**3GPP TSG RAN WG1 #106-e R1-2108361**

**e-Meeting, August 16th – 27th, 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

**Round 2 is intended to prepare the group for the 2nd GTW session (Friday 08/20 03:00 UTC toward the end). Please share your inputs by Friday 08/20 01:00 UTC.**

## Summary of companies’ inputs

The listed issues are structured primarily to facilitate some progress on pending issues identified in the agreements (see Appendix A).

### Issue 1 (Rel.17 unified TCI framework)

Table 1 Summary: issue 1 (from round 0 inputs)

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| **Proposal** | **Companies’ views** |
| 1.B-3 (non-dedicated DL DMRS as target RS) | **Support**: MTK, Qualcomm, Sony, FGI/APT, Ericsson, Fraunhofer IIS/HHI, Samsung, LG, Xiaomi, ZTE, Convida, CATT, Spreadtrum, Nokia/NSB, AT&T, NTT Docomo, [Lenovo/MotM] **Concern**: Intel, Huawei/HiSi, vivo, Futurewei, [OPPO] |
| 1.C (beam indication) | **Support**: MTK, Qualcomm, NTT Docomo, Sony, Ericsson, Fraunhofer IIS/HHI, Samsung, Xiaomi, ZTE, Convida, Spreadtrum, Nokia/NSB, AT&T, Intel, NTT Docomo, Lenovo/MotM, Futurewei**Concern**: Apple (wait until 1.B is concluded), CATT, vivo,  |
| 1.E (UL PC for SRS) | **Support**: Apple, MTK, Qualcomm, Lenovo/MotM, NTT Docomo, FGI/APT, Ericsson, Samsung, Intel, ZTE, Convida, CATT, vivo, Futurewei, Spreadtrum, AT&T, NTT Docomo**Concern**: OPPO  |

**Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC:

* DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH
	+ FFS: Any restriction on the SS type associated with the CORESET(s)

**Proposal 1.C**: On Rel.17 unified TCI framework, for any DL RS that does not share the same indicated Rel-17 TCI state(s) as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC, but can be configured as a target DL RS of a Rel-17 DL TCI (hence the Rel-17 DL TCI state pool), Rel-17 mechanism(s) which reuse the Rel-15/16 TCI state update signaling/configuration design(s) are used to update/configure such DL RSs with a Rel-17 TCI state.

**Proposal 1.E**: On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework, the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.

* If not associated, the setting(s) of (P0, alpha, closed loop index) for SRS per BWP is independent of the UL or (if applicable) joint TCI states
* This is only applicable for SRS sets using Rel-17 TCI state to determine their spatial relation.

FFS: Whether more than one parameter sets can be configured, e.g. for different traffic types

Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | **1) Check and update Table 1 if needed****2) Share your inputs on the above FL proposals. In particular:*** **1.B-3: removed brackets (see MediaTek’s comment below), kept intra-cell per Huawei’s comment (note that issue 1 has been and is only for intra-cell)**
* **1.C: previous version was used but please engage with the proposal from Futurewei**
* **1.E: please respond to OPPO’s argument below**

