**3GPP TSG RAN WG1 #106bis-e R1-2110514**

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

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#3 for multi-beam enhancement: ROUND 2

**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
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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, the largest number of configured TCI states is given as follows (following Rel-15/16 principles): * When a UE is configured with joint DL/UL TCI: the largest number of configured TCI states for joint DL/UL TCI state update is 128 per BWP per CC
* Further discuss and decide between the following when a UE is configured with separate DL/UL TCI:
	+ 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
	+ Alt2. The total largest number of configured TCI states for DL TCI and UL TCI state update is [128/192] per BWP per CC]

Note: TCI state pool for separate DL/UL TCI indication is still FFS**FL Note: Need to decide between Alt1 and Alt2 in this meeting** | **Alt1**: NTT Docomo, Apple, Samsung, ZTE**Alt2**: NTT Docomo, MTK, Ericsson, Samsung (if 192), Intel, QC(128), ZTE(if 192)，OPPO (128) |
| 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
 | **Support/fine**: Convida, Huawei/HiSi, Ericsson, ZTE, CMCC, Samsung, Sony, Nokia/NSB, Qualcomm, Fraunhofer IIS/HHI, Futurewei, MTK, NTT Docomo, Lenovo/MotM, Intel**Concern**: Apple, OPPO,  |
| 1.3 | **Proposed conclusion 1.I**: On Rel.17 unified TCI framework, there is no consensus in supporting the following DL source RS type:* SSB as QCL Type-D source RS, with TRS as QCL Type-A source RS
* SRS for BM as QCL Type-D source RS, optionally with TRS as QCL Type-A source RS

 **FL Note: This has been the situation (for at least 5 meetings) on additional source RS type for DL QCL Type-D reference for DL common UE-dedicated reception on PDSCH and all/subset of CORESETs:****SSB, with TRS as QCL Type-A source RS*** **Yes (5): ZTE, Samsung, MTK, vivo, Qualcomm**
* **No (10): Spreadtrum, OPPO, Intel, Apple, Sony, Ericsson, Huawei/HiSi, Futurewei, Docomo**
* **Yes (10): ZTE, IDC, Spreadtrum, Samsung, Convida, Nokia/NSB, vivo, Xiaomi, Sony**
* **No (11): OPPO, Fraunhofer IIS/HHI, MTK, Intel, Ericsson, Huawei/HiSi, LG, Futurewei, Docomo**
 | **Support/fine**: NTT Docomo, MTK, Ericsson, Apple**Concern**:  |
| 1.4 | **Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, * If there is at least one DL channel/signal that does not share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), it is signaled via RRC.
* If there is at least one UL channel/signal that does not share the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update), it is signaled via RRC.

FFS: Whether this configuration is per resource, per resource set, or per CORESET **FL Note: Re the wording concern from Futurewei and ZTE (which shares vs which doesn’t share), this seems immaterial as long as the respective RRC parameters employ correct range of values. That is, this should be up to RAN2. Please reconsider.** | **Support/fine**: Convida, Ericsson, [Huawei/HiSi], CMCC, Samsung, Sony, NTT Docomo, Lenovo/MotM, ZTE, Intel, Nokia/NSB, Qualcomm, LG, MTK, **Concern**: Apple, OPPO, [Futurewei, ZTE] (wording issue) |
| 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:* [Support the following: for each of the PUSCH, PUCCH, and/or SRS, one setting is optionally associated with each of the UL or (if applicable) joint TCI state in a BWP via RRC] Alt1

VS* [Support the following: for each of PUSCH, PUCCH, and/or SRS, each of UL or (if applicable) joint TCI state is optionally associated with one of configured settings in a BWP via MAC-CE.] Alt2

**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** | **Alt1**: * **Support/fine**: Ericsson, vivo, Qualcomm, Intel, NTT Docomo
* **Concern**:

**Alt2**:* **Support/fine**: ZTE, Samsung, Futurewei, MTK, Nokkia/NSB, OPPO
* **Concern**: Ericsson, Apple, Intel
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| 1.6 | For separate DL/UL TCI, UL TCI state poolAlt1: Shared pool with joint/DL TCI stateAlt2: Separate pool **FL Note: Strictly speaking, this could be decided in RAN2. Therefore, if there is no consensus, this will be left to RAN2** | **Alt1:*** **Support/fine (12)**: vivo, Spreadtrum, Samsung, Xiaomi, ZTE, Qualcomm, MTK, Convida, NTT Docomo, Intel, CATT, TCL
* **Concern**: Apple

