**3GPP TSG RAN WG1 #107-e R1-2112581**

**e-Meeting, November 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 | **Proposal 1.A.1**: On Rel-17 unified TCI framework, any SRS resource or resource set that is a valid target signal of a Rel-15/16 spatial relation based on the Rel-15/16 spatial relation rules (on source-target relations) can be configured as a target signal of a Rel-17 UL or, if applicable, joint TCI (hence the Rel-17 UL or, if applicable, joint TCI state pool).   * Note: This does not imply that DL and UL TCI state pools are separate or shared for separate DL/UL TCI (this issue is up to RAN2)   **FL Note**: Discussed offline [1] | **Support/fine**: Sony, Nokia/NSB, Ericsson, Samsung, MTK, Fraunhofer IIS/HHI, CMCC, Futurewei, Intel, vivo, NEC, AT&T, NTT Docomo, QC, CATT, Xiaomi, LG, TCL, Lenovo/MotM, Convida  **Concern**: OPPO, ZTE |
| 1.2 | **Proposal 1.A.2**: On Rel-17 unified TCI framework, for any SRS resource or resource set that does not share the same indicated Rel-17 TCI state(s) as dynamic-grant/configured-grant based PUSCH and all of dedicated PUCCH resources, but can be configured as a target signal of a Rel-17 UL or, if applicable, joint TCI (hence the Rel-17 UL or, if applicable, joint TCI state pool), Rel-17 mechanism(s) which reuse mechanisms similar to the Rel-15/16 spatial relation info update signaling/configuration design(s) are used to update/configure such SRS(s) with Rel-17 UL or, if applicable, joint TCI state(s).   * Applies for both intra-cell and inter-cell beam indication * Note: It is up to RAN2 to design MAC-CE signaling for the Rel-17 mechanism(s) which reuse mechanisms similar to the Rel-15/16 spatial relation info update signaling/configuration design(s) * [Note: All the Rel-17 UL or, if applicable, joint TCI states configured/activated to SRS resources in the same set can, by NW configuration, be associated with the same UL PC setting.] * [UE ignores the UL PC parameters associated with the UL or, if applicable, joint TCI state, and legacy power control parameters configuration signaling is reused]   **FL Note**: Discussed offline [1] | **Support/fine**: Sony, Nokia/NSB, Ericsson, Samsung, MTK, Fraunhofer IIS/HHI, CMCC, Futurewei, Intel, NEC, AT&T, NTT Docomo, QC, CATT, Xiaomi, Apple, LG, TCL, Lenovo/MotM, Convida  **Concern**: OPPO, ZTE |
| 1.3 | **Proposal 1.A.3**: The UE is not expected to be configured with Rel-15/Rel-16 TCI/SpatialRelationInfo if the UE is configured with Rel-17 TCI in any CC   * The above is at least applicable for UE that supports no less than N configured unified TCI States per CC, where N is 64 for FR2 and N is maximum number of configured SSBs for FR1   **FL Note**: Discussed offline [1] | **Support/fine**: Nokia/NSB, Ericsson, Samsung, Apple, MTK, Fraunhofer IIS/HHI, CMCC, Futurewei, Intel, vivo, NEC, AT&T, QC, CATT, Xiaomi, TCL, Lenovo/MotM, Convida, NTT Docomo  **Concern**: Sony, OPPO, |
| 1.4 | **Agreement**  On Rel-17 unified TCI framework, for intra-cell beam management, after X symbols from the UE receives the BFRR from NW, the UE assumes the same QCL parameter as the ones associated with the index qnew for all PDSCH/PDCCH receptions in a CC [or in a set of configured CCs with common TCI state ID activation and update], as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PDSCH/PDCCH reception.   * The above applies to Rel-15 SpCell BFR, [Rel-16 CBRA based SpCell BFR,] and Rel-16 SCell BFR * Note: qnew is a candidate beam identified by the UE in set q1. q1 is the set of candidate beams   Additional suggestions:   * (Apple) Add Note: q\_new only provides QCL-TypeD indication for CCs different from the failed CC * (Samsung) revise 1st text as “Or corresponding RS in a set of configured CCs with common TCI state ID activation and update”   **FL Note**: The bracketed texts are pending. If no consensus to remove the brackets, the text will be removed. | **1st bracketed text (CA):**   * **Remove brackets:** Apple (with a note added: q\_new only provides QCL-TypeD indication for CCs different from the failed CC), NTT Docomo, MTK, ZTE, Samsung (with update), Intel * **Remove text:**   **2nd bracketed text (CBRA):**   * **Remove brackets:** Apple NTT Docomo, Samsung, Intel * **Remove text:** * **Keep bracket and text:** ZTE(postpone it after R15/16 BFR is stable) |
| 1.5 | **Agreement**  On Rel-17 unified TCI framework, [at least when the UE is configured with joint DL/UL TCI], after X symbols from the UE receives the BFRR from NW, the UE uses the same UL spatial filter as the [one associated with the index qnew or the last PRACH transmission] for all PUSCH transmissions and all of PUCCH resources in a CC [or in a set of configured CCs with common TCI state ID activation and update], as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PUSCH and all of PUCCH resources.   * The above applies to Rel-15/16 SpCell BFR, [Rel-16 CBRA based SpCell BFR,] and Rel-16 SCell BFR * Note: qnew is a candidate beam identified by the UE in set q1. q1 is the set of candidate beams * FFS (RAN1#107-e): if the above also applies when the UE is configured with separate DL/UL TCI * FFS: UL PC control including qu, qd, and closed loop index   Additional suggestions:   * (Samsung) Revise 2nd text as “one associated with ~~the index q~~~~new~~ ~~or~~ the UL spatial domain filter of the last PRACH transmission associated with the index qnew”   **FL Note**: The bracketed texts are pending. If no consensus to remove the brackets, the text will be removed.   * 1st bracketed text is to be discussed with the FFS * 2nd bracketed text seems to depend on 1st bracketed text + 1st FFS | **3rd bracketed text (CA):**   * **Remove brackets:** Apple, NTT Docomo, MTK, ZTE, Samsung, Intel * **Remove text:**   **4th bracketed text (CBRA):**   * **Remove brackets:** Apple, NTT Docomo, Samsung * **Remove text:** * **Keep bracket and text:** ZTE(postpone it after R15/16 BFR is stable)   **Applicability (1st bracket + 1st FFS):**   * **Only joint DL/UL TCI:** MTK, Samsung * **Joint and separate DL/UL TCI:** Apple, NTT Docomo, ZTE, Intel   **2nd bracketed text (last PRACH):**   * **Remove brackets:** Apple, MTK, ZTE, Samsung (with update) * **Remove text:** NTT Docomo |
