS: how to define “beam alignment” when the spatial relation RS in the UL or (if applicable) joint TCI state and spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state are not DL RS.   [Mod: Please see my comment to OPPO] |
| NTT Docomo | Proposal 1.A: Support. Re MediaTek's comment, our understanding is "No" (i.e. a TCI state configured for DL TCI update can NOT be also configured for UL TCI update). It is because the content of UL TCI and DL TCI are different for separate TCI, in our view.  Considering that Rel.15 supports max 128 TCI states for PDSCH, 64 DL TCIs + 64 UL TCIs is too limmited.  Proposal 1.B.1: Support.  Proposal 1.B.2: Support Samsung's update.  Proposal 1.H: Support Alt.1. We suggest to take Alt.1, because it is a common part of Alt.1-2. We can make FFS for MAC CE in Alt.1, if needed.  [Mod: proposal 1.H is Alt1 ☺]  Proposal 1.G: Support. |
| Mod V13 | Minor revision on 1.B.2 and 1.G per inputs |

### Issue 2 (inter-cell beam management)

Table 3 Summary: issue 2

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 2.2 | **Proposal 2.H**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, in RAN1#107-e, select one of the following alternatives:   * **Alt1.** Rel-15 L1-RSRP reporting format is reused for all SSBRI-RSRP pairs in one L1-RSRP reporting instance, i.e. for K>1, (K-1) 4-bit differential L1-RSRP(s) calculated relative to the reference (absolute) 7-bit L1-RSRP * **Alt2**. Differential L1-RSRP per non-serving cell/serving cell is used:When more than one SSBRI/L1-RSRP pairs associated with a same PCI are reported, Rel-15 L1-RSRP reporting format is used for pairs associated with the same PCI, i.e. 4-bit differential L1-RSRP(s) calculated relative to the PCI-specific reference (absolute) 7-bit L1-RSRP     **FL note:** This is the situation from the previous rounds  **Alt1.** Rel-15 L1-RSRP reporting format is reused for all SSBRI-RSRP pairs in one L1-RSRP reporting instance, i.e. for K>1, (K-1) 4-bit differential L1-RSRP(s) calculated relative to the reference (absolute) 7-bit L1-RSRP   * Support **(16):** Samsung, MTK, Qualcomm, Ericsson, NTT Docomo, vivo, Nokia/NSB, Apple, Intel, OPPO, AT&T, Spreadtrum, Xiaomi, Huawei, HiSilicon   **Alt2**. Differential L1-RSRP per non-serving cell/serving cell is used:  When more than one SSBRI/L1-RSRP pairs associated with a same PCI are reported, Rel-15 L1-RSRP reporting format is used for pairs associated with the same PCI, i.e. 4-bit differential L1-RSRP(s) calculated relative to the PCI-specific reference (absolute) 7-bit L1-RSRP   * Support **(6):** ZTE, CMCC, Lenovo/MotM, Qualcomm (2nd preference), Sony   However, since this is the first time the topic was brought up, it would benefit from more careful comparison (TBD RAN1#107-e) | **Support/fine:** Samsung, MTK, Sony, Apple, CATT  **Concern:** |
| 2.3 | QCL assumption for paging reception after being activated with only one TCI state associated with PCI different from serving cell [2]  **Alt0.** UE not required to monitor paging associated with the newly activated TCI state  **Alt1**. UE to monitor paging in USS associated with the newly activated TCI state [11]  **Alt2**. UE to monitor paging in CSS configured for paging with the newly activated TCI state [offline]  **FL note:** Check comments from Ericsson, NTT Docomo, and Huawei (thorough explanation on RAN2 info) | **Alt0:** OPPO, vivo, Lenovo/MotM, MTK, Xiaomi, CATT   * Concern: Huawei, HiSilicon, Samsung, Apple   **Alt1**: Huawei/HiSi (2nd), Ericsson, Samsung (2nd preference), Futurewei, Spreadtrum, AT&T  **Alt2**: Huawei/HiSi (1st), NTT Docomo, Apple, ZTE, Samsung (1st preference), Futurewei, Spreadtrum, AT&T, Sony, MTK, NTT Docomo |
| 2.4 | **Proposal 2.F**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation), the non-UE dedicated channels/signals (on which such inter-cell beam indication does not apply) comprise:   * All PDCCH receptions on CORESET(s) along with the respective PDSCH receptions and respective PUSCH/PUCCH transmissions if the CORESET(s) is associated with Type3 CSS set only in SCell (not PCell) and any Type0/0A/1 CSS set   + FFS: the CORESET(s) associated with any Type2 CSS set (depending on the outcome of the paging issue)   **FL note**: This may be linked with 2.3 (2.3 needs to be resolved first):   * If 2.3 is resolved with Alt0 or only Alt1, 2.F seems to be fine as is * If 2.3 is resolved with Alt2 (or Alt1 + Alt2), 2.F needs to be refined | **Support/fine:** MTK, vivo, Lenovo/MotM, Qualcomm (with 3), Samsung, LG, AT&T, CMCC, CATT, NTT Docomo, Intel, Spreadtrum, Xiaomi  **Resolve issue [2.3] first:** Apple, Huawei/HiSi, Nokia/NSB, Futurewei, Sony, ZTE  **Concern:** Ericsson **(**activated TCI states should not be associated with CORESETs**)**, Apple (same concern as Ericsson) |