**Alt2**: * **Support/fine (11)**: CMCC, Ericsson, Futurewei, Huawei/HiSi, Fraunhofer IIS/HHI, IDC, Sony, Apple, AT&T, OPPO
* **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, Ericsson, Intel (without last bullet from prev round)**Concern:** ZTE, vivo, Spreadtrum, OPPO |
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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**

**FL Note: BFR for unified TCI will be a main topic in the next meeting. Please prepare your Tdocs accordingly for RAN1#107-e** |
| NTT Docomo | Our view are added in the table.**Proposal 1.A**: We support either Alt.1/2. For UL, we always assume beam correspondence, and we configure one DL resource out of 64 SSB beams as UL spatial relation. Hence, at least 64 RRC-configured UL TCI states are necessary per BWP.**Proposal 1.B.1:** Since Rel.15/16 spec. support this QCL chain, we think it is fair to support it for Rel.17 unified TCI, because some operators may already use this QCL chain. We assume it will be hard to change QCL chain for operators, who already deployed in their Rel.15/16 NW.**Conclusion 1.I**: Considering the limited remaining RAN1 meetings, we think we should accept the conclusion.**Proposal 1.B.2:** Support.**Proposal 1.H**: Support Alt.1. The setting of (P0, alpha, closed loop index) is already associated with each of TCI states. We don’t see the use case to update the setting by MAC CE additionally. **Proposal 1.G**: Support. |
| vivo | **Proposal 1.A**: Support Alt2 when a UE is configured with separate DL/UL TCI including up to 128 TCI states.We think it is not necessary to distinguish between the largest number of configured separate DL DCI states and the largest number of configured separate UL DCI states. DL TCI state and UL TCI state can be activated and indicated based on network implementation from a R17 TCI pool including up to 128 configured TCI states.**Proposal 1.B.2:** Fine with Proposal 1.B.2. **Proposal 1.H**: Support Alt1. For Alt2, we don’t see why the UL PC settings need to be dynamically associated with TCI state by MAC CE. This is against the spirit we have when the compromise is made in RAN1 #105e meeting to minimize RAN1 effort. For Rel-17 UL PC parameter setting, gNB can configure the association between multiple settings and the UL or (if applicable) joint TCI state by RRC for each of the PUSCH and PUCCH and SRS.**For issue 1.6**, support Alt1.TCI state from a TCI state pool is indicated as joint TCI state or separate DL and/or UL TCI state can be configured separately. **Proposal 1.G**: Don’t support this proposal. We still believe this is overdesign especially considering there is no RAN1 specifcation impact for this. RAN4 could find out their own way for dealing with this. |
| MediaTek | Proposal 1.A: Prefer Alt2. It is not necessary to define separate numbers for DL and UL, respective. A total number for DL and UL should be fine. Note that a TCI state used for DL TCI update can be used UL TCI update as well.Proposal 1.B.1: SupportProposed conclusion 1.I: Fine. Even we prefer to use SSB as QCL Type-D source RS for PDSCH/PDCCH reception, but we understanding this is controversial and not critical.Proposal 1.B.2: We are okay to both wordings. However, we would like to clarify such RRC signaling is not needed for channels/signals that are precluded from the applicable list for apply “the same indicated TCI state”, e.g., TRS. Thus, we suggest to add one sentence in the main bullet:**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):* If there is at least one of the DL channels/signals that does not share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), it is signaled via RRC.
* If there is at least one of the UL channels/signals that does not share the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update), it is signaled via RRC.

FFS: Whether this configuration is per resource, per resource set, or per CORESETIssue 1.6: We are fine to leave this issue to RAN2. Suggest one possible conclusion:**Suggested conclusion**: On Rel.17 unified TCI framework, in case of separate DL/UL TCI, it up to RAN2 decision/design on whether UL TCI shares the same TCI state pool as joint DL/UL TCI or UL TCI uses a separate TCI state pool from joint DL/UL TCI* Note: By previous agreements, DL TCI shares the same TCI state pool as joint DL/UL TCI

