**3GPP TSG RAN WG1 #106bis-e R1-2110492**

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

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#2 for multi-beam enhancement: ROUND 1

**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:

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| --- |
| 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

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| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 1.1 | Max number of configured TCI states | **Define max # configured TCI states:**   * **Joint/DL TCI apart from UL TCI:** 128 (Docomo, …) * **Total number across all types of TCI (joint, DL, and UL):** 256 (Docomo, Samsung, LG …), 128 (vivo)   **Define max # configured TCI states per BWP/CC**:   * **Yes**: ... * **No**: Docomo, Samsung |
| 1.9 | For separate TCI, UL TCI state pool  Alt1: Shared pool with joint/DL TCI state  Alt2: Separate pool  Note: Strictly speaking, this could be decided in RAN2. Therefore, if there is no consensus, this will be left to RAN2 | **Alt1:**   * **Support (12)**: vivo, Spreadtrum, Samsung, Xiaomi, ZTE, Qualcomm, MTK, Convida, NTT Docomo, Intel, CATT, TCL * **Concern**:   **Alt2**:   * **Support** (11): CMCC, Ericsson, Futurewei, Huawei/HiSi, Fraunhofer IIS/HHI, IDC, Sony, Apple, AT&T * **Concern**: |
| 1.10 | Additional source RS type for DL QCL Type-D reference for DL common UE-dedicated reception on PDSCH and all/subset of CORESETs | SSB, with TRS as QCL Type-A source RS   * **Yes (5):** ZTE, Samsung, MTK, vivo, Qualcomm * **No (9):** Spreadtrum, OPPO, Intel, Apple, Sony, Ericsson, Huawei/HiSi, Futurewei, Docomo   SRS for BM, optionally with TRS as QCL Type-A source RS   * **Yes (9):** ZTE, IDC, Spreadtrum, Samsung, Convida, Nokia/NSB, vivo, Xiaomi, Sony * **No (10):**, OPPO, Fraunhofer IIS/HHI, MTK, Intel, Ericsson, Huawei/HiSi, LG, Futurewei, Docomo |
| 1.11 | BFR enhancement for unified TCI:  X symbols after the UE receives the BFRR, the new/updated QCL source RS applies to both UE-dedicated PDCCH and PDSCH | **Yes**: Apple, NEC, Docomo  **No**: |
| 1.12 | BFR enhancement for unified TCI: can BFD RS share the same indicated Rel-17 TCI state as UE-dedicated PDSCH/PDCCH? | **Yes**: NEC, NTT Docomo, Convida, Apple (only CSI-RS without QCL indication, but we suggest to make it in a general way), Huawei, HiSilicon  **No**: |
|  |  |  |

Based on the above observation, the following moderator proposals can be made:

**Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states is given as follows (following Rel-15/16 principles):

* When a UE is configured with joint DL/UL TCI: the largest number of configured TCI states for joint DL/UL TCI state update is 128 per CC/BWP
* 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 CC/BWP, and the largest number of configured TCI states for UL TCI state update is 64 per CC/BWP

Note: TCI state pool for separate DL/UL TCI indication is still FFS

**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

**Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI,

* Whether a DL channel/signal shares 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.
* Whether an UL channel/signal shares 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.

Details are up to RAN2

FFS: Whether this configuration is per resource, per resource set, or per CORESET

**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], “beam alignment” also pertains to the following events:

* The PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state
* The QCL Type-D RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state
* The QCL Type-D RS of PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state
* [The QCL Type-D RSs of PL-RS and the spatial relation RS have the same source RS for QCL-TypeD]

**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:

* Support the following: for each of the PUSCH, PUCCH, and/or SRS, one setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC
  + Additional P0 can be provided by RRC for URLLC
    - FFS: Whether this additional P0 is per TCI or per BWP

VS

* [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.]