| 1.6 | **Proposal 1.E:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL channels/signals that share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), the following option on source RSs and QCL-Types is also supported:   * Option 3: CSI-RS for CSI is configured for QCL-TypeA and QCL-TypeD source RS   **FL Note**: It was explained that the so-called “circular” issue is avoided in practice via NW implementation, i.e. NW will not configure the same CSI-RS for CSI both as source and target RSs. | **Support/fine (23)**: Huawei/HiSi, Ericsson, CMCC, Samsung, Sony, Qualcomm, Fraunhofer IIS/HHI, Futurewei, MTK, NTT Docomo, AT&T, Lenovo/MotM, Intel, Xiaomi, CATT, TCL  **Concern**: Apple (object), OPPO, Nokia/NSB, ZTE |
| 1.7 | For Rel-17 unified TCI framework, on applying the indicated Rel-17 TCI state to PDCCH reception and the respective PDSCH reception, for intra-cell and inter-cell BM:   * Alt1: Per search space set determination   + For any PDCCH reception associated with a [Type2]/Type3 CSS and an USS set and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.   + For other PDCCH reception and the respective PDSCH reception, whether UE to apply the indicated Rel-17 TCI state can be configured per search space set by RRC * Alt2: Per CORESET determination   + For any PDCCH reception on a CORESET other than CORESET#0 that is associated with at least USS set(s) and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.   + For any PDCCH reception on a CORESET (including CORESET#0) that is not associated with any USS set and the respective PDSCH reception, whether or not UE to apply the indicated Rel-17 TCI state is determined per CORESET by RRC * Alt3: Per search space set determination   + For any PDCCH reception associated with a CSS set and the respective PDSCH reception, whether UE to apply the indicated Rel-17 TCI state can be configured per search space set by RRC * Alt4: Per MO determination   + During each MO, for any PDCCH reception on a CORESET that is associated with at least USS set(s) and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.   + During each MO, for any PDCCH reception on a CORESET that is not associated with any USS set and the respective PDSCH reception, whether UE to apply the indicated Rel-17 TCI state can be configured per CORESET by RRC   **FL Note**: IMO, this can (should) be left up to the editors (i.e. as long as the agreed function is properly implemented in the specs, it shouldn’t be an issue). But we can discuss and see if there is any additional insight. | **Alt1:** Apple  **Alt2:** Samsung, MTK, ZTE, NTT Docomo, TCL, Intel, Lenovo/MotM, vivo, Sony, NEC, [Ericsson]  **Alt3:** QC, NTT Docomo  **Alt4**: CATT |
| 1.8 | **Proposal 1.F**: After initial access or Reconfiguration with sync, and after a UE is configured with more than one Rel-17 TCI states,  before the UE receives and applies a first instance of beam indication   * For all PDSCH/PDCCH receptions in a CC [or in a set of configured CCs with common TCI state ID activation and update], as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PDSCH /PDCCH reception,  the QCL assumption for corresponding DM-RS/CSI-RS antenna port follows the Rel-15/16 rules for PDCCH DM-RS * For all PUSCH transmissions and all of PUCCH resources in a CC [or in a set of configured CCs with common TCI state ID activation and update], as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PUSCH and all of PUCCH resources, the UE transmits the UL signal/channel based on the Rel-15/16 rules for PUCCH   **FL Note**: A more concise version of proposal 1.F (from the previous version). After further thinking, we need “after initial access or reconf sync” since this behavior shouldn’t be used when a UE has a prior Rel-17 TCI state configuration. Also, the verbose description (which has caused debates during endorsement) is now streamlined. | **Suppor/fine:**  **Concern:** |

Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 1** 2. **Share more inputs here if needed**    1. **Proposal 1.A.1/2: proponents, please interact with the concern from OPPO (see x11715)**    2. **Proposal 1.A.3: proponents, please interact with the concern from OPPO/Sony (see x11715)**    3. **Proposal 1.E: proponents, please interact with concern from OPPO, Apple, Nokia (see x11715)**   **FL comment:**   * **The concerns on 1.A.1/2/3 should have been resolved with the added note in 1.A.2 (**Note: All the Rel-17 UL or, if applicable, joint TCI states configured/activated to SRS resources in the same set can, by NW configuration, be associated with the same UL PC setting.**)** * **Re Nokia’s concern on 1.E, there mihht be some misunderstanding from Nokia since Opt3 is actually supported in Rel-15/16 QCL rule as repeatedly pointed out by the proponents** |
| vivo | P**roposal 1.A.1, 1.A.3**, Support.  For proposal 1.A.2, the Rel-15/16 signaling may not be directly used since the spatial relation info is referring directly to CSI-RS ID, rather than a TCI state ID. The corresponding signaling design should be up to RAN2 including whether to reuse legacy MAC CE or design new MAC CE for this.  **Proposal 1.A.2**: On Rel-17 unified TCI framework, for any SRS resource or resource set that does not share the same indicated Rel-17 TCI state(s) as dynamic-grant/configured-grant based PUSCH and all of dedicated PUCCH resources, but can be configured as a target signal of a Rel-17 UL or, if applicable, joint TCI (hence the Rel-17 UL or, if applicable, joint TCI state pool), Rel-17 mechanism(s) which reuse mechanisms similar to the Rel-15/16 spatial relation info update signaling/configuration design(s) are used to update/configure such SRS(s) with Rel-17 UL or, if applicable, joint TCI state(s).   * Applies for both intra-cell and inter-cell beam indication * Note: It is up to RAN2 to design MAC CE signaling for the Rel-17 mechanism(s) which reuse mechanisms similar to the Rel-15/16 spatial relation info update signaling/configuration design(s) ~~can include the MAC CE defined in section 6.1.3.26 in 38.321~~   Note: All the Rel-17 UL or, if applicable, joint TCI states configured/activated to SRS resources in the same set can, by NW configuration, be associated with the same UL PC setting  **For 1.7**, to align the current spec for TCI state determination of a CORESET and the Rel-17 agreements, we suggest to have a conclusion or to add “UE does not expect these CORESETs to be associated with CSS.” to the first sub-bullet of Alt2 as mentioned in Round0.   * Alt2: Per CORESET determination   + For any PDCCH reception on a CORESET that is associated with at least USS set(s) and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.     - UE does not expect these CORESETs to be associated with CSS   + For any PDCCH reception on a CORESET that is not associated with any USS set and the respective PDSCH reception, whether UE to apply the indicated Rel-17 TCI state can be configured per CORESET by RRC |