Proposal 1.G: We support this proposal and prefer to remove the brackets from the main bullet. We believe this conclusion is beneficial when RAN1 discusses the detail of the UE feature “beam misalignment”. We also notice that in the previous agreement, how to define “beam alignment” if the PL-RS and the spatial relation RS in the UL or (if applicable) joint TCI state are not identical is an issue needed to be resolved by RAN1 (no “whether” in the following FFS).**Agreement from RAN1#106***…** *FFS: how to define “beam alignment” if the PL-RS and the spatial relation RS in the UL or (if applicable) joint TCI state are not identical*
 |
| Ericsson | 1.6: We should leave this to RAN2: explain what a DL/joint state contains, and an UL TCI state contains. Explicitly state that the two can be combined. Then leave it to RAN2 to design.1.7: Still difficult to understand what this would be used for. If the use case was clear, it would be easier to help arrive at a conclusion. |
| Nokia/NSB | Proposal 1.A: We would propose that for separate TCI we use 128 states for DL and 128 for UL, is any particular reason to use 64 states for UL?Proposal 1.B.1: SupportProposed conclusion 1.1: We are fine in order to move on.Proposal 1.B.2: SupportProposal 1.H: We support Alt2 while also could accept Alt1 in order to get progress.1.6: We prefer leave this to RAN21.7: Support  |
| Apple | 1.4: We think this needs some discussion. The first issue is SRS. If SRS does not share the indicated TCI, are we going to use spatialRelationInfo? The second issue is non-UE dedicated signal. So far we do not have definition about it, and the problem is that if non-UE dedicated signal does not share the indicated TCI, there is no legacy beam indication scheme in R16. The situation is even worse than SRS. Aperiodic CSI-RS may be easier, but there are still some problems, gNB is still able to indicate the beam by DCI, then would UE ignore it or not? Technically such RRC parameter is not helpful but it would take 10KB-25KB memory. One simple way may be to reserve one codepoint in trigger state to indicate the beam based on the shared TCI. |
| Samsung | **Proposal 1.A:** We are fine with Alt1 or Alt2 as long as the number of TCI states is 192 for Alt2.**Proposal 1.B.1:** Support **Proposed conclusion I.1:** It is not our preference to not have SSB and SRS are QCL Type-D source RS. But for progress we can accept.**Proposal 1.B.2:** We support. But would like to clarify the wording**Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, * ~~If there is at least one Any~~ DL channel/signal that does not share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), its DL TCI state is signaled via RRC.
* ~~If there is at least one~~ Any UL channel/signal that does not share the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update), its UL TCI state is signaled via RRC.

FFS: Whether this configuration is per resource, per resource set, or per CORESET **Proposal 1.H:** Support Alt2. This gives more flexibility to update the association between PC parameters and TCI states.**Issue 1.6:** Support Alt1.**Proposal 1.G:** We support the principle of the proposal, but have a comment: If the spatial relation RS in the UL TCI state is SRS, SRS doesn’t have a QCL Type source RS, instead it has a spatial relation source RS. Therefore, we would like to update the first and third bullets to reflect this as follows (other the proposal is incomplete for that case):* The PL-RS is identical to the QCL Type-D source RS or spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state
* The QCL Type-D source RS of PL-RS is identical to the QCL Type-D source RS or spatial relation source RS of the spatial relation RS in the UL or (if applicable) joint TCI state