| 2.1 | **Proposal 2.E**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, support event-driven beam reporting   * If UE consecutively identify an event happens, UE can trigger the L1-RSRP report * The event at least includes:   + The L1-RSRP from one SSB within list of SSBs with PCIs different from serving cell is larger than the best L1-RSRP measured from a list of serving cell SSB plus an offset, where the offset is configured by RRC   + The L1-RSRP from one SSB within list of non-serving cell SSB is larger than a pre-defined value which is configured by RRC   + The list of serving cell SSBs and SSBs with PCIs different from serving cell are configured by RRC   + Indication for activating a reporting configuration * The L1-RSRP report is transmitted by MAC CE, which includes   + SSBRI from the list of SSBs with PCI different from serving cell   + L1-RSRP for the corresponding SSB * A prohibit timer is introduced to prohibit UE sends multiple L1-RSRP report MAC CEs, which is similar to PHR | **Support/fine**: Apple, NTT Docomo, ZTE, Nokia/NSB, Lenovo/MotM (remove last bullet), Qualcomm, AT&T, Xiaomi, Sony, Huawei, HiSilicon, CATT  **Concern**: Futurewei, Intel, LG (concern on MAC CE), MTK, Ericsson, Samsung (concern on MAC CE), OPPO, vivo, Spreadtrum |

Table 4 Additional inputs: issue 2

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 3** 2. **Share more inputs here if needed** |
| Ericsson | On 2.3, this is from 38.331:  **- RRC\_CONNECTED:**  - The UE stores the AS context;  - Transfer of unicast data to/from UE;  - At lower layers, the UE may be configured with a UE specific DRX;  - For UEs supporting CA, use of one or more SCells, aggregated with the SpCell, for increased bandwidth;  - For UEs supporting DC, use of one SCG, aggregated with the MCG, for increased bandwidth;  - Network controlled mobility within NR and to/from E-UTRA;  - The UE:  - Monitors Short Messages transmitted with P-RNTI over DCI (see clause 6.5), if configured;  - Monitors control channels associated with the shared data channel to determine if data is scheduled for it;  - Provides channel quality and feedback information;  - Performs neighbouring cell measurements and measurement reporting;  - Acquires system information;  - Performs immediate MDT measurement together with available location reporting.  So the UE is supposed to monitor for P-RNTI for paging messages. |
| NTT Docomo | Issue 2.3: As in WID, UE can always receive from serving cell. Even for minimum UE capability (i.e. one PCI for either serving cell PCI or non-serving cell PCI), and if UE is activated with one Rel.17 TCI state from non-serving cell PCI, UE must receive Type0/0A/1/2[/3] CSS with Rel.15/16 TCI states or Rel.17 TCI states from serving cell.   |  | | --- | | iv. For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done). This includes L1-only measurement/reporting (i.e. no L3 impact) and beam indication associated with cell(s) with any Physical Cell ID(s) |   Hence, UE can receive paging (in Type2 CSS) from serving cell. Based on this understanding, we are fine with Alt.0.  Short Message should be also considered with Paging. We believe it is very important to ensure that UE can always receive Paging/Short Message. Short Message includes ETWS (Earthquake and Tsunami Warning System), which is very important to protect human’s life, especially in Japanese environment.  After some discussion with our RAN2 colleagure, as long as UE can receive Paging/Short Message from serving cell, there is no need to receive it from non-serving cell. However, if UE cannot receive Paging/Short Message from serving cell, UE should be able to receive it from non-serving cell. Hence, we keep our name noted in Alt.2. In Alt.2, TCI state of CORESET with Type2-CSS set can be updated, when Rel.17 TCI states are updated to non-serving cell PCI, but TCI states of CORESET with Type0/0A/1 cannot be updated to non-serving cell PCI.  For Alt.1, we think the spec. impacts to introduce USS for paging are large, hence it is not preferred. |