| Apple | 1.A.2: We think it is important to keep per set level PC. Resource level PC may lead to symbol level Tx power change, which is challenging from UE implementation perspective.  **Proposal 1.A.2**: On Rel-17 unified TCI framework, for any SRS resource or resource set that does not share the same indicated Rel-17 TCI state(s) as dynamic-grant/configured-grant based PUSCH and all of dedicated PUCCH resources, but can be configured as a target signal of a Rel-17 UL or, if applicable, joint TCI (hence the Rel-17 UL or, if applicable, joint TCI state pool), Rel-17 mechanism(s) which reuse the Rel-15/16 spatial relation info update signaling/configuration design(s) are used to update/configure such SRS(s) with Rel-17 UL or, if applicable, joint TCI state(s).   * Applies for both intra-cell and inter-cell beam indication * Note: The Rel-17 mechanism(s) which reuse the Rel-15/16 spatial relation info update signaling/configuration design(s) can include the MAC CE defined in section 6.1.3.26 in 38.321 * UE ignores the power control parameters associated with the UL or, if applicable, joint TCI state, and legacy power control parameters configuration signaling is reused * ~~Note: All the Rel-17 UL or, if applicable, joint TCI states configured/activated to SRS resources in the same set can, by NW configuration, be associated with the same UL PC setting.~~   1.4 and 1.5, our view was provided above. |
| Mod V04 | **Revised per inputs.**  **Also revised 1.A.3 per offline input from NTT Docomo, Apple, and MTK** |
| NTT Docomo | Proposal 1.A.1: Support.  Proposal 1.A.2: Support.  Proposal 1.A.3: Support.  If any company remove the sub-bullet, we will have concern to remove "in a band". The reason of our concern comes from the mandatory supported value/number of UE capability in Rel.17 TCI state. In Rel.15 TCI state, there was mandatory supported value/number of UE capability. For example, in Rel.15, mandatory value of RRC-configured TCI state for PDSCH is 64 in FR2 and “the max number of SSBs in the band (= max. 8)” in FR1. We are not sure whether Rel.17 TCI state can also support at least the same mandatory values in both FR1 and FR2. If not (e.g. Rel.17 TCI state can support 64 in FR2, but smaller value than Rel.15 in FR1), we will need to use Rel.15/16 TCI state for FR1 while we will use Rel.17 TCI state for FR2. If we remove “[in a band]” in Proposal 1.A.3, we suggest to clarify that “If UE supports Rel.17 TCI state, UE shall at least support UE capability for Rel.17 TCI state with the same value/number as what was supported in mandatory in Rel.15 TCI state”.  Issue1.4: We support to remove the 1st bracket (CA). In Rel.17, CC-common TCI pool is supported. If we only update QCL assumption of a CC, the beam miss alignment happens between CCs. We already have mechanism to derive QCL type A/D RS on other BWP/CC, we can reuse it.  We support to remove the 2nd bracket (CBRA-BFR). It is supported in Rel.16, and we should not preclude it.  Issue1.5: For the applicability (1st bracket + 1st FFS), we believe both joint TCI and separate TCI should be included.  For 2nd bracketed text (last PRACH), we don’t think the text for PRACH is needed. At least, for joint TCI, DL/UL TCI state is applied to both DL and UL. So, q\_new should be DL RS. For separate UL only TCI state, q\_new can be PRACH beam as in the existing spec. However, as Qualcomm mention it in online, we assume PRACH beam is the same as SSB beam, in most probable UE implementation, so we think it is fine to remove the text.  Proposal 1.E: Support.  Issue 1.7: We think the main issue is for a CORESET that associated with both CSS and USS.  For the second bullet of Alt1, for a CORESET associated with USS only, we think applying the indicated Rel-17 TCI state is sufficient.  For the first bullet of Alt2, if such a CORESET is associated with USS and CSS, we think it is not proper to apply always the indicated Rel-17 TCI state for inter-cell scenario.  We don’t prefer Alt.4.  Between the Alt.1-4, Alt3 looks more reasonable to us. |
| MediaTek | On 1.4, we prefer to remove the 1st brackets to make sure common beam update according to the new beam across CCs can be achieved. Note that for a set of CCs configured with common TCI activation and update, only one serving beam is used across the CCs at a time. If UE detects beam failure on the serving beam in any of these CCs, we don't see this serving still can work on other CCs. Thus, it is reasonable to update the new beam for CCs with common beam update.  On 1.5, for CA part, the same view as in Issue 1.4.  For the 2nd bracketed text (last PRACH), we are fine to remove the brackets since the last PRACH transmission is used in Rel-15/16 SpCell BFR. It may be better to clarify the difference between Rel-15/16 SpCell BFR and Rel-16 Scell BFR in the proposal.  **Agreement**  On Rel-17 unified TCI framework, [at least when the UE is configured with joint DL/UL TCI], after X symbols from the UE receives the BFRR from NW, the UE uses the same UL spatial filter as the one associated with the index qnew (for Rel-16 SCell BFR) or the last PRACH transmission (for Rel-15/16 SpCell BFR) for all PUSCH transmissions and all of PUCCH resources in a CC or in a set of configured CCs with common TCI state ID activation and update, as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PUSCH and all of PUCCH resources.  For the applicability (1st bracket + 1st FFS), we prefer to apply this only for joint TCI mode. Note that for separate TCI mode, DL and UL serving beam can be different, but BFD only performed based on DL serving beam but not UL serving beam. Thus, when beam failure happens, UL serving doesn't have to be updated accordingly.  On 1.7, we can decide which alternatives first, then the details.  Re commend from vivo, according to your proposal, for Rel-17 unified TCI, if a CORESET is associated with any USS set, it is not allowed to associate any CCS set with it? It is a quite big restriction and we don't see why we need put such configuration restriction. Current wording in Alt2 does not violate the RAN1 agreement – for non-UE-dedicated PDCCH/PDSCH, whether it share the indicated Rel-17 TCI state is configured by RRC. If NW still can configure a CORESET associated with only CSS set(s), and configured it NOT to share the indicated Rel-17 TCI state. |