I illustrate this with a picture for better clarityWe don’t see the need for the text in square brackets in the main bullet. |
| Lenovo/MotM | Proposal 1.A: There is no agreement that a UE cannot be configured with a mixture of different TCI types. We need to discuss the total number of DL TCI states and UL TCI states when the UE is configured with different TCI types. We are OK with the number 128 and 64 for total DL TCI and total UL TCI states configured in a mixture TCI state pools. Proposal 1.B.1: SupportProposal 1.H: Support Alt1.  |
| Intel  | Views updated in the Table.**Proposal 1.H:** We do not see any need to have dynamic update of these associations. Therefore Alt.1 is sufficient specially at this late stage. We also agree with FL that a decision is required here. We cannot say “no conclusion” similar to other controversial issues and push this to RAN2 as well. **Proposal 1.G:** Ok with current version but tend to agree with Ericsson that the use case is still unclear. What happens if a UE reports no support for “beam alignment” as described in these bullets?**Issue 1.6:** We keep postponing discussion on this issue every meeting. But we feel that a decision one way or the other would help refine the RAN1 design for other issues related unified TCI indication.  |
| Futurewei | **Proposal 1.A**: We are ok with either Alt 1 or Alt 2.**Proposal 1.B.1:** Support.**Conclusion 1.I**: Support.**Proposal 1.B.2:** As we commented previously, it is clearer and cleaner to use the wording “which shares” based on the agreements in RAN1 106-e on the channels/signals that can share the Rel-17 indicated TCI state. We are fine if “does not share” in both subbullets is replaced with “shares”. **Proposal 1.H**: Support Alt. 2.**Proposal 1.G**: Support. |
| Qualcomm | For 1.A, support Alt2 with 128For 1.B.1, fineFor conclusion 1.1, fineFor 1.B.2, fineFor 1.H, support Alt1. For 1.G, support |
| ZTE | **Proposal 1.B.2:** We share the same views with Futurewei. BTW, it seems that it is to imply some implicit rule proposed by companies, like ‘without TCI state/spatial relation configuration’. To be honest, we can not agree that ‘do not shares’ is based on the implicit rule. We have already some default solution in Rel-15/16, and if still going with that way, the whole spec for beam management will be totally unreadable and the basic motivation for unified TCI state may be broken. In short, an explicit signaling is beneficial.Meanwhile, we think the MTK’s nice efforts for refining the wording is not required, if “does not share” in both subbullets is replaced with “shares”. **Proposal 1.H**: Our first priority is Alt-2 as you see, and if going with Alt-1, we think that we need to avoid ambiguities that a ‘single/same’ PC setting is associated with all TCI states. Please review the following suggestions:‘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’ |
| OPPO | As we commented in previous round, for proposal 1.G, the case of when the QCL-TypeD RSs of PLRS and UL spatial RS have the same source of QCL-TypeD shall be included. **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
* The QCL Type-D RSs of PL-RS and the spatial relation RS have the same source RS for QCL-TypeD.
 |
| Spreadtrum | **Proposal 1.A**: We can go with majority since it’s only about the number of RRC-configured TCI states. In our view, the number of **active** DL TCI states and the number of **active** UL TCI states is more important.**Proposal 1.B.1**: Although we think CSI-RS for CSI is not necessarily to be a QCL source RS, for progress, we are OK to support it.**Proposed conclusion 1.I:** Given the current situation, we are OK to make the conclusion for SSB and SRS for BM together.**Proposal 1.B.2:** Support.**Proposal 1.H:** Support Alt1. We are still not convinced on the potential benefit to support MAC CE based association.Issue 1.6: OK to leave it up to RAN2. |

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

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 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 non-serving cell SSBs is larger than the best L1-RSRP measured from a list of serving cell SSB plus an offset, where the offset is configured by RRC
	+ The list of serving cell SSBs and non-serving cell SSBs are configured by RRC
* The L1-RSRP report is transmitted by MAC CE, which includes
	+ SSBRI from the list of non-serving cell SSB
	+ L1-RSRP for the corresponding SSB
* A prohibit timer is introduced to prohibit UE sends multiple L1-RSRP report MAC CEs, which is similar to PHR
 | **Support/fine**: Apple, NTT Docomo, ZTE, ...**Concern**: Futurewei, Intel, LG, MTK, Ericsson, Smasung (concern on MAC CE), OPPO ...  |
| 2.2 | **Proposal 2.H**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP**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: Need to finalize by selecting one of the alternatives** | **Alt1:** Samsung, MTK, Qualcomm, Ericsson, Docomo, vivo, Nokia/NSB, Apple, Intel, OPPO**Alt2:** ZTE, CMCC, Samsung (2nd preference), Lenovo/MotM, Qualcomm (2nd preference), Sony |
| 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 assocaited 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: We may need to quickly check with RAN2 (also related to the LS reply).** * **Does the UE need to monitor paging for the newly activated TCI state of a PCI different from the serving cell in RRC connected state?**
* **If so, is it on USS or CSS or both?**
 | **Alt0:** [Samsung], MTK, OPPOConcern: NTT Docomo**Alt1**: Huawei/HiSi, Ericsson, NTT Docomo, MTK**Alt2**: Huawei/HiSi, NTT Docomo, Apple, ZTE |
| 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 is undoubtedly 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**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)  |