 |
| OPPO | We still have concern on 1.E and do not see the justification to associate (P0, alpha, closed loop index) with each TCI state for SRS resource set. @ZTE: as in rel15/16, the (P0, alpha, closed loop index) is configured per SRS resource set, not per source. The reason is because the same PC shall be applied to all the SRS resource within one set. The PC configuration per SRS resource set is separate from that of PUSCH. We do support the SRS resource to use same closed loop index or different closed loop index as PUSCH. Here is the 213:For the SRS power control adjustment state for active UL BWP  of carrier  of serving cell  and SRS transmission occasion - , where  is the current PUSCH power control adjustment state as described in Clause 7.1.1, if *srs-PowerControlAdjustmentStates* indicates a same power control adjustment state for SRS transmissions and PUSCH transmissions; or-  if the UE is not configured for PUSCH transmissions on active UL BWP  of carrier  of serving cell , or if *srs-PowerControlAdjustmentStates* indicates separate power control adjustment states between SRS transmissions and PUSCH transmissions, and if *tpc-Accumulation* is not provided, where In our view, the rel15/16 rule shall be reused and unified TCI framework for MB shall not change the uplink power control operation.  |
| MediaTek | Proposal 1.B-3 means at least for the case if a CORESET is associated with both CSS set (non-UE-dedicated reception) and at least one USS set (UE-dedicated reception), the PDCCH receptions on this CORESET can share the same indicated Rel-17 TCI state. The intension is avoiding that one CORESET needs to apply different TCI (Rel-17 TCI + e.g., Rel-15/16 DL TCI) if the CORESET is associated with both CSS and USS. Note that R15/R16 DL TCI is indicated per CORESET, not per search space set. Compared with applying Rel-17 TCI to all non-UE-dedicated PDCCH receptions, this could be a compromise solution that still allows separate beam indications for non-UE dedicated reception and UE dedicated reception, respective, if NW would like to do so. |
| Futurewei | On Proposal 1.C, our understanding is that basically this is R17 mechanism using R17 TCI state but reuse R15/16 design.  So we would like to make the following modifications:**Proposal 1.C**: On Rel.17 unified TCI framework, for any DL RS that does not share the same indicated Rel-17 TCI state(s) as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC, but can be configured as a target DL RS of a Rel-17 DL TCI (hence the Rel-17 DL TCI state pool), R17 mechanism(s) which reuse the Rel-15/16 TCI state update signaling/configuration design(s) are used to update/configure the Rel-17 TCI state. |
| NTT Docomo | Proposal 1.B-3: Support.Proposal 1.C: Support.Proposal 1.E: Support. Regarding to the OPPO’s concern, even if the setting of (P0, alpha, closed loop index) can be associated with TCI state, gNB can indicate the same setting across multiple SRS resources, if gNB wants to indicate the same parameters. So, we think gNB implementation can solve the issue. |
| ZTE | Proposal 1.B-3: Support. Just clarification, in our views, this rule can apply to both inter and intra-cell cases. But for progress, we are fine to agree it for intra-cell firstly.Proposal 1.C: Support. Proposal 1.D: Support.@OPPO, The separate closed loop is used for FDD (PUSCH-less) mainly, and can not be adjusted by DCI format 0\_0/1/2. It means that there exists Tx-power gaps between PUSCH and SRS for CB/NCB, regardless of gNB design. DCI overhead is an another issue. Then, how to achieve the uplink adaptation is a serious issue. In general, compared with Rel-15 design, we now prefer to have a really dynamic beam switch for UL and there are more than one activated UL TX beam. If we can dynamic switch PUSCH closed loop well, due to the same reason, we need to enhance SRS as well. At least, we need to have clear mechanism to achieve a goal that the **closed loop procedure for SRS is tied with the currently active PUSCH closed loop indicated by Rel-17 TCI**.  |
| vivo | Proposal 1.B-3:For DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH, they are related to outcome of issue2. The behavior for inter-cell management should be clarified firstly.[Mod: This proposal is only for intra-cell as clearly stated. No reason to complicate discussion and stop progress by including inter-cell here while the proposal clearly says “intra-cell”. They can be the same or different. Settle intra-cell first, then inter-cell – we have been doing so since day 1]Proposal 1.C: Fine with the formulation from Futurewei. |
| Convida Wireless | We’re fine with the proposals. Some editorial suggestions:**Proposal 1.B-3**: …: * … if the CORESET(s) is associated with any USS set