| ZTE | Regarding 1.A.3, we think that the proposal should be refined for ‘pool’ only.  **Proposal 1.A.3**: The UE is not expected to be configured with Rel-15/Rel-16 TCI/SpatialRelationInfo pool if the UE is configured with Rel-17 TCI in any CC  [Mod: I checked, there is no pool for this. Or perhaps I am wrong?]  Regarding 1.4, 1.5, we provide our views in the above table. In general, we prefer to handle Rel-15/Rel-16 PCell/SCell BFR firstly, and then we can review the CBRA PCell-BFR. In our initial thoughts, it may be handled by Proposal 1.F together.  Regarding 1.6, not support.  Regarding 1.7, Alt2, and the following part may NOT be needed, after reviewing the whole bullets.   * + - [UE does not expect these CORESETs to be associated with CSS] |
| Samsung | **Proposal 1.A.1**: Support  **Proposal 1.A.2**: Support  **Proposal 1.A.3**: Support  **Issue 1.4**: First bracket, as the TCI state ID is common across the configured CCs it would seem that the beam should be applied across CCs. However, the RS corresponding to the new in different CCs could be different. Therefore, we suggest to remove the bracket with the following update:  Or corresponding RS in a set of configured CCs with common TCI state ID activation and update  Second bracket is fine to remove. This could apply to CBRA BFR  **Issue 1.5**: 1st bracket: As beam failure detection is done on the DL RS, for UL the new beam only applies in case of joint TCI state. In case of separate TCI state, failure of DL beam doesn’t imply failure of UL beam.  For the second bracket, for UL, beam should follow the UL spatial filter of last PRACH transmission associated with the index q\_new. This is also aligned with Rel-15/16 design. Therefore, suggest to remove bracket and update as follows: “~~[~~one associated with ~~the index q~~~~new~~ ~~or~~ the UL spatial domain filter of the last PRACH transmission associated with the index qnew~~]~~”  Third bracket as the TCI state ID is common across the configured CCs it would seem that the beam should be applied across CCs based on the spatial filter of the last PRACH.  Fourth bracket is fine to remove. This could apply to CBRA BFR  **Proposal 1.E**: Support  **Issue 1.7**: Support Alt2 with sub-bullet. |
| CMCC | Issue 1.7: We have one question for Alt3.  For Alt3, whether UE to apply the indicated Rel-17 TCI state can be configured per search space set. If two search space sets associated to the same CORESET, one search space set is configured as to apply the indicated Rel-17 TCI, the other is configured as not to apply, how should UE assume the TCI state of the CORESET? |
| Samsung | After some offline discussion, we suggest the following update for Alt2 of issue 1.7:   * Alt2: Per CORESET determination   + For any PDCCH reception on a CORESET other than CORESET#0 that is associated with at least USS set(s) and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.     - ~~[UE does not expect these CORESETs to be associated with CSS]~~   + For any PDCCH reception on CORESET#0 or a CORESET other than CORESET#0 that is not associated with any USS set and the respective PDSCH reception, whether or not UE to apply the indicated Rel-17 TCI state is determined ~~can be configured~~ per CORESET by RRC configuration   CORESET#0 has special handling as it doesn’t have a PDCCH-TCI-list. |
| MediaTek | On Issue 1.7, we are supportive of Samsung’s suggestion. It is proper to preclude CORESET#0 from the list that always shares the indicated Rel-17 TCI state. In one example, for inter-cell BM, NW will not (cannot) configure CORESET#0 to share the indicated Rel-17 TCI state. |
| Intel | Views updated in the table  **Proposal 1.A.3:** We don’t see why the sub-bullet should be added. The comment from Docomo is not very clear for us. We may understand including “in a band” with some assumption that the beam is same for a given band, but using the restriction on the supported number of configured TCI states is not clear. Additionally, it may be up to network configuration to even support different frameworks in different CCs within a band. Note that restriction of Rel-17 TCI within a band also means that in bands configured with Rel-17 TCI, mTRP will not work.  **Issue 1.7:** Support Alt-2. Ok with Samsung’s update. |
| NTT Docomo2 | Proposal 1.A.3: Re Intel’s comment. The sub-bullet is added just in case Rel.17 TCI state supports less number of RRC-configured TCI state than Rel.15 TCI state in UE feature (which we don’t hope). With the sub-bullet, if Rel.17 TCI state supports less number of RRC-configured TCI state than Rel.15 TCI state, proposal 1.A.3 is not applied.  But, on the other hand, we agree with Intel’s concern. In Rel.17, many features except 8.1.1 are enhanced based on Rel.15/16 TCI state/spatial-relation (e.g. M-TRP, Coverage enh., etc.).  Based on Proposal 1.A.3, if unified TCI state is configured in any of CC, these features cannot be configured. In other word, if NW configures any of these features in any of CC, NW cannot configure Rel. 17 TCI state. We think this is too restrictive, and we need to consider this issue more. Otherwise, the applicability of unified TCI state becomes too limited. We’d like to postpone the decision of Proposal 1.A.3, because we think Proposal 1.A.3 is not urgent but it makes big limitation. |