Table 2 Additional inputs: issue 1

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| --- | --- |
| **Company** | **Input** |
| Mod V0 | **1) Check and update your view Table 1**  **2) Share your inputs on the above FL proposals esp re**   * **New proposals 1.B.1, 1.B.2** * **Wording refinement for proposals 1.G and 1.H (changed ‘is’ to ‘can be’). We have already discussed these two for 4 weeks!** |
| NTT Docomo | **Issue 1.1/Proposal 1.A**: at least 128 TCI states should be supported for joint TCI states, same as Rel. 15 TCI states. For separate TCI states, 128 DL TCI states should be supported for DL, and 64 or 128 UL TCI states should be supported for UL.  For max # configured TCI states per BWP/CC, if we follow Rel.15, max number of configured TCI state per CC and max number of active TCI states per BWP per CC should be reported (as below). We don’t see necessity to define configured TCI states per BWP per CC.   |  | | --- | | ***tci-StatePDSCH* (TS38.306)**  Defines support of TCI-States for PDSCH. The capability signalling comprises the following parameters:  - *maxNumberConfiguredTCIstatesPerCC* indicates the maximum number of configured TCI-states per CC for PDSCH. For FR2, the UE is mandated to set the value at least to 64 (i.e. value 128 is an optional value). For FR1, the UE is mandated to set these values at least to the maximum number of allowed SSBs in the supported band;  - *maxNumberActiveTCI-PerBWP* indicates the maximum number of activated TCI-states per BWP per CC, including control and data. If a UE reports X active TCI state(s), it is not expected that more than X active QCL type D assumption(s) for any PDSCH and any CORESETs for a given BWP of a serving cell become active for the UE. The UE shall include this field.  Note the UE is required to track only the active TCI states. |   [Mod: See proposal. I followed Rel-15/16 principle as you described]  **Proposal 1.B.1**: Support. It is aligned with existing Rel.15 QCL chain.  **Proposal 1.B.2**: Does it imply that “a list of DL channels/signals”, which is target RS of Rel.17 TCI state is configured? Originally, we assumed that Rel.17 TCI states are configured for each DL/channel/signals (similer as Rel.15 TCI state configuration). In that case, the “list of DL channels/signals” seems not needed. Could you clarify why “a list of DL channels/signals” is needed?  [Mod: As discussed and stated in too numerous occasions: YES, ALL signals/channels valid as target can be configured with Rel-17 TCI states. However, NOT such signals/channels SHARE the SAME Rel-17 TCI states as UE-dedciated PDSCH/PDCCH. Also the UL analogues. So a list or some other means to configure this is needed]  **Proposal 1.G**: Support.  **Proposal 1.H**: We don’t see much difference between “is” and “can be”. **@Qualcomm**, could you repeat what is the intention of the update?  **Issue 1.10 (Additional source RS type for DL QCL):** Considering the limited remaining workload of Rel.17, we think this is low priority.  [Mod: I symphatize with this]  **Issue 1.11/12 (BFR):** We believe the discussion for the relation between unified TCI and BFR is important and essential.  [Mod: I agree] |
| vivo | **Proposal 1.A**:  In Rel-17 unified TCI framework, 3-bits TCI field in beam indication DCI is reserved to indicate common beam. There is no motivation to increase the number of active TCI codepoints considering M=N=1 case. The number of configured TCI states by RRC in Rel-15/Rel-16 is enough. We support:  **Revised Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states (including joint TCI state(s), DL-only TCI state(s), and/or UL-only TCI state(s)) is 128.  **Proposal 1.B.1:** We prefer to agree on 1.B.2 first before we touch this issue since it would be confusing if the source RS needs to follow the indicated joint TCI.  **Proposal 1.B.2:** Agree in principle, but both DL and UL channels/signals need to be included, e.g. aperiodic CSI-RS for CSI, aperiodic CSI-RS for BM, aperiodic SRS for BM. The application of Rel-17 TCI state for aperiodic CSI-RS and aperiodic SRS can be flexibly configured via RRC per resource set or per usage.  **Revised Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, a list of DL channels/signals that share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH and UL channels/signals that share the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update) are ~~is~~ configured via RRC.   * FFS: configuration per resource set, per resource or per usage.   [Mod: Done. Note we only agree on N=1 and by conclusion from previous meeting, we don’t need ‘or subset’]  **Proposal 1.G**: We still believe this is overdesign especially considering there is no RAN1 specifcation impact for this. These cases can be discussed in UE feature. Otherwise, RAN4 could find out the best way for dealing with this.  **Proposal 1.H**: the following agreement was achieved in RAN1 #105e, which explicitly states that each of the TCI state should be associated with one of the settings. We prefer not to discuss the case that some of the TCI states are associated with PC settings while some others are not associated with PC settings.  **Agreement**  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 and PUCCH, the setting of (P0, alpha, closed loop index) can be associated with UL or (if applicable) joint TCI state per BWP.   + In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.   + (Working Assumption) In this case, for each of the PUSCH and PUCCH, each of the activated UL or (if applicable) joint TCI states is associated with one of the settings. * If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal per BWP is independent of the UL or (if applicable) joint TCI states * FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state. * FFS: (to be decided in RAN1#106-e) whether to configure the same setting of (P0, alpha, closed loop index) per TCI state across channels and apply a channel dependent component, or configure a channel dependent setting of (P0, alpha, closed loop index) per TCI state   **Revised Proposal 1.H**: On Rel.17 unified TCI framework, 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:   * Support the following: for each of the PUSCH, PUCCH, and/or SRS, one setting is associated with each of the UL or (if applicable) joint TCI states in a BWP via RRC   [Mod: Done] |
| MediaTek | Proposal 1.A: We think we should define the max number per CC, as the UE capability *maxNumberConfiguredTCIstatesPerCC* in Rel-15 where the max value is 128, and we prefer to keep the same number.  Proposal 1.B.1: No strong preference, but we are okay.  Proposal 1.B.2: We are fine to use RRC to indicate whether the DL channel/signal share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update). However, we prefer to configure this per RS resource/resource set or per CORESET, instead of using a list.  [Mod: Done]  Proposal 1.G: Regarding the main bullet, it is unclear what does “the same CSI-RS for BM” mean. Also, accoriding to the comment from HW, the definition of “TCI spatial relation RS” may not be clear, we can use “the spatial relation RS in the UL or (if applicable) joint TCI state” instead, which is used in the previous agreement.  Thus, we suggest the following changes:  **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, “beam alignment” also pertains to the following events:   * The PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D RS of PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state * [When UL spatial relation RS of UL TCI spatial relation RS is a BM SRS resource, the PL-RS or the QCL Type-D RS of PL-RS is identical to the configured PL-RS of the SRS resource]   [Mod: Done]  Proposal 1.H: In the main bullet, it is already mentioned “when”, and one setting need to be associated with each of the UL or (if applicable) joint TCI states according to previous agreement. Thus, we prefer the following change:  **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:   * Support the following: for each of the PUSCH, PUCCH, and/or SRS, one setting is associated with each of the UL or (if applicable) joint TCI states in a BWP via RRC   [Mod: Done] |
| Lenovo/MotM | Proposal 1.A: It needs to be clarified whether the number of configured TCI states under discussion is on per carrier, per band, or per UE basis.  Proposal 1.B.1: Support. The R16 QCL rule for PDSCH/PDCCH should be reused.  Proposal 1.B.2: Does this mean the channels/signals in the list are all in the same CC, or can they be in different CCs?  [Mod: Added FFS, let’s see what other companies think]  Proposal 1.G: Support.  Proposal 1.H: Support. |
| Qualcomm | For 1.A, support max # of 128 per BWP  For 1.B.1, fine  For 1.B.2, support  For 1.G, support, prefer to keep the bracket for more clarification  For 1.H, support. To our understanding, for TCIs not associated with any setting, they will use the default setting  [Mod: Correct] |
| Samsung | **Proposal 1.A:** Rel-15/16 supports 128 TCI states for DL beam indication within one cell. In Rel-17, the unified TCI framework is expanded to support, joint DL/UL TCI state indication, separate DL TCI state indication, separate UL TCI state indication, as well as intra-cell and inter-cell beam management. Therefore, we think that it is reasonable to increase the number of RRC configured TCI states to 256. This would reduce the number of required RRC reconfigurations for TCI states.  **Proposal 1.B.1:** While supporting CSI-RS for CSI as a source RS is not an essential aspect for completing this work item, we are fine to support given that this is already supported in Rel-15/16 and for progress.  **Proposal 1.B.2:** We are fine to have a list of channels/signals that follow the TCI state of UE dedicated channels. This should be for DL as well as UL channels/signals.    **Proposal 1.G:** We see no need for the last bullet (in square bracks). If a the source RS of the UL or Joint TCI state is SRS for beam management, the beam alignment can be covered by case 1 or case 3.  [Mod: Removed]  **Proposal 1.H:** We suggest the following update for clarity:  **Proposal 1.H**: On Rel.17 unified TCI framework, 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 PUSCH, an UL or (if applicable) joint TCI state can be associated with one setting per BWP via RRC * for PUCCH, an UL or (if applicable) joint TCI state can be associated with another setting (possibly the same or different from PUSCH and/or SRS) per BWP via RRC * for SRS, an UL or (if applicable) joint TCI state can be associated with another setting (possibly the same or different from PUSCH and/or PUCCH) per BWP via RRC   [Mod: Thanks, this has the same meaning as the current version – but if needed, this more elaborate wording can be used]  We think that Yan’s (Qualcomm) concern has been resolved by changing “is” to “can be”  We also think that the WA in the following agreement (from RAN1#105-e) is no longer needed when we agree to proposal 1.H.  **Agreement**  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 and PUCCH, the setting of (P0, alpha, closed loop index) can be associated with UL or (if applicable) joint TCI state per BWP.   + In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.   + (Working Assumption) In this case, for each of the PUSCH and PUCCH, each of the activated UL or (if applicable) joint TCI states is associated with one of the settings. * If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal per BWP is independent of the UL or (if applicable) joint TCI states * FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state. * FFS: (to be decided in RAN1#106-e) whether to configure the same setting of (P0, alpha, closed loop index) per TCI state across channels and apply a channel dependent component, or configure a channel dependent setting of (P0, alpha, closed loop index) per TCI state   [Mod: I agree] |
| Mod V7 | **Revised proposals: proposal 1.A follows Rel-15/16 principle** |
| Apple | **Proposal 1.A:** Support  **Proposal 1.B.1**: Do not support. There are several reasons:   * This shared TCI state would anyway be applied to aperiodic CSI-RS when scheduling offset is below threshold, but CSI-RS for CSI should not be the QCL source for other CSI-RS. * The use case is unclear. Usually gNB needs to provide TRS. If CSI-RS for CSI is configured as QCL source, such CSI-RS should be QCLed with TRS. Then this unnecessariliy brings in an additional stage in QCL chain. * There would be a risk for no TRS. If the CSI-RS for CSI is not configured with any QCL source, UE cannot identify any TRS. * CSI-RS for CSI usually contains >1 ports. So such CSI-RS cannot be used for RLM/BFD. This would require explicit configuration of BFD/RLM RSs. Explicit configuration would require RRC reconfiguration.   **Proposal 1.B.2:** Do not support the proposal. This indicated TCI should be applied to all the PDSCH/PDCCH/PUCCH/PUSCH as agreed.  [Mod: Agreement says “can share”, not “always shares”, meaning it has an option to share or not]  **Proposal 1.G**: OK  **Proposal 1.H**: We think we do not need to mandate gNB to provide the PC setting for each TCI. Maybe one way is to say “one setting is optionally associated”. In addition, as discussed online, additional P0 should be configured for URLLC. We suggest the following change.  **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:   * Support the following: for each of the PUSCH, PUCCH, and/or SRS, one setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC   + Additional P0 can be provided by RRC for URLLC     - FFS: Whether this additional P0 is per TCI or per BWP   **[Mod: OK]** |
| OPPO | For 1.B.1: do not support. We agreed to reuse the QCL rule in rel16 and the proposal of 1.B.1 would contradict with the QCL rule specified in rel16. The indciated TCI of rel17 would be applied to PDCCH, PDSCH and CSI-RS resource. Therefore, the QCL rule contained in the indicated TCI shall be a applicable to all of the PDCCH, PDSCH and CSI-RS.  For 1.B.2: The proposal seem to contradict with our previous agreement on unified TCI state. As agreed, the indciarted TCI state is applied to all the PDSCH/PDCCH/PUSCH and PUCCH for intra-cell beam management. How come do wen need need to configure them in RRC?  [Mod: See comment to Apple]  For 1.G: why in the main bullet is says “they are not CSI-RS for BM”? Suggest to delete it. And one more case for beam alignment is missed here: it is when the QCL-TypeD RSs of PLRS and UL spatial RS have the same source of QCL-TypeD:  [Mod: See MTK’s response below]  **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~~, “beam alignment” also pertains to the following events:   * The PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D RS of PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D RSs of PL-RS and the spatial relation RS have the same source RS for QCL-TypeD.   [Mod: OK on 4th bullet, in brackets] |