FFS: if the CORESET(s) is not associated with any USS set**Proposal 1.E**: …FFS: Whether more than one parameter set~~s~~ can be configured, e.g. for different traffic types[Mod: Thanks, done] |
| OPPO2 | Considering some special specification on CORESET#0 defined in 213, we now have some concern on 1.B-3.According to the 213 specification, if a TCI state is indicated to CORESET#0, the CSI-RS contained in that TCI state must be QCLed with a SSB and that SSB is used by the UE to derive the monitoring occasions for Type0/0A/2-PDCCH CSS.Our concern on proposal 1.B-3 is: the indicated rel-17 TCI state might not meet this requirement. If the CSI-RS contained in rel-17 TCI state is not QCLed with a SSB, then how can the TCI state be applied to CORESET#0.[Mod: See response from e.g. MTK, Apple, Ericsson, Samsung, and see if your concern is resolved.Also note that the proposal is “the following DL RSs can share the same...” not “the following DL RSs always shares the same ...” Meaning it is configurability] |
| MediaTek  | Proposal 1.B-3: Support. We also fine to add restriction under Proposal 2.A.1to strictly align the WID, e.g., PDCCH reception associated with Type0/1/2 CSS set cannot be associated a CORESET if the if the CORESET is associated with any USS set, if this can address the concern on both Proposal 1.B-3 and Proposal 2.A.1. Re the comment from OPPO, we think Rel-15/16 DL TCI may also face the same situation but NW should avoid such configuration for CORESET#0, and Rel-17 TCI doesn't preclude to indicate a TCI sate includes a CSI-RS QCLed with SSB. Why this would be an issue for Rel-17 TCI and this proposal?Proposal 1.C: Support. We think the proposal already implies Rel-17 framework would reuse Rel-15/16 TCI state update signaling/configuration mechanism(s) to update/configure the Rel-17 TCI state, thus re-wording seems not needed.[Mod: Please check latest version based on Futurewei’s and Ericsson’s refinement]Proposal 1.E: Support and share same view with ZTE. |
| Apple | Proposal 1.B-3: For intra-cell BM, we do not see any reason to use separate beam indication for common signal and dedicated signal. However, separate beam indication would lead to different default beams. We think there are two options to handle the issue as follows. Option 1 would be a clean and simple version. For option 2, we assume the beam indication would not be applicable for Type0/1 CSS. Since usually connected mode UE does not need to receive SIB and RAR. Thus for SIB, it is still based on beam sweeping operation, and for RAR, it is based on the RACH beam as legacy approach. But after UE sends a RAR, there would be a potential case with 2 beams – one for RAR, the other for other signals. One way is to use the beam for RAR to receive all signals to avoid default beam collision similar to CORESET0, another way is to define a gap where UE does not receive anything else before it decodes RAR, but this would take too much overhead.**Option 1: Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC: * DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH

**Option 2: Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC: * DMRS(s) associated with non-UE-dedicated reception on Type2/3 CSS and USS and the associated PDSCH
* No additional beam indication mechanism for Type0/1 CSS
* After a CB-PRACH, the QCL and spatial relation assumption for the PDCCH/PDSCH/PUCCH/PUSCH and aperiodic CSI-RS across CCs at least within a band should be reset to be associated with the SSB associated with the CB-PRACH