| Huawei, HiSilicon | **Issue 2.3:** We checked with our RAN2 colleagues, and are informed that:   * + - 1. In connected mode, UE should monitor P-RNTI (as mentioned by E///), not just for paging message but also other short messages such as ETWS/CMAS (as mentioned by DCM).       2. Though system information can be updated by RRC signaling, other short messages such as ETWS/CMAS should be delivered with low latency.   Here, the underlying assumption is UE supports only one active TCI state and/or UE has been activated with only one active TCI state (associated with PCI different from serving cell). In this case, the UE will not actively maintain the beamformed communication link with serving cell TRP, so we are not sure whether it is reliable for the UE to monitor paging from serving cell TRP.    With the discussions thus far, to us, it is now more sensible that UE monitors paging from the activated/maintained communication link with TRP with different PCI. In addition, with Alt-2, the only change is QCL assumption for CSS for paging monitoring, and no other changes are expected. We updated our preferences in table above. |
| Samsung | **Propoasl 2.H:** We support this proposal. We prefer Alt1, Alt2 unnecessarily complicates the design as the size of the measurement report with Alt2 depends not only on the number of measurements K, but also on the PCI(s) the measurements belong to. But we agree that finalizing it in the next meeting gives us a chance to study this a bit more  **Issue 2.3:** After reading the RAN2 specs and discussing with the RAN2 collegueaus we think that paging messages can be sent in RRC connected state, and could plausibly be sent when a UE has beam on a neighboring cell with PCI different from that of the serving cell. Therefore, Alt0 is not a viable option. In Rel-15/16 paging is sent using Type2-PDCCH CSS, Alt1 (paging on USS) deperats from the Rel-15/16 design principle and so it is less preferred. Alt2 keeps the Rel-15/16 design of pagaing (for the search space), we would like to further persue this option to minimize the changes. The concern from Ericsson and Apple on “activated TCI states should not be associated with CORESETs” is not clear to us. In Rel-15/Rel-16 the PDCCH derives its TCI state from the CORESET, we believe that the same principle should be followed in Rel-17. The unified TCI state becomes the TCI state of the CORESET assoiciated with UE dedicated channels.  **Proposal 2.F**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation), the non-UE dedicated channels/signals (on which such inter-cell beam indication does not apply) comprise:   * All PDCCH receptions on CORESET(s) along with the respective PDSCH receptions and respective PUSCH/PUCCH transmissions if the CORESET(s) is associated with any Type0/0A/1/[2]/3 CSS set   **Proposal 2.F:** Support, with changes. In general, for inter-cell beam management, the UE should not receive dedicated-UE-channels on CSS, as CSS would also be associated with non-UE-dedicated channels, which don’t follow the unified TCI state. However, given issue 2.3, we would like to consider one exception which is Type2-PDCCH CSS that can be used for paging, we think that this search space can follow the unified TCI state.  [Mod: OK. Type2 is now FFS]  **Proposal 2.E:** We support event driven reporting, but have concern on MAC CE based even driven reporting. This requires involvement of RAN2 in the design of the corresponding MAC CE, we have concern given that we are approaching the end of Rel-17. Event driven reporting is not esstential to the completion of Rel-17, therefore we can consider postponing to a future release. |