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**
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| NTT Docomo | Our view are added in the table.**Proposal 2.E**: Support. For companies who are supportive event-driven beam reporting, they should be more flexible for MAC CE based or L1 based. We prefer MAC CE based, but also fine with L1 based, because both are benefitial.**Proposal 2.H**: Support Alt.1. We think Alt.1 has smaller UCI overhead than Alt.2.**Issue 2.3**: Support Alt.1/2. We have concern on Alt.0. The minimum UE capability UE is activated with TCI states with either serving cell or non-serving cell by MAC CE. When TCI states associated with only non-serving cell are activated for the UE, Alt.0 means UE cannot monitor paging. We think this is an issue.**Proposal 2.F**: We are fine. |
| vivo | **Proposal 2.E:** Do not support.**Proposal 2.H:** Support Alt1.**For issue 2.3**, we prefer Alt0. This is for UE only supporting 1 TCI state. We prefer to add this in the main bullet when have more mature versions.**Proposal 2.F:** Support. And this may not be necessarily coupled with 2.3 since 2.3 is for the case when only one TCI state is supported but this can at least be clarified for the case when two TCI states are supported. |
| MediaTek | Proposal 2.E: We have concern on only reporting of the one non-serving SSB when the event is triggered since NW may not be able to decide to change the serving beam to non-serving cell only based on the L1-RSRP of the non-serving SSB. We also have concern on the MAC-CE-based reporting if there is no PUSCH resource. The reporting latency may not be smaller than NW-initiated reporting in this case due to the need of SR. Proposal 2.H: We prefer Alt1 and we don't see the need to introduce a new format as Alt2. If the difference of L1-RSRP of a beam is out of range, it means the beam quality is very bad and it is unlikely to use the reported beam for transmission/reception.Issue 2.3: Either Alt0 or Alt1 is fine to us.Proposal 2.F: We support the proposal, and prefer to keep the PDCCH beam behavior aligned with Rel-15/16 as much as possible, i.e., beam is per CORESET applied, instead of per search space set or per RNTI. Any of the new behaviors will cause huge spec and implementation efforts. We also share simalr view with vivo that Issue 2.3 is not an issue when UE support more than one activated TCI states.Regarding whether to preclude/include Type3 CSS set, we are open it.  |
| 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. |
| Nokia/NSB | 2.E: For event based reporting, UE should be able to indicate network when a specific reporting configuration should be activated by network. Network can then configure the reporting on L1.**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 non-serving cell SSBs is larger than the best L1-RSRP measured from a list of serving cell SSB plus an offset, where the offset is configured by RRC
	+ The list of serving cell SSBs and non-serving cell SSBs are configured by RRC
	+ **Indication for activating a reporting configuration**
* The L1-RSRP report is transmitted by MAC CE, which includes
	+ SSBRI from the list of non-serving cell SSB
	+ L1-RSRP for the corresponding SSB
* A prohibit timer is introduced to prohibit UE sends multiple L1-RSRP report MAC CEs, which is similar to PHR

