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

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

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

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

**Document for:** Discussion and Decision

## Introduction

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

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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**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, when a UE is configured with separate DL/UL TCI, the largest number of configured TCI states for DL TCI state update is 128 per BWP per CC, and the largest number of configured TCI states for UL TCI state update is 64 per BWP per CC   * Note: This doesn’t imply that UL TCI shares the same TCI state pool as or uses a different TCI state pool from joint DL/UL TCI   **FL Note**: This is the situation from the previous rounds  **Alt1**. The largest number of configured TCI states for DL TCI state update is 128 per BWP per CC, and the largest number of configured TCI states for UL TCI state update is 64 per BWP per CC   * **Support (16)**: NTT Docomo, Apple, Samsung, ZTE, Nokia/NSB (128 UL), Futurewei, LG (128 UL), Xiaomi, Fraunhofer IIS/HHI, Sony, Huawei, HiSilicon, Spreadtrum, MTK   **Alt2**. The total largest number of configured TCI states for DL TCI and UL TCI state update is 128 per BWP per CC   * **Support (8)**: NTT Docomo, Ericsson, Intel, Qualcomm, OPPO, vivo, Futurewei, Convida | **Support/fine**: NTT Docomo, Apple, Samsung, ZTE, [Nokia/NSB], Futurewei, [LG], Xiaomi, Fraunhofer IIS/HHI, Sony, Huawei, HiSilicon, Spreadtrum, MTK  **Concern**: |
| 1.2 | **Proposal 1.B.1:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL channels/signals that share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), the following option on source RSs and QCL-Types is also supported:   * Option 3: CSI-RS for CSI is configured for QCL-TypeA and QCL-TypeD source RS   **FL Note**: It was explained that the so-called “circular” issue is avoided in practice via NW implementation, i.e. NW will not configure the same CSI-RS for CSI both as source and target RSs. | **Support/fine (21)**: Convida, Huawei/HiSi, Ericsson, ZTE, CMCC, Samsung, Sony, Nokia/NSB, Qualcomm, Fraunhofer IIS/HHI, Futurewei, MTK, NTT Docomo, AT&T, Lenovo/MotM, Intel, Xiaomi  **Concern**: Apple, OPPO |
| 1.4 | **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL or UL channels/signals that can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH or dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update):   * That a DL channel/signal ~~[not]~~ sharing the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update) is indicated via RRC. * That an UL channel/signal ~~[not]~~ sharing the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update) is indicated via RRC.   FFS: Whether this configuration is per resource, per resource set, or per CORESET  **FL Note:** Whether “not” is removed or kept seems immaterial as long as the respective RRC parameters employ correct range of values. That is, this should be up to RAN2. | **Support/fine (23)**: Convida, Ericsson, CMCC, Samsung, Sony, NTT Docomo, AT&T, Lenovo/MotM, Intel, Nokia/NSB, Qualcomm, LG (“not” removed), MTK, vivo, Futurewei (“not” removed), ZTE (“not” removed), Fraunhofer IIS/HHI (“not” removed), Xiaomi, Huawei, HiSilicon (“not” removed)  **Concern**: Apple, OPPO |