| ZTE | **For 1.A:** It seems that the proposal is clarify the maximum number of Rel-15/16 for DL TCI and spatial relation and if so, we need to explicit mention that the above does not imply that either a joint or separate pool is supported. Also, the last FFS seems redundant and is much relevant to Proposal 1.B.2.  **Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states is given as follows (following Rel-15/16 principles):   * When a UE is configured with joint TCI: the largest number of configured joint TCI states is 128 per CC/BWP * When a UE is configured with separate DL/UL TCI: the largest number of configured DL-only TCI states is 128 per CC/BWP, and the largest number of configured UL-only TCI states is 64 per CC/BWP   ~~FFS: whenever applicable, whether this configuration is per resource, per resource set, or per usage~~  Note that TCI state pool for separate DL/UL TCI indication is still FFS  [Mod: OK]  **For 1.B.1:** Support. We do NOT identify the necessity of precluding this candidate as in Rel-15/16.  **For 1.B.2:** Support in principle. To be honest, this proposal is confusing. Firstly, we have ‘a list of’, and then ‘configuration is per resource, …’. Then, we prefer this configuration is per set. Then, the added FFS may not needed, considering that the UE only need to follow the list of CC(s) being applied by indicated TCI state. Please review the following modification.  **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI,   * Whether DL channels/signals can share 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. * Whether UL channels/signals can share 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   [Mod: OK]  **For 1.G:**  Not support. The technical reasons from our sides have been mentioned several time before, and we also share the same views with vivo.  **For 1.H:**  Maybe, we can reuse the same wording in WA last meeting. This meeting is second last meeting, and this issue also has RRC impacts. We suggest to complete two candidate solution (RRC only or RRC+MAC-CE) and make down-selection during online.  **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:   * Support the following:   + Alt1: for each of the PUSCH, PUCCH, and/or SRS, ~~one setting is associated with~~ each of the UL or (if applicable) joint TCI state can be associated with one setting in a BWP via RRC   + Alt2: for each of PUSCH, PUCCH, and/or SRS, each of UL or (if applicable) joint TCI state can be associated with one of configured settings in a BWP via MAC-CE.   [Mod: OK, we can try online. If we cannot reach consensus, we can leave it to RAN2] |
| Spreadtrum | **Proposal 1.B.2**: Regarding the list of DL/UL channels/signals, PDCCH is associated with a CORESET ID, but PDSCH does not have an ID for indexing. We suggest to change the ‘list’ to ‘group’, and how to group the channels/signals can be up to RAN2.  **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI,   * a ~~list~~group of 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) is configured via RRC.   + FFS: Whether or not the ~~list~~group can include channels/signals from different CC(s) from the UE-dedicated reception on PDSCH/PDCCH * a ~~list~~group of UL channels/signals that share 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 or not the ~~list~~group can include channels/signals from different CC(s) from the dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources   FFS: Whether this configuration is per resource, per resource set, or per CORESET  Note: How to group the channels/signals is up to RAN2  [Mod: See revision] |
| MediaTek | Proposal 1.A: In our view, whether UE is configured with jont DL/UL TCI or separate DL/UL TCI doesn't impact the TCI state pool configuration. Instead, it only means NW can indicate two different TCI states for DL and UL, respectively. Even UE is configured with separate DL/UL TCI, a TCI state indicated for DL can be indicated for UL as well (i.e., spatial filter is derived from the RS of DL QCL Type D). Therefore, we don't see the need of additional 64 TCI states for UL. In summary, we prefer to the following update to the proposal:  **Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states is given as follows (following Rel-15/16 principles):   * When a UE is configured with joint DL/UL TCI: the largest number of configured TCI states for joint DL/UL TCI update is 128 per CC/BWP * When a UE is configured with separate DL/UL TCI: the largest number of configured TCI states for DL and/or UL TCI update is 128 per CC/BWP   FFS: whenever applicable, whether this configuration is per resource, per resource set, or per usage  [Mod: OK for wording, but 128 may not be agreeable for UL based on comments.]  Proposal 1.B.2: We see how to provide such configuration (whether or not share the same indicated Rel-17 TCI state) can be left to RAN2 design. RAN1 can focus on whether the configuration is per resource, per resource set, or per CORESET provided. Regarding the configuration should be applied to channels/signals per CC or all CCs, we can further discuss. However, we think the flexibility of per-CC configuration should be left to NW.  **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI,   * Whether or not DL channels/signals share 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.   + FFS: Whether or not the configuration can apply to channels/signals from different CC(s) from the UE-dedicated reception on PDSCH/PDCCH * Whether or not UL channels/signals share 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 or not the configuration can apply to channels/signals from different CC(s) from the dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources   FFS: Whether this configuration is per resource, per resource set, or per CORESET  [Mod: See revision]  Proposal 1.G: Re OPPO’s comment, the reason to preclude CSI-RS for BM because if any one of PL-RS and spatial relation RS is CSI-RS for BM, it is possible that UE determines a beam different from the one determined from the corresponding QCL-TypeD source RS according to a BM procedure. |
| LG | Proposal 1.A: Supporting a larger max number is beneficial for the purpose of inter-cell beam management and also for keeping the same level of flexibility for configuring joint/separate TCI states as is in Rel-15/16  Proposal 1.B.2: We are supportive on vivo’s revision.  Proposal 1.G: Support the proposal without the bracket on the last bullet.  Responding to QC/Samsung’s question/comment, the purpose is to address the case when BM SRS resource is configured as spatial relation of the SRS resource. In this case, BM SRS may not have spatial relation. Consider the following case:   * BM SRS resource set (e.g. periodic) without spatial relation configured (e.g. for UL Tx beam refinement) * Another [BM] SRS resource set (e.g. aperiodic/semi-persistent) to be used as source RS for UL TCI   It is possible that one resource of the first BM SRS resource set is configured as spatial relation for the indicated UL TCI selected among the second SRS resource set. This case is not covered by the top three bullets since there is NO downlink RS as UL TCI or spatial relation RS of the UL TCI, thus not applicable as pathloss RS. |
| Mod V15 | Revised proposals |
| Convida | Proposal 1.A:  Question for clarification: Does the proposal imply that switching between joint TCI and separate DL/UL TCI (by RRC) also might imply RRC reconfiguration of the TCI state pool(s)? For example, assume a shared pool is used for joint and separate TCI, and 128 TCI states are configured and used for joint TCI, i.e. 128 TCI states are applicable to UL spatial filter etc. Upon RRC reconfiguration to separate DL/UL TCI, does the gNB have to reconfigure the TCI state pool such that only 64 of the 128 TCI states are applicable to UL? This would seem undesirable.  Another question: For a UE configured with separate DL/UL TCI, can a DL TCI (e.g. TCI codepoint 0) be derived from TCI state A and an UL TCI (e.g. TCI codepoint 1) be derived from the same TCI state A? If so, would TCI state A be counted among the 128 (DL) or among the 64 (UL)?  We’re fine with the other proposals. |
| Apple | Proposal 1.B.2: We have concern for the proposal. If the agreement is interpreted as gNB can choose not to share the indicated TCI for some signals, we think one way is not to do anything. Based on the beam indication for the signaling itself, gNB can choose whether to indicate the shared TCI or not.  Besides, if we would like to give gNB the flexibility with a different way as legacy beam indication, such flexibility should not be provided in RRC level. RRC level means no flexibility. |
| NTT Docomo | Thank you FL for the reply and updating the proposal.  **Proposal 1.A:** Support. But, could you update “per CC/BWP” to “per BWP per CC”, because it is confusing.  **Proposal 1.B.1:** Support.  **Proposal 1.B.2:** Support.  **Proposal 1.G:** Support.  **Proposal 1.H:** Support. |
| vivo | **Proposal 1.A**: we think it is not necessary to distinguish between the largest number of configured separate DL DCI states and the largest number of configured separate UL DCI states. DL TCI state and UL TCI state can be activated and indicated based on network implementation from a R17 TCI pool including up to 128 configured TCI states.  **Revised Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states is given as follows (following Rel-15/16 principles):   * When a UE is configured with joint DL/UL TCI: the largest number of configured TCI states for joint DL/UL TCI state update is 128 per CC/BWP * ~~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 CC/BWP, and the largest number of configured TCI states for UL TCI state update is 64 per CC/BWP~~   Note: TCI state pool for separate DL/UL TCI indication is still FFS  **Proposal 1.B.1 and Proposal 1.B.2**  We prefer to agree on 1.B.2 first before we touch this issue since it would be confusing if the source RS needs to follow the indicated joint TCI.  **Proposal 1.G**: Don’t support this proposal refering the reason mentioned before. |
| Fraunhofer IIS/HHI | **Proposal 1.A, 1.B.1:** Support  **Proposal 1.B.2:** Just a clarification. Is the level of support for the configuration (per resource/resource set/CORESET) mentioned in the FFS up to RAN1 to study or that is up to RAN2 as well? If the support of the RRC configuration itself is up to RAN2 decision, then RAN1 can’t be left to decide on the level of support. If that’s the case, it may imply that the RRC configuration is supported and only the details of the configuration (except for the level of configuration) are left to RAN2. So, the work for RAN2 would be on “how to configure”, and not “whether to configure” as mentioned the proposal. The proposal is hence confusing on the work to be done by RAN2 and RAN1, and on the decision to support the RRC configuration of the channels/signals sharing the common TCI state update.  **Proposal 1.G:** The last bullet seems to go into another level of QCL-typeD reference as Sony mentioned in round 0. We believe that is not required. We’re ok to keep it in brackets. |
| Sony | **On issue 1.10,** we changed our preference in Table 1.  **Proposal 1.A**  We are okay with the direction of considering joint DL/UL TCI state case and separate DL/UL TCI state case separately. Just one clarification question, for separate UL/DL TCI state configuration, the total number of configured DL TCI states and UL TCI states could be up to 192 (128 + 64) per BWP per CC. Is this correct understanding? If that’s case and majority view is okay with that, we are fine as well.  **Proposal 1.B.1**  Support. We think it’s neve too late to correct it right.  **Proposal 1.B.2**  We are fine with the RRC configuration on which channel/signal can share the indicated TCI state.  But we do share similar view with Fraunhofer that at the bottom we say “Details are up to RAN2”, but RAN1 may continue to study the configuration level. Perhap we could say as below  FFS: Whether this configuration is per resource, per resource set, or per CORESET  Remaing details are up to RAN2 |
| Ericsson | **Proposal 1.A, 1.B.1:** Support  **Proposal 1.B.2:** The way this is formulated goes against the spirit of common beam. The configuration should state which signals/channels do not use the common beam. We prefer to state that RRC is used to configure which signals/channels do not use the common beam.  **Proposal 1.H:** We are not ok with the “additional P0”. This is unrelated, and could be a separate FFS. Do not support association via MAC CE. |
| Huawei, HiSilicon | **Proposal 1.B.1:** Support. It has been agreed to reuse R15 QCL rule, which supports using CSI-RS for CSI as QCL source for PDCCH/PDSCH. Reading the arguments from Apple/OPPO, they are mostly talking about their preferred configurations, which are not the only configurations allowed by agrrements. For example, while aperiodic CSI-RS for CSI can be optionally configured to follow PDCCH/PDSCH, periodic CSI-RS for CSI can still be used as QCL source for PDCCH/PDSCH. We failed to see a solid reason to revert preivous agreement.  **Proposal 1.B.2:** With the statement of “Details are up to RAN2”, it is unclear whether the FFS point (i.e., whether this configuration is per resource, per resource set, or per CORESET) is to be discussed in RAN1 or RAN2. We slightly prefer to discuss in RAN1.  **Proposal 1.G:** It is perhaps better to replace “QCL Type-D RS” as “QCL Type-D source RS” for better readability.  **Proposal 1.H:** Suggest labeling these alternatives so that companies can share their preference. We support the MAC-CE-based approach. |
| CMCC | **Proposal 1.A, 1.B.1:** Support. The R15/16 QCL rule for PDSCH/PDCCH should be reused, we see no reason to preclude CSI-RS for CSI.  **Proposal 1.B.2:** Support. Ericssion’s suggestion is also fine to us.  **Proposal 1.G：**For the text [and they are not CSI-RS for BM], we think it means they are not CSI-RS with the higher layer parameter *repetition* set to 'on'. If yes, it can be clarified.  **Proposal 1.H:** Support. |
| Samsung | **Proposal 1.H**: Sightlyprefers MAC CE approach:  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 other proposals (1.A 1.B.1, 1.B.2 and 1.G) |