| MediaTek | **Issue 2.3:**   * Alt0, we share similar view with DCM that UE still can receive paging if the beam switch back to the serving cell. Alt0 doesn't prohibit UE from receiving paging if UE supports only one activated TCI states. * Alt1, since it may cause large implementation and spec impact, we don't prefer it. * Alt2, we are also okay to this alternative, and remove Type2 CSS from Proposal 2.F.   **2.H**: Support. Okay to postpone it to the next meeting.  **2.F:** Support. We are okay to remove Type2 CSS from the list if Alt2 in Issue 2.3 is adopted in the end. One suggestion is we can put “Type2” in brackets, and resolve the brackets after Issue 2.3 is resolved.  [Mod: Done]  **2.E:** Not support |
| Sony | **Proposal 2.H**: support.  **Issue 2.3**: thanks to the explanation from Erisson, Docomon and Huawei, we tend to agree for UE with only one active TCI state from NSC and NO active TCI state from SC, the UE should be able to monitor paging from NSC. That seems the only choice under such circumstance. So we change our preference on Alt.2.  **Proposal 2.F:** since there is an extreme case in issue 2.3, our preference is to resolve it first, i.e. whether the CORESET associated with Type2 CSS set can be deemed as non-UE-dedicated channel. Then come back to handle the non-UE-dedicated channel/signal.  [Mod: Yourcinput is resolved in revised version]  **Proposal 2.E**: supportive. Though we prefer the UCI-based event reporting, for the sake of avoid further delaying this decision process, we can live with the MAC CE based event reporting. |
| Qualcomm | For 2.H, support with 1st preference for Alt1  For issue 2.3, support Alt0. This is already agreed to our understanding, i.e. in the agreement for switching between serving and non-serving cell with 1 active TCI state  [Mod: I tend to agree with this]  For 1st 2.F, support  For 2nd 2.F, support |
| OPPO | Re 2.H: Suggest to do the down-selection now, no next meeting. Alt1 has clear majority.  Re 2.F: we are ok to include the Type 3 CSS here. But not all the Type 3 CSS. In PCell, the UE monitors C-RNTI, MCS-RNTI and CS-RNTI in Type 3 CSS set. Therefore, in PCell, the Type 3 CSS shall follow the rel-17 indicatd TCI state:  [Mod: I tend to agree with this. Revised. Let’s see if other companies are ok. Else we can leave the whole Type3 FFS]  **Proposal 2.F**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation), the non-UE dedicated channels/signals (on which such inter-cell beam indication does not apply) comprise:   * All PDCCH receptions on CORESET(s) along with the respective PDSCH receptions and respective PUSCH/PUCCH transmissions if the CORESET(s) is associated with any Type0/0A/1/2~~/3~~ CSS set and Type 3 CSS set (in SCell Only, not primary cell) |
| NEC | Proposal 2.H: Support to decide in RAN1#107e.  Issue 2.3:  For **Alt2**, monitoring paging in USS is a bit contradictory to common practice, thus it is not preferred.  For **Alt1**, although we support UE to monitor paging in CSS, we believe that we haven’t had agreement that the newly activated Rel-17 inter-cell TCI state would be applied to non-UE dedicated channel/RS. In this case, UE would always have a separated QCL assumption (e.g., previous TCI associated with serving cell) other than newly activated TCI state associated with different PCI, to receive the non-UE dedicated channel/RS, including paging.  With that being said, we tend to agree with DoCoMo and MediaTek on Alt 0, if it means that UE can still receive paging in CSS from serving cell. If this is correct understanding, maybe we can clarify this for Alt 0:  **Alt0.** UE not required to monitor paging associated with the newly activated TCI state, and UE can monitor paging in CSS configured for paging with the previous activated TCI state associated with serving cell.  [Mod: Not sure if this wording reflects what’s being sai by Docomo and MTK. It is only valid for 1 atcive TCI state. Please also check Qualcomm’s point. I tend to agree that Alt0 is already supported.]  Proposal 2.F: prefer to solve issue 2.3 firstly. |
| ZTE | For 2.H, support. Some further discussion is needed. In general, the SSB Tx power from different cell may be quite different, and we may also need to consider RSRP definition herein (e.g., whether a coupling loss is much better).  For 2.3/2.4, we suggest to complete 2.3 firstly and then we can further review 2.4. |
| Apple | 2.E, we can add “a dedicated SR for event-driven report can be optionally configured”, if this can be helpful for progress. |