**2.F**: Propose to discuss paging issues first (2.3). Ok to consider asking RAN2. **2.H**: Alt.1 |
| Apple | 2.3: to answer the question from FLFL note: We may need to quickly check with RAN2 (also related to the LS reply). * Does the UE need to monitor paging for the newly activated TCI state of a PCI different from the serving cell in RRC connected state? 🡪 Yes
* If so, is it on USS or CSS or both? 🡪 Type2 CSS
 |
| Samsung | **Proposal 2.E:** We support event driven reporting, but have concern on MAC CE based even driven reporting. This requires involvement of RAN2 in the design of the corresponding MAC CE, we have concern given that we are approaching the end of Rel-17.**Proposal 2.H:** Support Alt1**Issue 2.3:** We would like to first understand the use case; this might require sending LS to RAN2.Reading 38.331, it seems that paging applies to UEs in the RRC\_IDLE and RRC\_INACTIVE state (TS 38.331 section 5.3.2.3). In these states, the UE doesn’t have a dedicated connection to the network, therefore we don’t think that inter-cell beam management would apply in these cases.In TS 38.331 it is mentioned that:“For a UE in RRC\_CONNECTED, the network can provide system information through dedicated signalling using the *RRCReconfiguration* message, e.g. if the UE has an active BWP with no common search space configured to monitor system information, paging, or upon request from the UE.”This seems to be similar to the case we have, when the UE is receiving a dedicated channel on a beam associated with an SSB associated with a PCI of neighboring cell.We suggest to send an LS to RAN2 to check the applicability of paging to UEs in RRC CONNECTED mode.**Propsoal 2.F:** Support. We don’t think this issue should be coupled with issue 2.3. In our view a common search space has a TCI state with a source RS associated with an SSB (indirect association) associated with the serving cell. Hence, it can’t be used for UE dedicated channels with a beam on a neighboring cell. |
| Lenovo/MotM | Proposal 2.E: We are OK with the proposal except the last bullet. The prohibit timer is a RAN2 issue and shall be left to RAN2. 2.3: We support Alt0. A UE receives paging shall from its serving cell. There is no need to monitor paging message sent from a non-serving cell. Proposal 2.F:  |
| Intel  | **Proposal 2.E:** We are in general supportive of event driven approach but don’t think MAC-CE is useful from a latency standpoint. We prefer L1 reporting and propose to have a dedicate PUCCH SR for indicating when the UE is ready to report using UCI. **Issue 2.3:** As per agreement paging will be received by the UE from the serving cell and not from the cell with PCID corresponding to the newly activated TCI state. Then we are not sure how Alt. 1 or 2 satisfies this criterion. In our understanding, the UE can continue to monitor paging is CSS corresponding to serving cell PCID and autonomous beam switching can address the issue since overall operation is DPS i.e., UE receives the signals in a TDM manner.  |
| Futurewei | **Issue 2.3**: Support Alt.1/2. |
| Qualcomm | For 2.E, supportFor 2.H, support Alt1, can also live with Alt2For 2.F, prefer to have 3 |
| ZTE | **Proposal 2.H**: One comment for Alt-1: It is a typical case that TX power of SSBs from serving cell and non-serving cell may be different (based on an individual RRC parameter as 8.1.2.2 agreed). How to select SSB in L1-RSRP reporting? Shall we need to consider that the SSB Tx offset should be considered in the L1-RSRP reporting. On the other hand, due to independent differential reporting, we think that it can work well even if the offset is not considered.Issue 2.3, we support Alt.3. BTW, although we may have some similar purposes with E///, sorry to say that this logic is a little bit confusing. As you see the system information is also needed to be monitored. So, we also need to have USS to carry SIB, right? Even at this moment, personally speaking, I still believe that our intial proposal of changing all UE dedicated and non-dedicated channel to new non-serving cell is a right move-forward direction. Anyway, we now need to step-by-step downscope candidate channels to be assumed as non-UE dedicated one.- 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. |
| OPPO  | Regarding Proposal 2.F: Only the Type 3 CSS in SCell can be counted as non-UE dedicated channel because in PCell, the UE is configured to monitor C-RNTI in Type 3 CSS in PCell. |
| Spreadtrum | **Proposal 2.E**: Considering the benefit, we are OK to support event-driven beam reporting by MAC CE in principle. Regarding the event described in the proposal, it’s reasonable for inter-cell beam management. But for inter-cell mTRP, it seems to be too restrictive and not necessary. Therefore, we suggest to define a separate event for inter-cell mTRP: A threshold value defined for candidate beam identification in SCell-BFR can be reused, i.e. RRC parameter rsrp-Threshold-r16.**Proposal 2.H:** Prefer Alt1 based on the benefit of smaller overhead.Issue 2.3: For this special case, we prefer to have the possibility for UE to monitor paging, either Alt1 or Alt2 is OK to us.**Proposal 2.F:** Support |

### Issue 3 (beam indication signaling medium)

(done for this meeting – need to wait for issue 4 before discussing multiple BATs)

### Issue 4 (MP-UE)

Table 5 Summary: issue 4

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 4.1 | **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, * Support the UE reporting a list of UE capability values
	+ FFS: Whether the UE capability values comprises the number of SRS ports, number of UL transmission layers, coherence type, TPMI, or number of SRS resources within one SRS resource set
	+ FFS: Whether the list of UE capability values can be common across a set of BWPs/CCs
* The correspondence between a CSI-RS and/or SSB resource index and the reported list of UE capabilities 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