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

Table 3 Summary: issue 2

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 2.5 | Whether to support event-driven inter-cell beam reporting and if so the event definition   * Alt1. Support L1-based event-driven beam reporting for inter-cell beam management and inter-cell mTRP * Alt2. Support MAC CE based event-driven beam reporting for inter-cell beam management and inter-cell mTRP * Alt3. In Rel-17, event-driven beam reporting is not supported for inter-cell beam management and inter-cell mTRP   Note: Since it was agreed to finalize this issue in RAN1#106bis-e, if there is no consensus or if Alt1 and Alt2 proponents cannot converge, Alt3 is by default the outcome for Rel-17 | **Alt1**:   * Support (10): Huawei/HiSi, Xiaomi, Intel, Sony, LG, Samsung, Qualcomm (2nd preference), Futurewei, AT&T * Concern:   **Alt2**:   * Support (11): ZTE, Lenovo/MotM, CATT, Xiaomi, NTT Docomo, Nokia/NSB, Apple, Qualcomm (1st preference), Convida * Concern: Samsung   **Alt3 (4)**: OPPO, vivo, Ericsson, MTK |
| 2.6 | UCI design for L1-RSRP reporting: Reuse Rel-15 L1-RSRP table | **Yes:** Samsung, MTK, Qualcomm, Ericsson, ZTE, FGI/APT, Huawei, HiSilicon, CATT  **No:** |
| 2.7 | UCI Format:  Alt.1 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 7-bit L1-RSRP  Alt2. Differential L1-RSRP per non-serving cell/serving cell: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 7-bit L1-RSRP | **Alt1:** Samsung, MTK, Qualcomm, Ericsson, Docomo, vivo  **Alt2:** ZTE, CMCC, Samsung (2nd preference), Lenovo/MotM, Qualcomm (2nd preference), Sony |
| 2.8 | QCL assumption for paging reception after being activated with only one TCI state associated with PCI different from serving cell [2]  Alt-1: UE to monitor paging in USS with the newly activated TCI state [11]  Alt-2: UE to monitor paging in CSS configured for paging with the newly activated TCI state [offline] | Alt-1: Huawei, HiSilicon, Ericsson, Docomo  Alt-2: Huawei, HiSilicon, Docomo, Apple |

Proposals 2.A and 2.B are taken from the final outcome of the offline discussion [1].

The following observation can be made:

* 2.3: There is no consensus in adding the additional restriction
* 2.4: Alt1 represents the super-majority view
* 2.5: Among the proponents of event-driven reporting, there is no consensus on whether to support L1-based or MAC-CE-based solution

Based on the above observation, the following moderator proposals can be made:

**Proposed conclusion 2.A**: On Rel-17 beam indication enhancements for inter-cell beam management, the supported number of physical cell IDs different from that of the serving cell that are associated with activated TCI states for 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) will be decided as a part of UE feature discussion.

* Decide in conjunction with inter-cell mTRP, where the candidate value(s) include at least 1

**Proposed conclusion 2.B**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, there is no consensus on UE timing assumption on reception of signals from TRPs with PCIs different from the serving cell compared to that for serving cell

**Proposal 2.D**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, NMAX (the maximum number of RRC-configured PCIs different from the serving cell for measurement/reporting) is up to UE capability with candidate values of 1 and X.

* Note: X as agreed in AI 8.1.2.2
* When NMAXis configured to be X, the UE is RRC-configured for L1-RSRP measurement with up to X PCIs different from the serving cell PCI
* Additional restriction may be added by RAN4
* FFS: UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability

**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 if the CORESET(s) is associated with any Type0/0A/1/2 CSS set

**Proposal 2.G**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, the L1-RSRP reporting reuses Rel-15 L1-RSRP table

Table 4 Additional inputs: issue 2

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Proposals 2.A, 2.B, 2.D are relatively stable apart from some minor issues**  **1) Check and update your view in Table 3 (esp issue 2.5 per proponents’ strong request to continue discussion)**  **2) Share your inputs on the above FL proposals, especially re**   * **Red text in proposed conclusion 2.B** * **Any refinement needed for proposal 2.D** * **New proposal 2.F (on the definition of non-UE-dedciated channels/signals raised by MTK)** * **New proposal 2.G (on L1-RSRP reporting format)** |
| NTT Docomo | 2.A: Support.  2.B: Support.  2.D: Support.  2.E: Support MAC CE based event triggered beam reporting. One drawback of beam reporting for non-serving cell would be larger UCI overhead (including higher reporting frequency). If event based beam reporting is supported, in addition to regacy beam reporting, gNB can configure legacy beam reporting in low frequency. For UCI based, since both gNB and UE should have the common understanding of UCI payload, it is difficult to use UCI for event based beam reporting. On the other hand, UE can send MAC CE whenever UE wants. Hence, we believe MAC CE is more suitable for the event triggered beam reporting.  2.F: As agreed “Combo” proposal in RAN1#106e, “non-UE dedicated” is not supported for inter cell beam indication. Hence the intention of 2.F is to preclude “All PDCCH reception…”, is this correct understanding?   |  | | --- | | **Agreement**  On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC:   * DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH * FFS (to be concluded in RAN1#106bis-e): Non-UE-dedicated PUCCH and non-UE-dedicated PUSCH   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) applies to:   * The channels and signals as for intra-cell beam management except for non-UE dedicated channels/signals * For the aforementioned applicable channels and signals, SSB associated with a physical cell ID different from that of the serving cell is used as an indirect QCL reference for DL TCI (in case of separate DL/UL TCI) or joint TCI, or an indirect/direct QCL reference for UL TCI (in case of separate DL/UL TCI)   + Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel. Here, Rel-15/16 QCL rule is reused by replacing SSB with SSB associated with a physical cell ID different from that of the serving cell * For inter-cell beam management, the support of more than one Rel-17 active DL TCI state / QCL per band is a UE capability   + If UE does not support such capability, MAC-CE based beam indication (activation of one TCI state) can be used to switch between two different DL receptions along two different beams     - Note: The serving cell does not change when beam selection is done   + Note: This does not preclude the possibility for TA update on non-serving cell   + FFS: For a UE supporting Rel.17 beam indication feature for inter-cell beam management, up to 5 CORESETs can be configured per BWP |   Proposal 2.G: For K>1, we can reuse (K-1) Rel-15 differential L1-RSRP, where the first L1-RSRP value is the largest L1-RSRP among serving cell/non-serving cell, and remaining K-1 L1-RSRP (includes both serving cell/non-serving cell) can be differential L1-RSRP. |
| vivo | For Proposed conclusion 2.B, RAN4 LS already says: For the case when the measurement RS from the non-serving cell is within SMTC in FR1, legacy measurement behavior based on L3 measurement may be reused from RAN4 perspective. So we propose the following revision:  **Revised Proposed conclusion 2.B**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, for Rel-17 discussion purpose, RAN1 assumes that the reception of signals from TRPs with PCIs different from the serving cell compared to that for serving cell is within one CP length associated with the SCS of the active DL BWP.   * For the case when the Rx signals from TRPs with PCIs different from the serving cell are within SMTC at least for FR1, legacy measurement UE behavior is reused.   [Mod: OK, but I will keep this bullet in brackets since some companies still need more time]  For Proposal F, we are fine.  For Proposal G, we are ok with the first bullet. But for the second bullet, we don’t understand the benefit of differential L1-RSRP within each cell, which has the larger UCI payload size compared to legacy report format. Therefore, we suggest removing the second bullet.  **Revised Proposal 2.G**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP:   * The L1-RSRP reporting reuses Rel-15 L1-RSRP table * ~~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 7-bit L1-RSRP~~   **[Mod: OK]** |
| MediaTek | Proposed conclusion 2.B: It is unclear for us what “legacy UE behavior” mean in this proposal. From our understanding, performing L1-RSRP measurement/reporting on SSBs with PCID different from the one of the serving cell is a new feature in Rel-17, and there is no legacy UE behavior corresponding to this featue. Thus, we prefer to remove the sub-bullet.  Proposal 2.F: Re question from DCM, yes, your understading is correct.  Proposal 2.G: In a L1-RSRP reporting instance, whether themore than one SSBRI/L1-RSRP pairs are associated with a same PCID or different PCIDs, we prefer to use differential reporting for all of them. If the L1-RSRP of a beam is out of range of differential reporting, it means the beam quality is really bad where the reported beam will not be used as serving BPL.  **Proposal 2.G**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP:   * The L1-RSRP reporting reuses Rel-15 L1-RSRP table * Rel-15 L1-RSRP reporting format is used for all SSBRI-RSRP pairs in one L1-RSRP reporting instrance, i.e. 4-bit differential L1-RSRP(s) calculated relative to the 7-bit L1-RSRP |
| Lenovo/MotM | Proposal 2.A: Support  Proposal 2.B: Support  Proposal 2.D: Support  Proposal 2.E: If event-driven reporting is not supported, the dedicated UL resource required for CSI reporting will be significant. This is because the number of RS transmitted by non-serving cell and need to be measured for CSI will be at least as many as, or even more, than those transmitted by the serving cell. To reduce the total CSI-report overhead, event-driven report shall be supported.  Proposal 2.F: Support  Proposal 2.G: Support |
| Qualcomm | For 2.A, support  For 2.B, support, except for the contents in bracket. There is no legacy UE behavior for L1 measurement based on SSB from non-serving PCI in SMTC window.  For 2.D, support. For the FFS, support TDMed measured SSBs as baseline  For 2.E, support MAC-CE based event driven report. Can also live with L1 based  For 2.F, Type3 CSS can schedule group common DCI and hence should also be includes => This proposal may not be needed, since non-UE dedicated includes all CSS and corresponding PDSCH by definition, to our understanding  For 2.G, fine |
| Samsung | **Conclusion 2.A:** Support.  **Conclusion 2.B**: Support without the sub-bullet. The purpose of this conlusion is reception of DL channels and signals from different TRPs. The sub-bullet seems to be for measurements, which is beyond the scope of this conclusison.  [Mod: Still in brackets]  **Proposal 2.D**: Support.  **Proposal 2.E:** OK to support L1 event driven reporting (Alt1). We have concern on using MAC CE for beam reporting given that in Rel-15/16 beam reporting has been done by L1. Shifting this now to RAN2, would require RAN2 to design a new MAC CE which might not be feasible given the short time left in Rel-17.  We suggest the following for proposal 2.E:  **Proposal 2.E**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, ~~[event-driven – after more discussion]~~ support L1-based event-driven beam reporting for inter-cell beam management and inter-cell mTRP.  **Proposal 2.F:** This is OK, but to clarify that this definition only applies for inter-cell beam managenment. In case of intra-cell beam management, UE dedicated channels can be received on CCS.  [Mod: Done]  **Proposal 2.G:** Support.  **Issue 2.8:** It is not clear what is the use case for this functionality. A UE is configured with TCI state having a source RS associated with the a neighbouring cell PCI when it has dedicated traffic to receive/transmit. In this case, it is not expect that a UE would receive a paging message. Further more, the network can signal the UE to use a TCI state associated with the serving cell before sending a paging message. |
| Mod V7 | **Revised proposals. Proposal 2.G: 2nd bullet may be controversial for now – will discuss next round**  **Proposals 2.A, 2.B, 2.D, 2.G are relatively stable now and will be moved to reflector for email endorsement** |
| Apple | **Conclusion 2.A**: OK. But maybe this can be a working assumption. We noticed some companies there mentioned the discussion would focus on FR1. If that is the outcome, we have to do this work.  **Conclusion 2.B**: OK with the main-bullet only. SMTC is used for L3 measurement, which requires blind search. For L1-RSRP, in our view, what we need to do is SSB+SSB collision handling instead of SMTC.  **Proposal 2.D**: Support  **Proposal 2.E**: We woud like to mention that BFR cannot handle this issue since currently CBD RS cannot be a non-serving cell SSB.  **Proposal 2.F**: We suggest we consider issue 2.8 first. We think it is better that we can first figure out how to treat paging.  **Proposal 2.G**: OK. |
| ZTE | We can support proposal 2.A/2B/2D/2G except for the bracket in 2.B  For 2.E: Support, and we share the same views with DOCOMO.  For 2.F: Some clarification whether the CORESET(s) can additionally associated with any Type3 CSS set and USS set is needed. In technical, we do not think that this issue is urgent, and it can be postpone to the following meetings after some RAN2 related discussion/conclusion is stable. |
| Spreadtrum | **Proposed conclusion 2.B:** Support the main bullet, the sub-bullet is not needed.  **Proposal 2.G:** Support the latest version. |
| LG | Support 2.A, 2.B, and 2.D.  Proposal 2.E: We have a similar view with Samsung. Also, it can be applied in a simple way by enhancing L3 event based method, and then, it brings the benefit on signaling overhead and latency for inter-cell L1 reporting.  Proposal 2.F: Fine to clarifiy the non-UE dedicated channels/RSs for inter-cell BM. |
| Mod V15 | 2.A and 2.G have been endorsed.  **Revised 2.B (no consensus based on email discussion since vivo and Intel raised numerous concerns).**  **2.D will be discussed in GTW**  **Strangely most companies who support event-driven ignored my request (scroll up and see my instruction at the top of this table) to share their preference on Alt1 vs Alt2 (Yes, I fully understand you support event driven, but there are only 2 meeting left and we have 2 alternatives and no definition of event!).**  **In that case, if this persists, I will propose to conclude no consensus on supporting event-driven during GTW or next round** |
| MediaTek | Supprot 2B, 2D, 2F  Regarding Issue 2.5, we also prefer to conclude no consensus on supporting event-driven reporting due to lack of time. |
| Apple | For event driven, if possible, we can try the following proposal:   * **Support event-driven beam report**   + **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 non-serving cell SSBs 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 list of serving cell SSBs and non-serving cell SSBs are configured by RRC**   + **The L1-RSRP report is transmitted by MAC CE, which includes**     - **SSBRI from the list of non-serving cell SSB**     - **L1-RSRP for the corresponding SSB**   + **A prohibit timer is introduced to probit UE sends multiple L1-RSRP report MAC CEs, which is similar to PHR** |
| NTT Docomo | 2.B: We are fine.  2.D, 2.F: Support.  2.E (event triggered): We prefer MAC CE based, but we accept L1 based as well. |
|  |  |
| vivo | Fine with 2B, 2D, 2F.  For Issue 2.5, support FL’s proposal to conclude no consensus. |
| Sony | On **Issue 2.7**, we add our preference of Alt.2 on differential L1-RSRP reporting.  **Proposal 2.D**  By reading the main bullet, we feel if we change Nmax to N (the number of RRC configured PCI different from…), that’s still soomth. And NW doesn’t always configure the maximum value, but any valid value equal or lower than the maximum. So, can we suggest to slight reword as below> If anything we got wrong, please be free to let us know.  **Proposal 2.D**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, N(the number of RRC-configured PCIs different from the serving cell for measurement/reporting) is up to UE capability with candidate values of 1 and X.   * Note: X as agreed in AI 8.1.2.2 * When Nis configured to be X, the UE is RRC-configured for L1-RSRP measurement with up to X PCIs different from the serving cell PCI * Additional restriction may be added by RAN4 * FFS: UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability |
| Ericsson | Proposal 2.D: support  Proposal 2.F: Do not support. Activated TCI states should not be associated with CORESETs. This is a Rel-15 design that we try to get away from in R17.  We would be fine to state that there is no consensus on 2.5 |
| AT&T | ok with proposals 2.B, 2.D, 2.F.  issue 2.5: event-driven reporting is beneficial. A slight preference for L1-based reporting. |
| Huawei, HiSilicon | **Proposal 2.B**: It is a bit surprising to see the proposed conclusion of “there is no consensus on UE timing assumption on reception of signals from TRPs with PCIs different from the serving cell compared to that for serving cell”. Perhaps we can leave this issue to RAN4.  **Proposal 2.F**: This proposal would imply that NW cannot page a UE after activating only one TCI state associated with PCI different from with serving cell. Given that RAN2 LS specifically asked about paging, we suggest discussing Issue 2.8 before touching on Proposal 2.F (similar view as Apple). |
| CMCC | Fine with 2B. Support 2D, 2F.  Issue 2.5, support FL’s proposal to conclude no consensus. |
| Samsung | Support proposals/conclusions 2.B and 2.D  Proposal 2.F: Support. We would also like to include the UL 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 CSS set |

### Issue 3 (beam indication signaling medium)

Table 5 Summary: issue 3

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| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 3.1 | BAT (Y) for CA:   * Alt1: The first slot and the Y symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication * Alt2: The first slot and the Y symbols are both determined on the carrier with smallest SCS among the carrier(s) applying the beam indication and the UL carrier carrying the acknowledgment * Alt3: The first slot and the Y symbols are both determined on the UL carrier carrying the acknowledgment. | **Alt1**: OPPO, Lenovo/MotM, Ericsson, CATT, CMCC, Xiaomi, NTT Docomo, Nokia/NSB, Huawei/HiSi, Spreadtrum, MTK, Intel, Apple, Qualcomm, Samsung (2nd pref), TCL,  **Alt2**: vivo, Samsung (1st), APT/FGI  **Alt3**: ZTE, Sony |
|  |  |  |

**Proposal 3.A**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication for CA, the first slot and the Y symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication.

* Note: For Rel-17 MAC-CE based beam indication/activation (when only a single TCI codepoint is activated), it follows the Rel-15 application timeline of MAC-CE activation
* [Y is configured per SCS, and one of the configured Y symbols is used depending on the SCS of the active BWP on the reference carrier (i.e. the carrier with the smallest SCS among the carrier(s) applying the beam indication)]