 [Mod: Please see revised version based on Qualcomm’s comment] |
| Ericsson | Proposal 1.B-3: Support. We think it’s a good idea to remove the brackets.[Mod: Please check latest version where restriction against non-USS is FFS]Proposal 1.C: Support the intention, and Futurewei’s clarification. Then, the mechanisms are not used to update the TCI state – that is simply RRC. Based on Futurewei’s proposal:**Proposal 1.C**: On Rel.17 unified TCI framework, for any DL RS that does not share the same indicated Rel-17 TCI state(s) as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC, but can be configured as a target DL RS of a Rel-17 DL TCI (hence the Rel-17 DL TCI state pool), R17 mechanism(s) which reuse the Rel-15/16 TCI state update signaling/configuration design(s) are used to update/configure such DL RSs with a Rel-17 TCI state.[Mod: I tend to agree with this assessment]Proposal 1.E: Support. To Oppo: having the same PC parameters for all SRS resources in a set can be achieved by configuration, and as we see it, it’s the most reasonable configuration. Defining different PC parameters for different TCI states is more of a corner case.  |
| Lenovo/MotM | Proposal 1.B-3: Support.Proposal 1.C: Support Futurewei’s proposal.Proposal 1.E: Support. |
| LG | Proposal 1.C: Prefer FL’s version because Futurewei’s version could be interpreted as copying all legacy features into Rel-17 framework, which could be redundant. [Mod: Please check revision based on Ericsson’s explanation]Proposal 1.E: Regarding OPPO’s concern on maintaining same Pc parameters within a same SRS resource set, we are supportive to keep the principle(i.e. maintaining same Pc parameter within a set), but to quickly switch and align power control for those UL channels/RSs sharing a same TCI state, 1.E gives benefit obviously. We are fine to add an FFS on how to maintain same Pc within a same SRS resource set if it can address OPPO’s concern. |
| ZTE2 | Proposal 1.B-3: After further offline discussion, we can NOT live with this version. We do not see any clear reason of distinguishing the CORESET with or without being associated with USS. Notice that we are not aware which CORESET is UE specific or not. **Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC: * DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH~~, if the CORESET(s) is associated any USS set~~
	+ ~~FFS: if the CORESET(s) is not associated any USS set~~

[Mod: Please see revised version based on Qualcomm’s input.]  |
| Qualcomm | For Proposal 1.B-3, suggest to put SS type in a general SS. In our understanding, no need any restriction. In R15/16, TCI can be configured to CORESET 0 regardless the SS type associated with it. No any restriction in spec. Similarly, there should be no any restriction for R17 TCI. **Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC: * DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH, ~~if the CORESET(s) is associated any USS set~~
	+ ~~FFS: if the CORESET(s) is not associated any USS set~~
	+ FFS: Any restriction on the SS type associated with the CORESET(s)

[Mod: Let’s try this way (which I think makes more sense at least to me)] For Proposal 1.C, supportFor Proposal 1.E, support |
| Samsung | **Proposal 1.B-3:** Support.Regarding issue raised by Oppo on CORESET#0, we are with MediaTek’s explanation that network has the flexibility to configure CORESET#0 with a TCI state whose Source RS is QCLed with SSB.We see a benefit in having different beams for UE-dedicated channels and UE-common channels when the CSS is using a CORESET not shared with USS, as these channels can have different coverage requirements. To address the concern from Apple in requiring the UE to support 2 different beams, we can have a UE capability that indicates whether the UE uses the same beam for UE common and UE-dedicated channels or if it can use separate beams.**Proposal 1.C**: Support**Proposal 1.E**: Support. Regarding Oppo’s concern, the proposal states: “This is only applicable for SRS sets using Rel-17 TCI state to determine their spatial relation”. It is not precluded to have Rel-15/16 TCI states for SRS that follow the Rel-15/16 power control behavior. This is up to network implementation. |
| InterDigital | It is important for resolution that Proposal 1.B-3 and Proposal 2.A.1 should be concluded simultaneously (not one-by-one approach), as some companies suggest resolving Proposal 2.A.1 first, and others suggest addressing Proposal 1.B-3, but they are strictly correlated in terms of CSS/USS.@Qualcomm, I think Rel-17 situation is different from before, as the Rel-17 TCI (so far agreed for intra-cell) can be dynamically indicated by DCI (1\_1/1\_2 at least) which will change not only for PDSCH beam but also for CORESET beams, then we need to agree clear behaviors on any possible cases regarding CORESET beams in relation to CSS/USS.Our view is the current formulation of Proposal 1.B-3 seems no problem which clearly says “if the CORESET(s) is associated with any USS set”. Then, gNB implementation way mentioned by Ericsson to avoid any impacts to CSS has still a practically meaningful trade-off option, which still offers a flexibility to gNB to manage beams for CSS/USS.We are fine with the following updates (in red) for both Proposal 1.B-3 and Proposal 2.A.1:===========**Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC: * DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH, if the CORESET(s) is associated with any USS set
	+ FFS: if the CORESET(s) is not associated with any USS set