**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 ...**Concern**: Intel, Apple (last bullet), OPPO |
|  |  |  |

Table 6 Additional inputs: issue 4

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 5**
2. **Share more inputs here if needed**
 |
| NTT Docomo | Support  |
| vivo | Regarding “list of UE capability value”, in case that two panels of UE have the same capability, is it possible to have the correspondence between UE panel and SSBRI(s)/CRI(s)? |
| MediaTek | Support. Re question from vivo, we think in that case UE can report two same capabilities in the list. |
| Nokia/NSB | Proposal 4.A: We are ok.  |
| Apple | If we only have the last bullet without previous sub-bullet as restriction, it would become NW controlled UE panel, as gNB can indicate any SRS, which we have strong concern. |
| Samsung | Support, with 2nd bullet revised as follows, since the UE reports one entry from the list in a beam reporting instance:The correspondence between a CSI-RS and/or SSB resource index and **an entry from** the reported list of UE capabilities is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance |
| Lenovo/MotM | Support 4.A. |
| Intel  | This proposal keeps morphing in every round of discussion. Now this reads very different from the previous rounds. Current wording is still vague and the main take-away is that this is specifically addressing the use-case of UE with assymmtric panels. For the case of panels with same number of ports, things work without this proposal. Panel activation/switching is up to the UE and the gNB need not be involved. At risk of repeating ourselves for the third FL summary in a row, we are still not sure why we need to address this particular asymmetric use case and that too in UL. As we mentioned in previous rounds, consider for example, a UE with one 2-port panel and one 4-port panel which can only receive with a single panel in the DL (common case). The same issue should be relevant even in this case, where the gNB may not know the maximum number of DL MIMO layers with which it can transmit to the UE. If the UE switched autonomously from a 4-port to a 2-port panel, the DL transmission may fail since UE cannot support 4-layer transmission anymore. Then why should we not support this even more relevant use case and provide targeted solutions for the UL case? This does not seem clear to us at all. |
| Qualcomm | Fine for 4.A |
| ZTE | We share the same views with Apple that the previous second last bullet should be added back, as we mentioned in 1st round. |
| OPPO | The lastest updated proposal cause concern to us, especially the last bullet. It should be UE who control the selection of one of those SRS resource set for UL transmission. But the current proposal means the system control the selection of SRS resource set, i.e., in implementation, the gNB controls the selection of UE panel, which is not aligned with our previous agreement.  |
| Spreadtrum | One clarification question: Since there’s no ‘logical index’ defined according to the proposal, does it preclude the possibility of introducing a parameter (which can be considered as an index) in a beam report to inform NW about the correspondence? |

### Issue 5 (MPE mitigation)

Table 7 Summary: issue 5

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 5.1 | **Proposal 5.C**: On Rel.17 enhancements to facilitate MPE mitigation, for selection of N from a candidate SSB/CSI-RS resource pool: * Down-select *by* RAN1#107-e between the following alternatives:
	+ Alt1. Based on L1-RSRP minus P-MPR value for each resource
	+ Alt2. Based on calculated Virtual PHR for each resource
		- Virtual PHR is modified by considering actual P-MPR
	+ Alt3. Based on L1-RSRP for each resource among the resources with P-MPR values less than a threshold
		- FFS: Reporting when there are only less than N P-MPR values under the threshold
	+ Alt4. No RAN1 spec impact (possibly left to RAN4)
* The candidate resource pool corresponds to a CSI-RS/SSB resource set configured via RRC (details up to RAN2)

**FL note: Since we have 1 meeting left, we need to down select or at least narrow down among the above alternatives.*** **Alt4 is by default one alternative**
* **Strive to choose one among Alt1/2/3 so that we may assess the benefit of the scheme against Alt4**
 | **Alt1**: MTK, Ericsson, Samsung, **Alt2**: Ericsson, Nokia/NSB**Alt3**: NTT Docomo, MTK, Samsung**Alt4**: vivo, MTK, Intel, OPPO |
|  |  |  |

Table 8 Additional inputs: issue 5

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 7**
2. **Add more inputs here if needed**
 |
| NTT Docomo | Our view is updated in the table. We would like to clarify the intention of Alt.3. P-MPR affects UL performance only if there is MPE issue. If several beams with no MPE issue (P-MPR less than a threshold) can be found, N beams with best L1-RSRP can be selected among the beams with no MPE issue. For the FFS part, if there is less than N beams with no MPE issue, e.g., only L beams with no MPE issue, a possible way is to report L beams with no MPE issue and to select the rest N-L beams based on L1-RSRP minus P-MPR.  |
| vivo | Support Alt4. The selection from a candidate SSB/CSI-RS resource pool depends on UE implementation based on L1-RSRP.The following simulation results show that the performance is very similar/neglegible using L1-RSRP as the metric or using other metric.* + Case 1(baseline): when MPE event is declared by UE, a modified L1-RSRP is triggered. The UE reports the uplink RSRP that considers the impact of blockage and MPE power back-off for panel/beam switching. gNB selects and determines the panel/beam switching according to the reported uplink RSRP.
	+ Case 2: when MPE event is declared by UE, a Rel-15 L1-RSRP report is triggered by gNB. The UE reports 4 beam pairs between gNB and UE based on downlink RSRP that considers the impact of blockage. gNB selects and determines the panel/beam switching according to the reported DL RSRP and P-MPR.
1. UL performance with full buffer traffic model for panel/beam switching