Table 6 Additional inputs: issue 3

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **1) Share your inputs on the above FL proposal 3.A especially on the red texts** |
| NTT Docomo | 3.A: Support. We are fine with the 1st bullet. For the 2nd bullet, when multiple values of Y are configured per SCS, how to select the one value of Y?   * [Value(s) of Y are configured per SCS and dependent on SCS of target BWP, one of the configured Y symbols is used] |
| vivo | The brackets of the second subbullet should be removed. Cells are activated and deactivated dynamically. BWPs are also switched dynamically. Is it correct understanding that all SCS would use the same value based on the configured worst case if all the SCS uses the same Y value? This would make the DCI based beam switch much slower. |
| MediaTek | For the first sub-bullet, we are fine to clarify the timeline for MAC-CE-based TCI update. Some minor changes and we don't think we need to repeat the corresponding spec in the proposal.   * Note: For Rel-17 MAC-CE based beam indication (when only a single TCI codepoint is activated), following the Rel-15 application timeline of MAC-CE activation   For the second sub-bullet, it is unclear how this related to the main bullet. Thus, we suggest the following change:   * Y is configured per SCS and one of the configured Y symbols is used depending on the SCS of the active BWP on the reference carrier   [Mod: Done, added clarification on ‘reference carrier’ since this term isn’t defined] |
| Lenovo/MotM | MediaTek’s change is OK to us. |
| Qualcomm | Support the 1st bracket with the following red added based on current spec. Also fine for the 2nd bracket.   * [Note: For Rel-17 MAC-CE based beam indication (when only a singleTCI state is activated), following the Rel-15 MAC-CE ACK timeline, the single activated TCI state is applied starting from the first slot that is 3ms after the slot containing the ACK corresponding to the PDSCH carrying the MAC-CE, wherein the first slot is based on the UL carrier carrying the acknowledgment]   213:  if the UE receives a MAC CE activation command for one of the TCI states, the UE applies the activation command in the first slot that is after slot where is the slot where the UE would transmit a PUCCH with HARQ-ACK information for the PDSCH providing the activation command and is the SCS configuration for the PUCCH.  [Mod: Check revision] |
| Samsung | We are fine with the main bullet.  For the first sub-bullet. We should follow the Rel-15 timeline as described in TS 38.133 section 8.10.3. We are fine with the change proposed by MediaTek  The intention of the second sub-bullet is not clear. We suggest the following update:  [A Value~~(s)~~ of Y ~~are~~ is configured per SCS ~~and dependent on SCS of target BWP~~, ~~one of~~ the configured ~~of~~ Y symbols corresponding to the smallest SCS among the carrier(s) applying the beam indication is used]  [Mod: Check revision] |
| Mod V7 | **Revised proposals, removed square brackets** |
| Apple | We think the whole MAC CE can follow the Rel-15 timeline, instead of whether the MAC CE is used for beam activation or indication. So we propose the following change.  **Proposal 3.A**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication for CA, the first slot and the Y symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication.   * Note: For Rel-17 MAC-CE based beam indication/activation, it follows the Rel-15 application timeline of MAC-CE activation * Y is configured per SCS, and one of the configured Y symbols is used depending on the SCS of the active BWP on the reference carrier (i.e. the carrier with the smallest SCS among the carrier(s) applying the beam indication)   [Mod: OK] |
| Xiaomi | We want to clarify that whether the proposal is applied to intra-band CA only. Since for inter-band CA, the SCS will be very smaller and the application time will be long, which can’t reduce the beam indication latency. So we suggest to add a note as below:  The above applies to intra-band CA.  [Mod: Inter vs intra-band is not differentiated from RAN1 spec perspective. This may be discussed later in RAN4 if needed] |
| OPPO | We do not think we need to configure Y per SCS. The system can just configure one Y = Y0 value for SCS = 15KHz and then for other SCS would be calculated as Y = Y0\*2^u. The number of symbols (Y) shall be proportional to the SCS so that same time length is applied on different SCS.  [Mod: in brackets now] |
| ZTE | For first bracket, we prefer to have QC’s version and a clear clarification is needed. In our views, we do not expect to have any further spec impact, but we just want to preclude any further ambiguities.  [Mod: Upon further check, they are the same. But the current version is more concise and general]  For second bracket, we do NOT identify strong motivation, considering that SCS and Y are also RRC configured and can be well handled by gNB. |
| Spreadtrum | Proposal 3.A: Support the latest version. |
| Mod V15 | Second bullet is now in brackets since at least 2 companies voice concern |
| MediaTek | One minor change to avoid confusion:  **Proposal 3.A**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication for CA, the first slot and the Y symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication.   * Note: For Rel-17 MAC-CE based beam indication (when only a single TCI codepoint is activated) and activation, it follows the Rel-15 application timeline of MAC-CE activation |
| NTT Docomo | 3.A: Support. Also, we are fine to remove [ ] from the 2nd bullet. |
| vivo | Same comment as previous.  The brackets of the second subbullet should be removed. Cells are activated and deactivated dynamically. BWPs are also switched dynamically. Is it correct understanding that all SCS would use the same value based on the configured worst case if all the SCS uses the same Y value? This would make the DCI based beam switch much slower.  Re ZTE, can you clarify how RRC configured single value is applied when there is dynamic BWP switch? Would you like to reconfigure the corresponding Y values?  Re OPPO, if a single value is configured based on the SCS of 15kHz, it would be in conflict with the intention of the main bullet: determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. Are you assuming a single value of Y is reported based only on SCS 15kHz? |
| Ericsson | Don’t support the text in brackets.  It is enough to configure one value Y, and that must be large enough so that the UE has time to perform the switch, according to its capabilities. We assume the capability will be per SCS. I guess the foreseen use case of the text in brackets is that we change BWP (and SCS) during the beam switch. But this would imply that the beam switch time itself would change during the beam switch, which seems complicated. |
| Huawei, HiSilicon | **Proposal 3.A:** The description of “and one of the configured Y symbols is used depending on the SCS of the active BWP on the reference carrier (i.e. the carrier with the smallest SCS among the carrier(s) applying the beam indication)” seems redundant and not needed. |

### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** |
| 4.1 | Proposal 4.A | **Support**: Huawei/HiSi, IDC, Spreadtrum, vivo, Fujitsu, Lenovo/MotM, Fraunhofer IIS/HHI, NTT Docomo, Sony, AT&T, Apple, LG, Qualcomm, ZTE, Xiaomi, Samsung, Nokia/NSB, MTK, CMCC,  **Not support**: Ericsson, OPPO, Intel |
| 4.2 | Multiple SRS resource sets with different SRS #ports | **#SRS resource sets**   * **2**: Samsung, OPPO, Fraunhofer IIS/HHI, ZTE * **3**: Samsung, Qualcomm   **#SRS resources in each set:**   * **UE reporting**: vivo, Qualcomm   **#SRS ports in each set**   * **1, 2, 4**: Samsung, Qualcomm, ZTE |
|  |  |  |

The following observation can be made:

* 4.1: Scheme 1 still represents the majority view. Among the proponents of Scheme 2, it is unclear if there is any convergence on the option (note that Scheme 2 includes 3 different schemes). Given the current situation, it seems proper to proceed with Scheme 1 (previously supported by some supporters of Scheme 2 as well).

Based on the above observation, the following moderator proposals can be made:

**Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,

* At least one logical index is introduced that is associated with a UE capability
  + Support UE reporting of a UE capability for each logical index
  + FFS: Whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set
  + The logical index and the associated UE capability can be common across a set of BWPs/CCs based on UE capability
* The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance
  + The valid time duration of the correspondence is until the next reporting instance of the same CSI-RS resource index or SSB index
  + FFS: When the reported correspondence is applied
  + 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 associated to a logical index, where the SRS resource set should be aligned with the UE capability for the logical index
  + [UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain][In such case, only one of the SRS resource sets can be triggered at a given time instance]