| Mod V15 | **Updated Alt2 description per input from Samsung and MediaTek which also addresses the issue when a CORESET is associated with CS and a USS (which should not be ruled out as proposed by vivo).**  **Also added proposal 1.H back with revision.** |
| OPPO | For Proposal 1.A.1, 1.A.2 and 1.A.3: we do not support. For the SRS not following the rel-17 DCI-indicated TCI states, the legacy mechanism of rel15/16 shall be applied. The proposal in 1.A.1/2/3 just introduce a 100% redundant function but introduce significant unnecessary specification effort. For instance, all the SRS related MAC CEs have to be re-designed because the current MAC CEs can not be re-used. And there is no benefit of reducing the pool because in rel15/16, there is no pool of spatial relation info for SRS. We would like to ask the company who proposed this proposal: please provide any technical justification for why we need introduce this 100% redundant function.  On 1.4: we prefer to remove the text in the first bracket. We are not supposed to change the design of BFR. The BFR is applied on each individual CC, not a set of CCs. The whole BFR operation is per CC: the beam failure detection is done per CC, and new beam is found per CC. The how can we switch the beam of non-related CC.  Re the text in second bracket: we are ok to remove the bracket.  On 1.5:   * 1st bracket: remove the text. This should not be limited to joint TCI only. * 2nd bracket: keep the text * 3rd bracket: remove the text. The BFR is only applied to each CC, not a set of CCs. Same reason as in 1.4 * 4th bracket: keep the text. CBRA shall be supported here.   On proposal 1.E: do not support. This has been discussed a few meetings. The issues of this proposal have been explained very well.  1.7: we support Alt2. That is aligned with the TCI state framework on PDCCH. |

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

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | **Proposal 2.C.2**: On Rel-17 enhancements for PCell and SCell BFR in inter-cell beam management, support to configure an SSB associated with a PCI different from the PCI of the serving cell for candidate beam detection [and BFD-RS].  **FL Note**: This proposal facilitates the support of “inter-cell BFR” | **Proposal 2.C.2:**   * **Support/fine**: Samsung, Intel, NEC, NTT Docomo, Futurewei, QC, CATT, Apple, [Nokia/NSB] * **Concern:** MTK, Ericsson, vivo, Sony, CMCC, ZTE (Rel-18), |
| 2.2 | **Agreement**  On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, a CSI-SSB-ResourceSet configured for L1-RSRP measurement/reporting includes at least a set of SSB indices where PCI indices are associated with the set of SSB indices, respectively. The PCI indices refer to PCIs within the set of PCIs configured for inter-cell beam management or inter-cell multi-TRP.   * The additionalInfo associated with SSB(s) with PCI(s) different from the serving cell agreed in RAN1 Agenda Item 8.1.2.2 is also applicable to inter-cell BM * Detailed signaling design is up to RAN2 * FFS (to be concluded in RAN1#107-e): Whether the above L1-RSRP measurement/reporting also includes group-based beam report for inter-cell mTRP   **FL Note:** On the red FFS text   * ‘Yes’ implies that group-based beam reporting is supported in the agreed L1-RSRP reporting for Rel-17 inter-cell mTRP * ‘No’ implies that group-based beam reporting is not supported in the agreed L1-RSRP reporting for Rel-17 inter-cell mTRP | **Views on red FFS text:**   * **Yes:** Apple, NEC, ZTE, CMCC * **No:** MTK, Samsung, NTT Docomo, |
| 2.3 | **Proposed conclusion 2.D**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, the UE behavior when there is overlap for L1-RSRP measurement for SSB associated with serving cell PCI and PCIs different from the serving cell PCI, there is no consensus on additional RAN1 specification impact  **FL Note: This is the current situation.** Need conclusion due to FFS:UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability  On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, the UE behavior when there is overlap for L1-RSRP measurement for SSB associated with serving cell PCI and PCIs different from the serving cell PCI:   * Alt-1: limit L1-RSRP based inter-cell measurement within SMTC window * Alt-2: define a higher layer configured measurement pattern to measure the SSB of each measurement cell in turn * Alt-3: UE expects the active resources for UE to measure L1-RSRP are always non-overlapping based on CSI report/resource configurations * Alt4: No RAN1 specification impact is needed   **Alt1:**  **Alt2:** Apple  **Alt3:** Sony  **Alt4:** Samsung, Intel, CATT, CMCC, NTT Docomo, ZTE | **Support/fine:** Samsung, Intel, CATT, CMCC, NTT Docomo, ZTE  **Concern:** |

Table 4 Additional inputs: issue 2

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| **Company** | **Input** | |
| Mod V0 | 1. **Check and update your view in Table 3** 2. **Share more inputs here if needed** | |
| vivo | @Samsung, Intel, CATT, CMCC,  There is the following UE measurement behaviour defined in RAN1 specification. If there is SSB overlap, how would UE perform the corresponding measurement? Is UE required to measure the most recent overlapped SSBs simultaneously?  “If the higher layer parameter timeRestrictionForChannelMeasurements in CSI-ReportConfig is set to "Configured", the UE shall derive the channel measurements for computing L1-RSRP reported in uplink slot n based on only the most recent, no later than the CSI reference resource, occasion of SS/PBCH or NZP CSI-RS (defined in [4, TS 38.211]) associated with the CSI resource setting.” | |
| Apple | Our view is provided | |
| Mod V04 | **No revision.**  **For issue 2.3, proponents of Alt4, please address vivo’s questions as a technical courtesy** | |
| NTT Docomo | Proposal 2.C.2: Support.  Issue 2.2: We think it is beneficial from technical perspective. However, some additional spec. impact is needed to support group-based beam reporting in inter-cell.  Issue 2.3: Support Alt.4. We have concern on Alt.3. Usually, SSB time-domain position of different cell is overlapped. So, Alt.3 makes impossible to measure L1-RSRP on non-serving cell SSB in most of cases. | |
