**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 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 * 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.   **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 [in a band]  **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  **Concern**: Sony, OPPO, [NTT Docomo] |
| 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   **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:** * **Remove text:**   **2nd bracketed text (CBRA):**   * **Remove brackets:** * **Remove text:** |
| 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   **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:** * **Remove text:**   **4th bracketed text (CBRA):**   * **Remove brackets:** * **Remove text:**   **Applicability (1st bracket + 1st FFS):**   * **Only joint DL/UL TCI:** * **Joint and separate DL/UL TCI:**   **2nd bracketed text (last PRACH):**   * **Remove brackets:** * **Remove text:** |
| 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, ZTE, 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 |
| 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 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 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 * 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  **Alt3:** QC  **Alt4**: CATT |

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 |
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### 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.  **FL Note**: This proposal facilitates the support of “inter-cell BFR” | **Proposal 2.C.2:**   * **Support/fine**: Samsung, Intel, NEC, NTT Docomo, ZTE, Futurewei, QC, CATT * **Concern:** MTK, Ericsson, vivo, Sony, CMCC |
| 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:** * **No:** |
| 2.3 | 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   **FL Note:** Need conclusion due to FFS:UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability | **Alt1:**  **Alt2:**  **Alt3:** Sony  **Alt4:** Samsung, Intel, CATT, CMCC |

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.” | |
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### Issue 3 (signaling medium)

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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   + [No two value sets can have identical entries]   + 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 | **1st bracketed text (repeated values):**   * **Remove brackets:** * **Remove text:**   **2nd bracketed text (the need for application time for ‘correspondence’):**   * **Remove brackets:** * **Remove text: LG**   **3rd bracketed text (SRS resource set characteristic):**   * **Remove brackets: LG(w/ revision)** * **Remove text:** |

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. |
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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) |