Table 8 Additional inputs: issue 4

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| --- | --- |
| **Company** | **Input** |
| Mod V0 | **1) Check and update your view in Table 7**  **2) Share your input on proposal 4.A especially re**   * **the red text between brackets** * **There are too many FFSs (not including issue 4.2). Suggest how to resolve the FFSs (or remove them)** |
| NTT Docomo | For the red text, we think the key point is how to solve the issue that multiple SRS resources overlapped in time. However, instead of the solution in red text, we think it is better to define a collision handling rule for two CB SRS resources overlapped in time, e.g., if two CB SRS resources overlap in time, UE only transmits the SRS with lower SRS resource set ID.  For the FFS regarding UE capability, we think at least number of SRS ports, number of UL transmission layers should be supported. And we are fine to further discuss the other parameters (coherent type).  For the FFS regarding timeline, we are fine to leave it as FFS. Fow now we are not clear about how to define gNB acknowledgment for beam reporting. |
| vivo | Agree in principle.  Based on the correspondence between a CSI-RS and/or SSB resource index and a logical index in beam report, it is necessary to clarify the valid time duration of the correspondence.  If UE capability for each logical index is supported, the parameters of SRS resource set in Rel-15 can be reused. The number of SRS resource in SRS resource set can be included in UE capability for different UL measurement requirements.  **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,   * At least one logical index is introduced that is associated with a UE capability   + Support UE reporting of a UE capability for each logical index   + FFS: Whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, or TPMI, number of SRS resources within one SRS resource set   + The logical index and the associated UE capability can be common across a set of BWPs/CCs based on UE capability * The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   + The valid time duration of the correspondence is until the next reporting instance   + FFS: The need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report   + FFS: Detailed design * 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 associated to a logical index, where the SRS resource set should be aligned with the UE capability for the logical index   + [Note: In Rel-17, from RAN1 perspective, there is no further enhancement on the simultaneous transmission for the SRS] vs. [UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain] |
| MediaTek | Regarding the first FFS (whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, or TPMI), we prefer either the number of SRS ports or the number of UL transmission layers.  Regarding the second FFS (the need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report), we don't see the need to specify anything since the correspondence is applied when the reported beam(s) is acitivated/configured by NW for later UL transmission.  Regarding the last note, we prefer the later one, which is more clear. |
| Lenovo/MotM | We support proposal 4.A in general. Regarding the last bullet, does it imply the same codebook is always used when the SRS resource sets have the same number of SRS ports? |
| Qualcomm | Support 4.A |
| Samsung | We can support this proposal for progress. Some comments:  Re 1st FFS, we prefer UE capability similar to Rel15 wherein number of SRS ports and coherence type are reported by the UE.  Re 2nd FFS on the timeline, the need is unclear, and perhaps this can be solved by NW implementation |
| Mod V7 | **Revised proposal (last bullet: it seems Apple’s version is preferred by some other companies)** |
| Apple | We would like to clarify whether the beam reporting instance contains BFRQ, or whether it is a special L1-RSRP/L1-SINR reporting instance configured by NW. Maybe not critical at current stage, but we would like to suggest we add a FFS as follows：  **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,   * At least one logical index is introduced that is associated with a UE capability   + Support UE reporting of a UE capability for each logical index   + FFS: Whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set   + The logical index and the associated UE capability can be common across a set of BWPs/CCs based on UE capability * The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   + The valid time duration of the correspondence is until the next reporting instance   + FFS: The need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report, or left to NW implementation   + FFS: Detailed design   + 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 associated to a logical index, where the SRS resource set should be aligned with the UE capability for the logical index   + UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain   [Mod: OK] |
| OPPO | The correspondence shall be per CSI-RS resource or SSB. Thus the time duration of correspondence shall be until the next reporting instance of one same CSI-RS resource or SSB.  …   * + The valid time duration of the correspondence is until the next reporting instance of the same CSI-RS resource index or SSB index   …  [Mod: OK] |
| ZTE | We do not believe that the applicable time of correspondence can be left to NW implementation. Based on this solution, the UE capability can be dynamically changed, and gNB response to this update is needed. By default, the TCI state is not associated with the logical index, right? If so, the mapping between TCI state and candidate logical index is still unclear. If the reporting is missing, a serious misalignment may occur.   * The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   + The valid time duration of the correspondence is until the next reporting instance   + FFS: The need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report~~, or left to NW implementation~~   Then, in our initial views, only one SRS resource set for CB need to be transmitted, although multiple sets can be pre-configured If going with the version from Apple, we wonder whether it means that multiple sets corresponding to different panels can be triggered together? Two candidates are listed herein and some clarification is needed.   * 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 associated to a logical index, where the SRS resource set should be aligned with the UE capability for the logical index   + Opt1: UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain   + Opt2: In such case, only one of the SRS resource sets can be triggered at a given time instance.   [Mod: OK] |
| Spreadtrum | Proposal 4.A: Support in principle. One clarification question: With the definition of valid time duration, does it mean that UE can change the correspondence only after a CSI report? |
| LG | Support the proposal. We could merge and simplify the two FFSs under the second bullet:   * The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   + FFS: details (e.g. when the reported correspondence is applied) ~~The need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report~~   + ~~FFS: Detailed design~~   Re the last note, we prefer the later one, which is clearer.  [Mod: OK] |
| Mod V15 | Revised and cleaned up proposals |
| MediaTek | Current proposal on the valid time duration of the correspondence is unclear. In the next reporting instance, UE may not report the same SSBRI/CRI, and we don't think the correspondence is still valid in such case. We think this is also a part of issue on whether and how to define the timeline for applying the correspondence, and we can further discuss them together.  Regarding the “detailed design”, we believe it not only includes the timeline issue, but also the signaling design to inform the correspondence to NW. Thus, we suggest to indicate that this need to be futher studied.   * + 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 |
| Apple | Regarding the last bullet for proposal 4.A, what ZTE suggested is fine to us as well. |
| NTT Docomo | For the very last sub-bullet “[UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain][In such case, only one of the SRS resource sets can be triggered at a given time instance], after further thinking, we are fine with the original version (the first sentence). We think the second sentence is not needed. As long as SRS are not overlapped in time, multiple SRS resource sets can be triggered. |
| vivo | Agree with MediaTek that the correspondence may not valid when the same CSI-RS resource index or SSB index is not included in next report instance. If the logical index corresponding to the same CSI-RS resource index or SSB index changes by UE implementation, but the L1-RSRP of the same CSI-RS resource index or SSB index is not reported in next reporting instance, the gNB scheduling may occur based on previous report.  Fine with current version. |
| Fraunhofer IIS/HHI | Agree with the proposal in principle. The last sub-bullet can be left with just one sentence “UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain”. The sentence following it is not necessary and can be removed. |
| Sony | We are supportive in principle.  First, we share the same feeling with MTK that the valid duration of the reported correspondence may need to be carefully checked by the group. For example, even if UE reports the same CRI/SSBRI at next beam reporting instance, it may correspond to another logical index. Only UE knows.  Another instance can be that, if UE reports the same CRI/SSBRI which corresponds to the same logical index, it’s reasonable to expand the valid duration continuously, rather than “until”.  So, we hope this valid duration can be under FFS.  Second, for the mentioned reporting type, it makes sense to start from L1-RSRP. As for L1-SINR, we think it could be not applicable, as the DL interference profile is asymmetric with that of UL interference. The purpose of the beam reporting we are talking about here is for UL multiple panel selection.  So, we hope we could agree L1-RSRP first, and leave other metrics as FFS. |
| Ericsson | Many of these statements are now quite vague: the introduction of a “logical” index which does not have any meaning in itself. How about if we focus on the list of capabilities instead:  **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,   * Support the UE reporting a list of UE capability values   + FFS: Whether the UE capability values comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set   Any association across CCs is unclear, and should be left as FFS.  The correspondence bullet would then be:   * The correspondence between a CSI-RS and/or SSB resource index and the entry in the capability value list is informed to the NW in a beam reporting instance, using the index in the list   The validity time is strange, how would that work with aperiodic CSI-RS? There is no fixed mapping between Tx beam and CSI-RS resource for aperiodic CSI-RS. In principle, this is not related to reporting, is it?  What does the FFS on “reported correspondence is applied” mean? Is there some additional scheduling delay involved here?  The last bullet contains some new restrictions that should be left to NW implementation. These should be removed:   * Support multiple codebook –based SRS resource sets with different maximum number of SRS ports   The restriction on transmission of the different SRS resource sets seems to have a rather wide applicability. It does not seem motivated to introduce such a restriction to handle a specific piece of functionality.    A question: is it so that one SRS resource set can contain SRS resources with different number of ports? (The word ‘maximum’ indicates that, otherwise all the SRS resources will have the same number of ports. Right?) Could we clarify? |
| AT&T | Support proposal 4.A.  Our understanding from the valid time duration bullet is that the same SSBRI/CRI does not necessarily have to be reported in the next reporting instance, but the correspondence will be updated at the time when the same SSBRI/CRI is reported. |
| Huawei, HiSilicon | **Proposal 4.A:** Support in principle. |
| CMCC | For the valid time duration, we think it depends on whether the correspendence between a CSI-RS and/or SSB resource index and a logical index is changed or not. If changed, UE should report this information to NW, and whether/how to the report this information to NW should be discussed.  The correspendence between a CSI-RS and/or SSB resource index and a logical index may be changed between two reporting instance of the same CSI-RS resource index or SSB index. Hence, we suggest to change the bullet as:  FFS: the valid time duration of the correspondence |

### Issue 5 (MPE mitigation)

Table 9 Summary: issue 5

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 5.1 | Proposal 5.A | **Support**: ZTE, Samsung, CATT, CMCC, Xiaomi, Intel, NTT Docomo, Ericsson, Sony, Nokia/NSB, Apple, Qualcomm, LG, IDC, MTK, Spreadtrum  **Not support**: vivo, Huawei, HiSilicon |
| 5.2 | Proposal 5.B | **Support**: ZTE, Samsung, CATT, CMCC, Xiaomi, Intel, NTT Docomo, Ericsson, Sony, Nokia/NSB, Apple, Qualcomm, LG, IDC, MTK, vivo, Huawei, HiSilicon, Spreadtrum  **Not support**: |
| 5.3 | How to perform selection of N from a candidate SSB/CSI-RS resource pool and how the candidate resource pool is configured | Selection of N is based on:   * **TCI state quality**: OPPO * **TCI state group quality**: IDC * **L1-RSRP and P-MPR**: Ericsson, NTT Docomo, Qualcomm, MTK * **Virtual PHR**: Nokia/NSB, ZTE, Convida   Candidate resource pool:   * **Configured via RRC**: CATT, ZTE * **Configured via RRC using CSI report config**: Samsung, [Nokia/NSB], MTK, IDC |
|  |  |  |

**Proposal 5.A**: On Rel.17 enhancements to facilitate MPE mitigation, confirm the following working assumption (in the midst of the previous agreement) as an agreement with the following refinement (highlighted in red):

On Rel.17 enhancements to facilitate MPE mitigation, support the following enhancement on the Rel-16 event-triggered P-MPR-based reporting (included in the PHR report when a threshold is reached, reported via MAC-CE):

* In addition to the existing field in the PHR MAC-CE, N≥1 P-MPR values can be reported
  + The N P-MPR values are reported together with the following:
    - ~~(Working Assumption)~~ For each P-MPR value, up to M SSBRI(s)/CRI(s), where the SSBRI(s)/CRI(s) is selected by the UE from a candidate SSB/CSI-RS resource pool (FFS: how to perform the selection)
      * Support M=1
      * FFS: ~~The supported value(s) of M~~ Whether M>1 is needed, and if so, the supported value(s)
* FFS: Whether N represents the number of selected beams or the number of panels
* FFS: Supported values of N
* FFS: Whether beam-specific and/or panel-specific PHR is also reported
* FFS: Additional reporting quantities, e.g. SSBRI/CRI, MPR+DL RSRP, or modified virtual PHR
* FFS: additional signaling (e.g. CSI triggering) from the NW

**Proposal 5.B**: On Rel.17 enhancements to facilitate MPE mitigation, support N=1, 2, 3, and 4

* N is defined as the number of reported measurements
* UE reports supported largest N value as a UE capability

**Proposal 5.C**: On Rel.17 enhancements to facilitate MPE mitigation, for selection of N from a candidate SSB/CSI-RS resource pool:

* Down-select *by* RAN1#107-e between the two alternatives:
  + Alt1. Based on L1-RSRP minus P-MPR value for each resource
  + Alt2. Based on calculated Virtual PHR for each resource
    - Virtual PHR is modified by considering actual P-MPR
  + Alt3. Based on L1-RSRP for each resource among the resources with P-MPR values less than a threshold
  + Alt4. No spec impact (left to UE implementation)
  + Alt5. Combination of Alt1 and Alt2
* The candidate resource pool is configured via RRC using CSI framework