| MediaTek | On the red FFS text in Issue 2.2, RAN1 never discusses about this and has no agreement on this. We need another agreement to confirm this new feature, and other details need to be provided in that agreement, instead of just one sub-bullet under this agreement to conclude this new feature. On the other hand, we don't think proper to do this at this final stage. | |
| ZTE | For 2.1, we share the same views with DOCOMO. But, if time is limited, we are fine to consider it together with UE-initialized L1-mobility in Rel-18.  For 2.2, if not supporting group based reporting, how to identify two different TCI states for simultaneous reception. It is a basic feature for inter-cell mTRP.  For 2.3, it is RAN4 issue, and we can wait for RAN4 inputs, if any. Regarding timeRestrictionForChannelMeasurements, it is by default that the most recent ‘available’ measurement is used. We experience the similar situation for CSI measurement while the corresponding CSI-RS for CSI is not measured, e.g., within scheduling restriction window specified by RAN4, if my memory is correct. | |
| Samsung | **Proposal 2.C.2**: Support  **Issue 2.2**: Benefit of red FFS not clear. Besides, detailed group based beam reporting format for MTRP including differential RSRP reporting format, SSBRI/CRI ordering in a group, assumptions of simultaneous reception and etc. has been discussed in 8.1.2.3, and are different from the inter-cell beam reporting here. Therefore, we suggest to remove.  **Issue 2.3**: No RAN1 spec impact. RAN4 to investigate first. | |
| CMCC | For 2.1： we think to support “inter-cell BFR”, besides the candidate beam RS, enhancement of BFD-RS, beam update after BFRR should also be discussed. We don't think it is proper to discuss this new issue at this final stage.  For 2.2: Support.  For 2.3: We think it is RAN4 issue. | |
| Nokia/NSB | **Proposal 2.C.2**: needs agreement on BFD-RS with different PCI as well. | |
| Intel | **Issue 2.3:** We think this is purely a RAN4 issue. For the restriction mentioned by vivo, if that is a problem (which is not clear), we can assume that it is applicable for intra-cell case and leave inter-cell case to RAN4. | |
| Mod V16 | **Added proposal 2.D for issue 2.3** | |
| OPPO | 2.C.2: We are fine with SCell, but have concern on PCell. The BFR of PCell is based on CFRA where new beam RS is associated with RACH. How/whether to associate NSC SSB with RACH need more study. So we are only fine with SCell now.  2.2: group-based beam reporting is not useful for inter-cell beam management but would be useful for inter-cell mTRP. So we are fine with the FFS part.  2.D: suggest to include it as UE optional capability | |
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### Issue 3 (signaling medium)

Table 5 Summary: issue 3

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| **#** | **Issue** | **Companies’ views** |
| 3.1 | Agreement  On Rel-17 DCI-based beam indication, regarding application time of the beam indication, the UE is configured with at least one beam application time (BAT) [per BWP per CC]   * Note: It was agreed that the BAT associated with the carrier(s) (hence BWP(s)/CC(s)) on which the beam indication applies is determined on the carrier with the smallest SCS among the carrier(s) (hence BWP(s)/CC(s)) applying the beam indication * TBD (RAN1#107-e): whether a second configured BAT is also supported, e.g. for MPUE or inter-cell BM, [per BWP per CC] * TBD (RAN1#107-e): Whether or not the UE may assume that BWPs configured with same SCS [in a same CC group] share a same value of BAT | One BAT per BWP per CC, no constraint:   * **Support/fine**: * **Concern**:   One BAT per BWP per CC, BWPs with same CSC (in a same CC group) share a same BAT (yellow):   * **Support/fine**: * **Concern**: |

Table 6 Additional inputs: issue 3

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 5** 2. **Share more inputs here if needed** |
| OPPO | The beam application time (Y symbols) is only a function of SCS. So it is ok to configure the value of Y per CC group, instead of per BWP per CC.  If Y is configured per BWP per CC, then we have to make sure the Y values of different BWP/CC with same SCS to be same. Otherwise, the UE procedure to determine TCI state application time would be problematic. Configuring Y per BWP/per CC only increase the overhead, which is generally not desired. |
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### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** |
| 4.1 | **Proposal 4.A**:  On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,   * Support the UE reporting a list of UE capability value sets   + Each UE capability value set comprises [at least] the max supported number of SRS ports   + [ ~~entries~~For any two different value sets, at least one capability value needs to be different]   + FFS (RAN1#107-e): which type(s) of UE capability other than the max supported number of SRS ports is included in a UE capability value set and whether the UE capability value set can be common across all BWPs/CCs in same band or BC * The correspondence between each reported CSI-RS and/or SSB resource index and one of the UE capability value sets in the reported list is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance.   + The Rel-15/16 beam reporting is reused, i.e. the index of corresponding UE capability value set is reported along with the pair of SSBRI/CRI and L1-RSRP/SINR (up to 4 pairs, with 7-bit absolute and 4-bit differential) in the beam reporting UCI   + [The UE shall assume that the correspondence report is activated from the time instance of the reporting]   + FFS (RAN1#107-e): Whether ACK mechanism from NW to UE is needed and, if so, the scheme   + FFS (RAN1#107e): The supported time-domain behavior(s) * [Support SRS resource set with usage ‘codebook’ with different number of SRS ports for different SRS resources]   **FL Note:** First see if we can resolve the 3 initial issues. If not, there is no point to discuss the FFSs since there is not enough consensus to proceed with this feature | **1st bracketed text (repeated values):**   * **Remove brackets:** ZTE, Intel, NTT Docomo, Samsung, Ericsson * **Remove text:** Apple, NEC, CMCC, Samsung   **2nd bracketed text (the need for application time for ‘correspondence’):**   * **Remove brackets:** NTT Docomo, ZTE (should be replaced by ‘from the time instance of ACK’), Samsung, Intel (agree with ZTE) * **Remove text:** LG, NEC, MTK * **No use case for 2nd bullet if the 3rd bullet in agreement of 106 meeting is not included:** OPPO   **3rd bracketed text (SRS resource set characteristic):**   * **Remove brackets:** LG (w/ revision), NTT Docomo, Samsung * **Remove text:** Apple, ZTE, Intel * **Replace the current wording with the wording in agreement of 106 meeting:** OPPO |