**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels and signals as for intra-cell beam management ~~configured to the same cell~~
	+ Note the same restriction for intra-cell beam management applies here, i.e., DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH, if the CORESET(s) is associated with any USS set

===========For **Proposal 1.C**, we also prefer the above FL’s version, as it clearly says “Rel-15/16 TCI state update signaling/configuration mechanism(s) are reused to update/configure the Rel-17 TCI state”, meaning legacy Rel-15/16 signaling elements can be directly reused. But, in Futurewei’s proposal, it sounded like a different signaling structure based on copying all legacy features into Rel-17 framework as LG pointed out, which we don’t see the necessity of doing that.For **Proposal 1.E**, we are okay with the FL’s version with updates by Convida. We share most of other companies’ views to respond to OPPO’s concern, as the Rel-17 agreed features so far already add more flexibility in terms of power control, compared with previous releases. And, gNB has still a flexibility to do the same behavior as legacy, e.g., for the SRS resource set-level same PC, so no problem. |
| Mod V17 | 1.B-3 and 1.C: revised based on input. Essentially the same direction as before1.E: no revision other than editorial |
| Futurewei2 | **Proposal 1.B-3:** This proposal and Proposal 2.A-1 are highly related. Suggest we resolve Proposal 2.A-1 first. Please also see our comments on Proposal 2.A-1.**Proposl 1.C:** To LG’s comments, our revision is not “copying all legacy features into Rel-17 framework, which could be redundant.”, it is just the R17 mechanism which reuse the Rel-15/16 TCI state update signaling/configuration design(s) to up-date/configure the Rel-17 TCI state. Since there exist no Rel-17 TCI state(s) in Rel-15/16, the original wording “Rel-15/16 TCI state update signaling/configuration mechanism(s) are reused to update/configure the Rel-17 TCI state” is misleading. We are also fine with Ericsson’s/FL’s latest revision with a small change: **Proposal 1.C**: On Rel.17 unified TCI framework, for any DL RS that does not share the same indicated Rel-17 TCI state(s) as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC, but can be configured as a target DL RS of a Rel-17 DL TCI (hence the Rel-17 DL TCI state pool), R17 mechanism(s) which reuse the Rel-15/16 TCI state update signaling/configuration design(s) are used to update/configure such DL RS(s) with Rel-17 TCI state(s). |
| AT&T | Proposal 1.B-3: support. Proposal 1.C: support |
| FGI/APT | Proposal 1.B-3: We support the latest FL proposal Proposal 1.C: With current shape formed by FL, we can support it. FW’s latest modification is also fine with us. Proposal 1.E: Support  |
| Samsung | **Proposal 1.B-3:** Support. We agree with Qualcomm’s point that Rel-15/16 has no restriction on having the same beam for UE dedicated and UE common channels for the intra-cell case.**Proposal 1.C:** Prefer original wording.**Proposal 1.E:** Support |

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

Table 3 Summary: issue 2 (from round 1)

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| **Proposal** | **Companies’ views** |
| 2.A-1 (applicable channels) | **Support**: Ericsson, Samsung, Qualcomm, Apple, MTK, NTT Docomo, AT&T, Spreadtrum, Lenovo/MotM, OPPO, Xiaomi, CATT, ZTE, CMCC, Sony, Nokia/NSB, Futurewei, FGI/APT, **Not support**: vivo, Huawei/HiSi,  |
| 2.A-3 (multiple cells) | **Support**: Ericsson, Samsung, Qualcomm, MTK, NTT Docomo, AT&T, Spreadtrum, Lenovo/MotM, OPPO, Xiaomi, CATT, ZTE, CMCC, Sony, Nokia/NSB, Futurewei, FGI/APT, **Not support**: vivo |
| 2.A-5 (indirect QCL) | **Support**: Ericsson, Samsung, Qualcomm, Intel, Apple (together with 2.A-1, keep ‘at leas’), MTK (keep ‘at least’), NTT Docomo, AT&T, Spreadtrum, Lenovo/MotM, OPPO, Xiaomi, CATT, LG, ZTE, CMCC, Sony, Nokia/NSB, Futurewei, FGI/APT, **Not support**: vivo (delete ‘at least’),  |