Table 10 Additional inputs: issue 5

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check Table 9 (if your views are correctly captured)** 2. **If you have inputs on the wording of the proposals 5.A and 5.B** 3. **Share your view on the new proposal 5.C** |
| NTT Docomo | Support proposal 5A and 5B  For proposal 5.C, we think among the beams with no MPE issue, it is better to select the beam based on L1-RSRP. Because in case PCMAX-PMPR is larger than configured UL Tx power, P-MPR does not affect UL performance. So, we prefer to select beams with higher RSRP among the beams with P-MPR less than a threshold. We suggest adding another alternative for down-seletion.   * Alt3. Based on L1-RSRP for each resource among the resources with PMPR less than a threshold. |
| vivo | **Proposal 5.A**: Don’t support the subbullet with only M=1. Beam report is dynamically reported while the P-MPR report is in MAC CE. If only one beam is selected for scheduling in the MAC-CE, it would be difficult to match the MAC CE report with the beam report in DCI.  *[Mod: To accmcodate vivo (the only company not OK with M=1 only), I added FFS for M>1]*  **Proposal 5.B**: Support  **Proposal 5.C**: The N P-MPRs are determined by UE, e.g. including preferred P-MPRs. The logical index corresponding to CSI-RS and/or SSB resource index in beam report can also included in P-MPR report to ensure the alignment of the association between P-MPR and SSBRI(s)/CRI(s) and effectively avoid wrong beam selection by gNB due to the change of the association.  Besides, the configuration of candidate resource pool needs further discussion.  **Revised Proposal 5.C**: On Rel.17 enhancements to facilitate MPE mitigation, for selection of ~~N~~M from a candidate SSB/CSI-RS resource pool:   * Down-select *by* RAN1#107-e between the two alternatives:   + Alt1. Based on L1-RSRP offset by P-MPR for each resource   + Alt2. Based on calculated Virtual PHR for each resource   + Alt3. Based on DL L1-RSRP without specification impact. * FFS: The candidate resource pool is configured vua RRC using CSI framework   The following simulation results show that the performance is very similar/neglegible using L1-RSRP as the metric or using L1-RSRP minus MPR.   * + Case 1(baseline): when MPE event is declared by UE, a modified L1-RSRP is triggered. The UE reports the uplink RSRP that considers the impact of blockage and MPE power back-off for panel/beam switching. gNB selects and determines the panel/beam switching according to the reported uplink RSRP.   + Case 2: when MPE event is declared by UE, a Rel-15 L1-RSRP report is triggered by gNB. The UE reports 4 beam pairs between gNB and UE based on downlink RSRP that considers the impact of blockage. gNB selects and determines the panel/beam switching according to the reported DL RSRP and P-MPR.  1. UL performance with full buffer traffic model for panel/beam switching  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | Dense Urban | | | Indoor Hotspot | | | |  | Mean SE of cell | 5%SE | 50%SE | Mean SE of cell | 5%SE | 50%SE | | Case1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | | Case2 | 0.04% | -2.10% | -0.23% | -0.04% | 0.00% | 0.01% | |
| MediaTek | Proposal 5.C: We are fine to down-select in the next meeting |
| Qualcomm | Support 5.A, 5.B  For 5.C, slightly prefer Alt1. Also can live with Alt2. For Alt2, suggest the following clarification   * + Alt2. Based on calculated Virtual PHR for each resource     - Virtual PHR is modified by considering actual P-MPR |
| Samsung | Support proposals 5.A and 5.B; and support Alt1 in Proposal 5.C |
| Mod V7 | **Revised proposal 5.A (added FFS, no substantial change) and 5.C**  **Proposals 5.A and 5.B will be moved to reflector for email endorsement** |
| Apple | Proposal 5.A: Support  Proposal 5.B: Support  Proposal 5.C: We suggest we add another alterative which is to merge Alt1+Alt2, by which we can observe better performance.  **Proposal 5.C**: On Rel.17 enhancements to facilitate MPE mitigation, for selection of N from a candidate SSB/CSI-RS resource pool:   * Down-select *by* RAN1#107-e between the two alternatives:   + Alt1. Based on L1-RSRP offset by P-MPR for each resource   + Alt2. Based on calculated Virtual PHR for each resource     - Virtual PHR is modified by considering actual P-MPR   + Alt3. Based on L1-RSRP for each resource among the resources with PMPR less than a threshold   + Alt4. No spec impact (left to UE implementation)   + Alt5. Alt1+Alt2 * The candidate resource pool is configured via RRC using CSI framework |
| Xiaomi | As for proposal 5.B, according to the agreement in last meeting, we don’t clear what is the definition of reported measurement. In addition, it has not been decided P-MPR value is reported per panel or per beam yet. So we suggest to add two notes to the first bullet as below:  **Proposal 5.B**: On Rel.17 enhancements to facilitate MPE mitigation, support N=1, 2, 3, and 4   * N is defined as the number of reported measurements   + Each measurement contains a P-MPR value and M SSBRI(s)/CRI(s)     - M=1     - *FFS: Whether M>1 is needed, and if so, the supported value(s)*   + The P-MPR value in different measurements can be same or different * UE reports supported largest N value as a UE capability |
| OPPO | On 5.C: the description of “L1-RSRP offset by P-MPR” is not clear. Is it the value of P-MPR? Or is it the power reduction on Pcmax for that resource? From our understanding, it should be the value of P-MPR.  Question on Alt2: the CSI-RS resource or SSB does not have power control parameters (PL-RS, p0, alpha, closed loop index). Then how can the UE calculate the PHR for a CSI-RS or SSB? Seem Alt2 does not work. Suggest to delete it.  On Alt3: With the condition “P-PMR less than a threshold”, the UE might find N CSI-RS resources or SSB that can meet this condition. That would contradict with the main bullet of “selection of N”. Suggest to delete the “with PMPR with less than a threshold”.  **Proposal 5.C**: On Rel.17 enhancements to facilitate MPE mitigation, for selection of N from a candidate SSB/CSI-RS resource pool:   * Down-select *by* RAN1#107-e between the two alternatives:   + Alt1. Based ~~on L1-RSRP offset by~~ the P-MPR value for each resource   + ~~Alt2. Based on calculated Virtual PHR for each resource~~     - ~~Virtual PHR is modified by considering actual P-MPR~~   + Alt3. Based on L1-RSRP for each resource among the resources ~~with PMPR less than a threshold~~   + Alt4. No spec impact (left to UE implementation) * The candidate resource pool is configured via RRC using CSI framework   [Mod: I cannot erase the alternatives proposed by other companies at this point. We can discuss how to clarify further or even reduce the number of alternatives] |
| ZTE | For 5.C, we may only need to discuss whether additional results (e.g., DL-RSRP and virtual PHR) can be reported. The selection rules are always up to UE implementation. Then, we support Alt2. |
| Spreadtrum | For proposal 5.B, as explained by Ericsson, ‘N is neither the number of beams nor panels: it’s the number of reported measurements’. However, with different understanding of N, the meaning of M will also be different. We wonder whether the P-MPR report is per beam or per panel will be decided, or it will be left for UE/gNB implementation.  [Mod: By default, P-MPR is associated with measurement RS (SSBRI/CRI). This can apply whether the UE is equipped with one panel or multiple panels] |
| LG | On Proposal 5.C: Support in principle and the clarification on the second bullet is needed as vivo mentioned. |
| Mod V15 | Revised proposal 5.C |
| MediaTek | Support both proposals |
| NTT Docomo | For OPPO’s comment on Alt.3 which is added by us, we can further clarify it as  Alt3. Based on L1-RSRP for each resource among the resources with P-MPR values less than a threshold. FFS: when less than N resources with P-MPR values less than a threshold. |
| Apple | For proposal 5.C: we thought it is related to reporting content, but the proposal seems to suggest this is for a selection rule. If that is the case, our suggestion is nothing is needed. Beam selection in beam report is UE’s freedom, no additional rule is needed. |
| vivo | Still have concerns over 5.A.   * Based on the discussion, we don’t believe M=1 works. It seems that the only assumption is the network would continusly use the fixed beam reported in the MACCE report. This is obviously not working. * During email discussion, it seems from Samsung’s understanding that the network may know MPE ending based on L1-RSRP report. The M=1 beam is used between the period of MPE starts and MPE ends. We don’t know how the network could know there is such event based on L1-RSRP report. * It is also admitted by some companies there are flaws with such design with the beam fixed until the next MPE report. This flaw can be easily fixed by allowing M>1. * There is the understanding that P-MPR would be the same for beams from the same panel. Allowing M>1 could also be flexible to save overhead for such cases. |
| Sony | Support both **Proposal 5.A** and **Proposal 5.C**. |
| Ericsson | Essentially support 5.A. Some of the FFSs can be removed:  **Proposal 5.A**: On Rel.17 enhancements to facilitate MPE mitigation, confirm the following working assumption (in the midst of the previous agreement) as an agreement with the following refinement (highlighted in red):  On Rel.17 enhancements to facilitate MPE mitigation, support the following enhancement on the Rel-16 event-triggered P-MPR-based reporting (included in the PHR report when a threshold is reached, reported via MAC-CE):   * In addition to the existing field in the PHR MAC-CE, N≥1 P-MPR values can be reported   + The N P-MPR values are reported together with the following:     - ~~(Working Assumption)~~ For each P-MPR value, up to M SSBRI(s)/CRI(s), where the SSBRI(s)/CRI(s) is selected by the UE from a candidate SSB/CSI-RS resource pool (FFS: how to perform the selection)       * Support M=1       * FFS: ~~The supported value(s) of M~~ Whether M>1 is needed, and if so, the supported value(s)   We note that M>1 becomes a little strange, since we would report multiple SSBRIs/CRIs per P-MPR.  Proposal 5.C: Essentially OK (we now have 5 alternatives, not 2). Comments:   * + “using the CSI framework” is unclear. Suggest removing.   Alt5 is unclear. |
| Huawei, HiSilicon | **Proposal 5.A:** Similar view as vivo.  **Proposal 5.C:** We have concern on this proposal. As RAN4 has been the leading WG on MPE mitigation in both R15 and R16, RAN1 should not change the metric in R17 without consulting RAN4. So we cannot agree with the proposal. |

### Issue 6 (advanced beam refinement/tracking)

Later round(s)