| CATT | Proposal 2.H: Support Alt1. If the L1-RSRP of a beam is out of range, it means the beam quality is not good. Then such beam should not be reported.  Issue 2.3: Support Alt0. UE should receive paging from its serving cell.  Proposal 2.F: Support.  Proposal 2.E, for the last sub-bullet of the second bullet, the detailed indication message needs to be clarified. Does it mean the similar parameter as TimeToTrigger in L3-based mobility measurement? |
| LG | Issue 2.3: Alt0 is supported. For inter-cell beam management, we have a similar view with Docomo that UE is possible to receive paging in CSS ‘from a serving cell’ with one active TCI state.  Proposal 2.E: Update the table that we support event-driven beam reporting but not based on MAC CE as similar to Samsung. |
| NTT Docomo2 | Proposal 2.H: Support, with 1st preference for Alt1.  Issue 2.3: after reviewing companies’ comments, we feel old beam in serving cell may be outdated in Alt.0. Since ETWS should be received in low latency, if gNB needs to send MAC CE to update old beam in serving cell to update the old beam, it would be too late to receive ETWS. On the other hand, in Alt.2, the new beam in non-serving cell is the latest beam. Hence, the new beam in non-serving cell is more reliable. Based on this, Alt.2 is more preferable.  Proposal 2.F: We suggest to complete 2.3 firstly and then we can further review 2.4.  Proposal 2.E: Support. We think this is useful. |
| Mod V13 | Revised 2.F based on Samsung’s/MTK’s and OPPO’s comments.  **Re issue 2.3, please check Qualcomm’s point that Alt0 is already supported by default for 1 active TCI state scenario. But a number of companies opine that this is not enough** |

### Issue 4 (MP-UE)

Table 5 Summary: issue 4

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 4.1 | **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,   * Support the UE reporting a list of UE capability value set(s)   + FFS: Whether each UE capability value set comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set   + FFS: Whether the UE capability value set can be common across a set of BWPs/CCs * The correspondence between a CSI-RS and/or SSB resource index and a UE capability value set from the reported list of UE capability value set(s) is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   + FFS: Whether and how to define the timeline for applying the correspondence   + FFS: How to inform the correspondence to NW in the reporting instance   + FFS: What type of beam reporting instance is considered, e.g. L1-RSRP/L1-SINR/BFRQ * Support multiple codebook-based SRS resource sets with different maximum number of SRS ports   + The indicated SRI is based on the SRS resources corresponding to one SRS resource set which is selected by the UE and aligned with the UE capability baed on the informed correspondence   **FL Note: Unless there is some critical, I suggest that companies not propose more refinement on the proposal. To reiterate, “logical index” isn’t agreeable to Ericsson.** | **Support/fine**: Lenovo/MotM, IDC, NTT Docomo, MTK, Nokia/NSB, Samsung, Qualcomm, LG, Spreadtrum, Huawei, HiSilicon, Sony  **Concern**: Intel, Apple (last bullet), OPPO (last bullet), , C ATT |

Table 6 Additional inputs: issue 4

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 5** 2. **Share more inputs here if needed** |
| Samsung | **Proposal 4.A:** Although we prefer to minimize number of FFSs, but can support it for progress |
| MediaTek | Support |
| Sony | We are supportive to the direction. From our understanding, we think the following editorial change can be considered.  For the 1st change, the reason is simply because a UE may report more than 1 sets for multiple panels or even single panel in different format from time to time.  For the 2nd change, we tend to think the intention is to build the correspondence between a DL RS and a UE capability value set, rather than one UE capability value, e.g. the number of SRS ports.   * Support the UE reporting a list of UE capability value sets   + FFS: Whether each UE capability value set comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set   + FFS: Whether the UE capability value set can be common across a set of BWPs/CCs * The correspondence between a CSI-RS and/or SSB resource index and a UE capability value set from the reported UE capability value set is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   Hope I get it right, but if not, please correct me, thank you.  [Mod: Correct, done] |