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 more inputs here if needed** |
| LG | Our views are provided in the table.  1st: This depends on whether to support additional UE capability value. We prefer to include the max number of SRS resources in the set for BM SRS and NCB/CB PUSCH. In this case, identical entries seem inevitable, e.g. for 3 panel, (2-port, 2 resources) + (2-port, 4 resources) + (4-port, 4 resources). So we may leave the text in square-brackets until UE capa value(s) are fixed or revise the wording to ‘~~No two value sets can have identical entries~~For any two different value sets, at least one capability value needs to be different.’ to leave the possibility for using multiple UE capa values in a set.  2nd: To our understanding, UE simply reports the best panel according to current panel activation status and it does not matter whether NW received the beam report or not. If NW didn’t receive it, NW would trigger beam/panel report again. In this regard, we think that defining timeline for NW assumption and ACK seem not critical part, which could also be discussed in CR phase.  3rd: If we don’t have this bullet, there is no fast panel selection at all since the first/second bullet is just additional information to NW and how to support fast panel selection is missed. From our perspective, signaling detail such as per-SRS-resource vs per-SRS-resource-set does not really matter as long as different PC is allowed for each panel. It is not reasonable to bring up a new alt such as BWP switching based solution at this last meeting. Please note that that approach has not been our agreed alternative and we don’t have time to figure out whether/how it works for panel switching within this last meeting. Regarding some concerns, we provided technical answers to Intel/Apple/Oppo in previous round, core parts are summarized below again:  **1. Concern that it is not realistic to assume multiple panels are activated at the same time**   * It has been Rel-15/16 assumption that multiple panels can be activated at the same time. Without such assumption, how we support Rel-16 mTRP DL with multi-beam simultaneous reception in FR2? * In the RAN4 LS(R1-2104169), it is stated ‘Thus far at least until Rel-16, RAN4 requirements have been established in a panel agnostic way, i.e. transparent to network so that beam switching requirements defined in Rel-15 are applicable for both the same panel and cross panel beam switch cases in RAN4’. Thus, it is obvious that RAN4 assume that multiple panels can be activated.   **2. Concern that this mandates UE to activate multiple panels and NW-initiated panel activation/selection.**   * To our understanding, the second bullet can address this concern. If UE activates only one panel, UE can report same UE capa value set ID across all CRI/SSBRI. According to this information, NW will not indicate SRI for inactive panel(s). If we need some guarantee, we can add a sub-bullet, e.g., ‘UE expects that the indicated SRI corresponds to at least one of the UE capability value set index(es), included in the most recent beam reporting.’   **3. Concern that switching DL capability would also be needed together**   * This enhancement is for UL only by WID and it is typical that DL max rank and UL max rank are different, which means that max DL rank can be same when panel is switched (e.g. from 2T4R panel to 4T4R panel). We may consider DL enhancement in later releases, if needed. |
| Apple | We provided our view for some brackets.  For the second bracket, hopefully there can be some clarification. We do not quite understand the intention.  For the third bracket, there seems to be no time to finish that.  Besides, we think the ACK for the beam report is important, or we need to consider this is another type of report instead of a beam report.  @LG, we double checked with our RAN4 team, the highlight sentence means current beam switching requirement does not consider cross panel beam switching, as panel is transparent. The key words are “panel agnostic way”. |
| Mod V04 | **Revised 1st bracketed text per LG’s comment. Removed 2nd bracketed text (I tend to agree with LG)** |
| s | **1st bracketed text (repeated values):** we don’t have strong view on this one. Slightly prefer to remove brackets, the reason is with report of two panels with different capability, NW can configure UL Tx corresponding to the panel-specific capability. While although UE may have two panels with identical entries, it seems less useful to report two identical entries. But we can also accept the other way (remove text), if it helps to make progress.  **2nd bracketed text (the need for application time for ‘correspondence’):** prefer to remove bracket. We think it is reasonable that the correspondence is active when reporting. Although we understand companies views about ACK from NW, we think we may not have enough time for it.  **3rd bracketed text (SRS resource set characteristic):** prefer to remove bracket. We think it is reasonable to support SRS resources with different number of ports to facilitate panel switching. By the way, we also support the original proposal (support multiple SRS resource sets…) |
| ZTE | 1st bracket text: We share the same views with LG, and the identical entries occur as usual.  2nd bracket text: We support in principle. But, it should be based on ‘gNB acknowledge message’, right?  3rd bracket text: We suggest to remove it, and to reuse the legacy description as Samsung mentioned above. |
| Samsung | Re the 1st bracket, we are fine either way for progress. The 2nd and the 3rd text within brackets should be kept. |