| 1.5 | **Proposal 1.H**: On Rel.17 unified TCI framework, for the case when the setting of (P0, alpha, closed loop index) for PUSCH, PUCCH, and/or SRS are associated with UL or (if applicable) joint TCI state per BWP, for each of the PUSCH, PUCCH, and/or SRS, one individual setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC  **FL Note**: This is the situation from the previous rounds  **Alt1**. Support the following: for each of the PUSCH, PUCCH, and/or SRS, one individual setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC   * **Support/fine (13)**: Ericsson, vivo, Qualcomm, Intel, NTT Docomo, Nokia/NSB, Lenovo/MotM, ZTE (2nd preference), Spreadtrum, Apple, LG * **Concern**:   **Alt2**. Support the following: for each of PUSCH, PUCCH, and/or SRS, each of UL or (if applicable) joint TCI state is optionally associated with one of configured settings in a BWP via MAC-CE   * **Support/fine (11)**: ZTE, Samsung, Futurewei, MTK, Nokia/NSB, OPPO, Fraunhofer IIS/HHI, Huawei, HiSilicon * **Concern**: Ericsson, Apple, Intel, vivo, Spreadtrum   **FL Note:** RAN2 cannot decide for RAN1 whether the setting is configured via RRC or can be updated via MAC CE. Whether the additional flexibility from MAC CE is truly beneficial or not is not within RAN2 capability to assess.  Thus, if there is no consensus on this issue, the previous agreement on optionally associating UL PCP setting (other than PLRS) with UL or, if applicable, joint TCI state shall be reverted, i.e. the setting is not associated with UL or, if applicable, joint TCI state – simply because such association is an incomplete feature | **Support/fine**: Ericsson, vivo, Qualcomm, Intel, NTT Docomo, Nokia/NSB, Lenovo/MotM, ZTE (2nd preference), Spreadtrum, Apple, LG  **Concern**: |
| 1.7 | **Proposal 1.G**: On path-loss measurement for Rel.17 unified TCI framework, at least for discussion purposes, when both PL-RS and spatial relation RS in the UL or (if applicable) joint TCI state are not the same [and they are not CSI-RS for BM with repetition ‘ON’], “beam alignment” also pertains to the following events:   * The PL-RS is identical to the QCL Type-D source RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the QCL Type-D source RS of the spatial relation RS in the UL or (if applicable) joint TCI state   **FL Note:** Any additional event (bullet) doesn’t seem acceptable for a number of companies. Even the above, some still have concern | **Support/fine:** Apple, MTK, Convida, Lenovo/MotM, Qualcomm, Samsung, NTT Docomo, CMCC, Nokia/NSB, Futurewei, CATT, Intel (without last bullet from prev), Fraunhofer IIS/HHI  **Concern:** ZTE, vivo, Spreadtrum, OPPO (4th case not included), Ericsson (use case unclear), LG (5th case not included) |

Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 1** 2. **Share more inputs here if needed. For 1.4, share any response to Apple below**   **FL Note: BFR for unified TCI will be a main topic in the next meeting. Please prepare your Tdocs accordingly for RAN1#107-e** |
| Apple | 1.4: We think this needs some discussion. The first issue is SRS. If SRS does not share the indicated TCI, are we going to use spatialRelationInfo? The second issue is non-UE dedicated signal. So far we do not have definition about it, and the problem is that if non-UE dedicated signal does not share the indicated TCI, there is no legacy beam indication scheme in R16. The situation is even worse than SRS. Aperiodic CSI-RS may be easier, but there are still some problems, gNB is still able to indicate the beam by DCI, then would UE ignore it or not? Technically such RRC parameter is not helpful but it would take 10KB-25KB memory. One simple way may be to reserve one codepoint in trigger state to indicate the beam based on the shared TCI. |
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### Issue 2 (inter-cell beam management)

Table 3 Summary: issue 2

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

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** |
| Ericsson | On 2.3, this is from 38.331:  **- RRC\_CONNECTED:**  - The UE stores the AS context;  - Transfer of unicast data to/from UE;  - At lower layers, the UE may be configured with a UE specific DRX;  - For UEs supporting CA, use of one or more SCells, aggregated with the SpCell, for increased bandwidth;  - For UEs supporting DC, use of one SCG, aggregated with the MCG, for increased bandwidth;  - Network controlled mobility within NR and to/from E-UTRA;  - The UE:  - Monitors Short Messages transmitted with P-RNTI over DCI (see clause 6.5), if configured;  - Monitors control channels associated with the shared data channel to determine if data is scheduled for it;  - Provides channel quality and feedback information;  - Performs neighbouring cell measurements and measurement reporting;  - Acquires system information;  - Performs immediate MDT measurement together with available location reporting.  So the UE is supposed to monitor for P-RNTI for paging messages. |
| NTT Docomo | Issue 2.3: As in WID, UE can always receive from serving cell. Even for minimum UE capability (i.e. one PCI for either serving cell PCI or non-serving cell PCI), and if UE is activated with one Rel.17 TCI state from non-serving cell PCI, UE must receive Type0/0A/1/2[/3] CSS with Rel.15/16 TCI states or Rel.17 TCI states from serving cell.   |  | | --- | | iv. For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done). This includes L1-only measurement/reporting (i.e. no L3 impact) and beam indication associated with cell(s) with any Physical Cell ID(s) |   Hence, UE can receive paging (in Type2 CSS) from serving cell. Based on this understanding, we are fine with Alt.0.  Short Message should be also considered with Paging. We believe it is very important to ensure that UE can always receive Paging/Short Message. Short Message includes ETWS (Earthquake and Tsunami Warning System), which is very important to protect human’s life, especially in Japanese environment.  After some discussion with our RAN2 colleagure, as long as UE can receive Paging/Short Message from serving cell, there is no need to receive it from non-serving cell. However, if UE cannot receive Paging/Short Message from serving cell, UE should be able to receive it from non-serving cell. Hence, we keep our name noted in Alt.2. In Alt.2, TCI state of CORESET with Type2-CSS set can be updated, when Rel.17 TCI states are updated to non-serving cell PCI, but TCI states of CORESET with Type0/0A/1 cannot be updated to non-serving cell PCI.  For Alt.1, we think the spec. impacts to introduce USS for paging are large, hence it is not preferred. |
| Huawei, HiSilicon | **Issue 2.3:** We checked with our RAN2 colleagues, and are informed that:   * + - 1. In connected mode, UE should monitor P-RNTI (as mentioned by E///), not just for paging message but also other short messages such as ETWS/CMAS (as mentioned by DCM).       2. Though system information can be updated by RRC signaling, other short messages such as ETWS/CMAS should be delivered with low latency.   Here, the underlying assumption is UE supports only one active TCI state and/or UE has been activated with only one active TCI state (associated with PCI different from serving cell). In this case, the UE will not actively maintain the beamformed communication link with serving cell TRP, so we are not sure whether it is reliable for the UE to monitor paging from serving cell TRP.    With the discussions thus far, to us, it is now more sensible that UE monitors paging from the activated/maintained communication link with TRP with different PCI. In addition, with Alt-2, the only change is QCL assumption for CSS for paging monitoring, and no other changes are expected. We updated our preferences in table above. |
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### Issue 4 (MP-UE)

Table 5 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 set   + FFS: Whether each UE capability value set comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set   + FFS: Whether the UE capability value set can be common across a set of BWPs/CCs * The correspondence between a CSI-RS and/or SSB resource index and a UE capability value from the reported UE capability value set is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance   + FFS: Whether and how to define the timeline for applying the correspondence   + FFS: How to inform the correspondence to NW in the reporting instance   + FFS: What type of beam reporting instance is considered, e.g. L1-RSRP/L1-SINR/BFRQ * Support multiple codebook-based SRS resource sets with different maximum number of SRS ports   + The indicated SRI is based on the SRS resources corresponding to one SRS resource set which is aligned with the UE capability   **FL Note: Unless there is some critical, I suggest that companies not propose more refinement on the proposal. To reiterate, “logical index” isn’t agreeable to Ericsson.** | **Support/fine**: Lenovo/MotM, IDC, CATT, NTT Docomo, MTK, Nokia/NSB, Samsung, Qualcomm, LG, Spreadtrum, Huawei, HiSilicon  **Concern**: Intel, Apple (last bullet), OPPO (last bullet), ZTE (last bullet) |

Table 6 Additional inputs: issue 4

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 5** 2. **Share more inputs here if needed** |
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