|  |  |  |
| --- | --- | --- |
|  | Dense Urban | Indoor Hotspot |
|  | Mean SE of cell | 5%SE | 50%SE | Mean SE of cell | 5%SE | 50%SE |
| Case1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Case2 | 0.04% | -2.10% | -0.23% | -0.04% | 0.00% | 0.01% |

 |
| MediaTek | We prefer not to add an additional measurement quantity now, and prefer to use the already defined measurement quantities, i.e., P-MPR and L1-RSRP. Thus, either Alt1 or Alt3 is fine to us. We are also oaky to leave this to RAN4 if no consensus can be reached in this meeting. |
| Ericsson | Alt3 will not facilitate comparison of beam qualities with different P-MPRs.  |
| Nokia/NSB | We would prefer Alt2 as it provides actual transmission capability in relation to the required transmission power/EIRP assuming the certain UL TX beam. However, it is not clear in Alt2 what is meant with **actual** P-MPR, in our view Alt2 should consider the P-MPR value associated to the candidate SSB/CSI-RS, i.e. the **virtual** P-MPR.* + - Virtual PHR is modified by considering ~~actual~~ **virtual** P-MPR
 |
| Apple | We think the whole proposal is not needed, how to select beam to report is up to UE. Whether it would be handled by RAN4 would be up to RAN4, but I am not sure how RAN4 would test the MPE detection accuracy.  |
| Samsung | Support Alt1 and Alt 3 |
| Intel  | OK with Alt. 4 |
| Qualcomm | Fine for either Alt1 or Alt2 |
| OPPO | Prefer Alt4.None of Alt1~3 would work.On Alt1: the description of “L1-RSRP offset by P-MPR” is not clear. Is it the value of P-MPR? Or is it the power reduction on Pcmax for that resource? From our understanding, it should be the value of P-MPR.On Alt2: the CSI-RS resource or SSB does not have power control parameters (PL-RS, p0, alpha, closed loop index). Then how can the UE calculate the PHR for a CSI-RS or SSB? Seem Alt2 does not work. Suggest to delete it. On Alt3: With the condition “P-PMR less than a threshold”, the UE might find N CSI-RS resources or SSB that can meet this condition. That would contradict with the main bullet of “selection of N”. Suggest to delete the “with PMPR with less than a threshold”. |
| Spreadtrum | Support the proposal. Alt1 is preferred. Comparing with Alt3, Alt1 allows UE to select a usable beam even if it’s experiencing MPE issue. For Alt2, how to calculate Virtual PHR needs to be further discussed, and there’s risk to reach no consensus. |

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

FL observation:

* While most companies observe the importance and potential benefits of specifying advanced beam refinement/tracking especially UE-initiated beam management (beam selection, activation, and reporting/measurement for DL and/or UL), the amount of required work is too large for only one RAN1 meeting. There is virtually no hope in finishing the work even if the group converges to one option (e.g. Opt 1 or 2 of ALT1)
* Meanwhile there are still numerous unresolved problems for issues 1-5 (which, per previous agreements, takes higher precedence given the WID)
* Note that UE-initiated beam management seems to be a popular candidate for Rel-18 MIMO Advanced WI ☺ It is my hope that the outcome of the discussion will be instrumental in drafting the WID for Rel-18 MIMO Advanced.

**Proposed conclusion 6.1**: Discussion on advanced beam refinement/tracking (“issue 6”) is suspended for the remaining of Rel-17 NR\_FeMIMO multi-beam enhancement (due to lack of time).

Table 9 Additional inputs: issue 8

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your input, if any, on proposed conclusion 6.1** |
| NTT Docomo | It is unfortunate, but we can understand. We think explicit conclusion is not needed in this meeting, but we can deprioritize the discussion order. |
| MediaTek | We are fine to postpone this issue to Rel-18 since the spec effort for UE-initiated beam activation/selection would be quite huge. However, we share the same view with FL that we also prefer the agreements made for Issue 6 so far could be the starting point for Rel-18 MIMO discussion. If possible, can we add one sub-bullet in the conclusion as follows:* The agreements reached for Issue 6 can be a starting point for corresponding discussion in Rel-18 WID, if any.
 |
| Ericsson | Support. Do not add statements related to Rel-18 – focus on Rel-17. |
| Samsung | While we are not happy with the conclusion, we understand its practical necessity. |
| Lenovo/MotM | Support. We will have plenty of time for this topic in R18.  |
| Futurewei | We are ok with the conclusion given the limited remaining time for Rel-17. |
| Spreadtrum | We are OK to make the conclusion. |