| CMCC | As we commented in the GTW, we have agreed that the UL Tx panel(s) can be a same set or subset of DL Rx panel(s).  **Agreement (@RAN1#103)**  In Rel-17 enhancement on MP-UE to facilitate fast UL panel selection and MPE mitigation, UL Tx panel(s) are assumed to be a same set or subset of DL Rx panel(s)  To our understanding, the reported index of UE capability value sets in the beam reporting instance means the CSI-RS/SSB is measured by the corresponding panel. If the UL Tx panel(s) is the subset of DL Rx panels, how can UE inform the UL Tx panels to NW? |
| Intel | Added our views in the table.  For the third bullet, we think it should be removed. As we commented before, current BWP framework can be used to make this feature work. Since, previously, we had agreed to modifications, we do not think we are bound by that agreement to only support the options listed. We have brought up BWP based switching in RAN1-106bis-e and not in this last meeting and we think at this late stage, this is the best way forward.  With respect to specific technical concerns, we have some follow-up to respective companies:  @LG: Thanks for the further discussion, but our understanding of RAN4’s discussion is that they consider “panel-agnostic” switching which does not mean that there is no delay for switching between the multiple active panels. In our comments, we did not imply that we ONLY support single active panel. We simply think that current BWP framework can achieve the same goal. In terms of so-called FAST panel switching, it is ultimately up to RAN4 to define the switching delay. For example, there might be similar delay as BWP switching for switching between different active panels. It may depend on whether baseband hardware is shared, and reconfiguration is required for the panel switching. In our understanding, using BWP switching framework is a more future-proof solution in that it can support both DL and UL with MIMO layer adaptation for panel switching. For us it’s not clear why only SRI based solution needs to be used.  Additionally, for the ACK, as we explained before, it is necessary since we are talking about asymmetric panels and if the gNB misses the UCI and the same TCI state is active (i.e., new UE panel faces the same direction as old panel) then PUSCH may not be received since the MIMO layer adaption will not work especially if UE is switching from say a 4Tx panel to a 2Tx panel. |
| Mod V16 | **For the 3 main issues (before even trying to address the three FFSs) companies’ views are too divergent** |
| OPPO | The current proposal has critical issues:  On the 3rd bullet: the scheme of UE-initiated panel selection does not work with the current 3rd bullet where only one SRS resource set is configured or with the 3rd bullet being removed.   * If the 3rd bullet is removed: how can the “UE-initiated panel selection” is supported? If it is by UE implementation, then the 2nd bullet of beam reporting shall be removed too since the mapping between CRI/SSBRI and UE panel is UE implementation, it is needed to report such mapping to the gNB. With 3rd bullet being removed, how does the gNB apply the reported information. * If the 3rd bullet is kept with the current wording of just one SRS resource set: the “UE-initiated panel selection” is still not supported by the spec, i.e., it is just supported by UE implementation. The SRS resource set with different SRS resources with different ports is supported in rel16 already. * We suggest to go back to the 3rd bullet in original agreement made in August meeting and clarify that the UE indicates on SRS resource set to the gNB that is used for PUSCH transmission.   On the 2nd bullet: if “multiple SRS resource set**s**” are not supported, then the beam reporting in 2nd bullet does not make any sense. The UE-initiated panel selection can be conducted totally by UE implementation, then why does the UE reports the mapping between CRI/SSBRI and the panel to the system? There is no use case for such reporting. Furthermore, 2nd bullet make a wrong assumption that all the UE panels are activated at the same time, which we shall not assume.  So far, we are only ok with the 1st bullet in the current proposal.  The agreement made in 106 meeting (08/2011) is copied here:  **Agreement**  On Rel.17 enhancements to facilitate UE -initiated panel activation and selection, down select **or modify**from the following two schemes in RAN1#106bis-e:   * Scheme 1:   + A panel entity corresponds to a reported CSI-RS and/or SSB resource index in a beam reporting instance (i.e. Opt1-1 per RAN1#104-bis-e agreement)     - The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index is informed to NW       * FFS : Detailed design of how to inform the correspondence to NW     - Note: the correspondence between a CSI-RS and/or SSB resource index and a panel entity is determined by the UE (analogous to Rel-15/16)   + Support UE reporting of maximum number of SRS ports and coherence type for each panel entity as a UE capability   + Support multiple c odebook -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, where the SRS resource set should be aligned with the UE capability for the panel entity * Scheme 2:   + Support UE reporting one of the following (to be down selected in RAN1#106bis-e):     - Opt1. A list of supported UL ranks (number of UL transmission layers)     - Opt2. A list of supported number of SRS antenna ports     - Opt3. A list of coherence types (as in Rel-15) indicating a subset of ports   + The NW configures an association between an ~~rank~~ index and rank/number of SRS antenna ports/coherence type   + Include at least one of the index, the maximum UL rank or SRS antenna ports or coherence type corresponding to a reported SSBRI/CRI in a beam reporting instance     - FFS : timeline to apply above result in the beam report instance   + Support multiple codebook-based SRS resource sets with different number of SRS antenna ports     - The indicated SRI is based on the SRS resources corresponding to one SRS resource set, where the SRS resource set should be aligned with the UE reported info corresponding to the index |
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# References

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| 1 | R1-2111716 | Summary of offline discussion on unified TCI, inter-cell beam management, and MPUE | Moderator (Samsung) |