| Qualcomm | Suggest the following wording change. Below is an example to my understanding.  For example, UE reports a list including the following 3 value sets with each set reflecting one type of panel. Then, UE reports a particular set associated with a reported DL RS. Either reporting the set ID or all values in that set in the beam report is TBD. I think this corresponds to Scheme 1 and 2 in previous agreement  UE capability value set #0: {SRS port # = 1, max # of layers = 1, # of SRS resources = 1}  UE capability value set #1: {SRS port # = 2, max # of layers = 2, # of SRS resources = 1}  UE capability value set #2: {SRS port # = 4, max # of layers = 4, # of SRS resources = 2}   * Support the UE reporting a list of UE capability value set(s)   + FFS: Whether each UE capability value set comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set   + FFS: Whether the UE capability value set can be common across a set of BWPs/CCs   The correspondence between a CSI-RS and/or SSB resource index and a UE capability value set from the reported list of UE capability value set(s) is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance  [Mod: OK now I understand. Done] |
| OPPO | The last sub-bullet is still unclear. “One SRS resource which is aligned with UE capabilty”? All the CB-based resource sets configured to one UE shall be aligned with the UE capability, right? Since this proposal is for UE-initiated panel activation and selection, as in the main bullet. That means the SRS resource set is selected by the UE, which shall be clear in the proposal. Therefore, the indicated SRI would be based one SRS resource in the CB-based SRS resource selected by the UE, which is of course aligned with the UE capability too.  So, suggest to update the poosal as follows:  **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,  …   * Support multiple codebook-based SRS resource sets with different maximum number of SRS ports   + The indicated SRI is based on the SRS resources corresponding to one SRS resource set which is selected by the UE and aligned with the UE capability   [Mod: OK] |
| NEC | Support. |
| ZTE | We are fine with QC’s update. Regarding the OPPO’s comment, we can understand their motivation, but for making this proposal consistency, we have the following suggestion based on QC’s update:  **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,  …   * Support multiple codebook-based SRS resource sets with different maximum number of SRS ports   + The indicated SRI is based on the SRS resources corresponding to one SRS resource set which is aligned with the UE capability value set based on the informed correspondence.   [Mod: OK] |
| Apple | OK with ZTE’s update.  If ths logic index is not agreeable, we do not know how to support the bullet  “The correspondence between a CSI-RS and/or SSB resource index and a UE capability value from the reported UE capability value set is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance”.  Would Ericsson clarify it a little bit? |
| CATT | Proposal 4.A seems to Scheme 1+ Scheme 2 in previous agreement. Per our understanding, the capability value set corresponds to the different UE panels. Suppose UE has two panels, the two panels have same capability value set and UE reports the correspondence between a CSI-RS and/or SSB resource index and a same UE capability value to gNB, how the reported information is used for the use case of uplink panel selection for interference mitigation needs to be clarified. |
| LG | Support the proposal. Further clarification of wording from Sony/Qualcomm is also good. |
| NTT Docomo | Support the proposal and support the revision from Qualcomm. |
| Mod V13 | Revised per comments.  **@Ericsson: please check Apple’s question and respond if possible**  **@All: Is it possible to resolve some of the FFS points. There are four big ones and not including other open issues (e.g. supported capability value sets, whether 2 BATs are needed)** |