**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:

* The same channels and signals as for intra-cell beam management, with the following restriction for PDCCH reception with a physical cell ID different from the serving cell:
	+ If the PCCCH reception is associated with Type0/1/2 CSS set, it cannot be associated with a CORESET that is associated with a USS set

**Proposal 2.A.3**: On Rel.17 beam indication enhancements for inter-cell beam management, for the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation):

* Support a UE feature on how many cells (including the serving cell) can be associated with the activated TCI states, where the list of candidate values includes 1
* Note: If UE reporting is configured for only one physical cell ID, the NW can [activate TCI states associated with either the same physical cell ID as or a different physical cell ID from that of the serving cell] [only activate TCI states associated with the same physical cell ID as that of the serving cell]

**Proposal 2.A.5**: On Rel.17 beam indication enhancements for inter-cell beam management, SSB associated with a physical cell ID different from that of the serving cell is used as an indirect QCL reference for the same channels and signals as for intra-cell beam management

* Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel. Here, Rel-15/16 QCL rule is reused by replacing SSB with SSB associated with a physical cell ID different from that of the serving cell

Table 4 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | **1) Check and update Table 1 if needed****2) Share your inputs on the above FL proposals. In particular:*** **2.A-1: please respond to Huawei’s and vivo’s comments**
* **2.A-3: previous version was used with Docomo’s note**
* **2.A-5: previous version was used (‘at least’ is kept)**
 |
| vivo | Question: What are companies understanding with RAN2’s agreement: “UE receives and transmits using UE-dedicated channel on TRP with different PCI” and “UE should use common channels BCCH PCH etc. from the serving cell (as in legacy)”?* RAN2 confirm the simplified procedures on the inter-cell multi-TRP-like model as a baseline RAN2 understanding:

Scenario 1: Inter-cell multi-TRP-like model  1. UE receives from serving cell, configuration of SSBs of the TRP with different PCI for beam measurement, and configurations needed to use radio resources for data transmission/reception incl resources for different PCI.  2. UE performs beam measurement for the TRP with different PCI and report it to serving cell. 3. Based on the above reports, TCI state(s) associated to the TRP with different PCI is activated from the serving cell (by L1/L2 signaling).  4. UE receives and transmits using UE-dedicated channel on TRP with different PCI.  5. UE should be in coverage of a serving cell always, also for multi-TRP case, e.g. UE should use common channels BCCH PCH etc. from the serving cell (as in legacy). |
| Huawei/HiSi | **Proposal 2.A.1:** First, according to the response from Darcy, we suggest changing “the same cell” as “the unchanged serving cell”. Assuming Proposal 1.B-3 for intra-cell case is agreed, it is still unclear to us whether Proposal 2.A.1 would ask the UE to receive system information from a cell with a PCI that is different from the serving cell. If the answer is yes, then this goes directly against the WID updated in RAN#92-e. If the answer is no, then the non-UE-dedicated channels should not be included in the proposal |
| NTT Docomo | Proposal 2.A.1: Support. But, we are not sure what “configured to the same cell” intends. If we remove it, we can understand what the proposal means, so we feel this part can be removed.Proposal 2.A.3: Support.Proposal 2.A.5: Support. |
| ZTE | Proposal 2A.1: Firstly, we can not live with the description of ‘the unchanged serving cell’. In our views, the intention of this proposal is align the same solution for between intra-cell and inter-cell mobility. If revised to ‘unchanged serving cell’, it seems that we come back to the proposal 1.B-3. As a compromise, we are fine to use the wording as in RAN2 LS like ‘inter-TRP with different PCI’. Then, we are fine with Huawei’s suggestion that UE may not decode the SIB message from the TRP/cell with different PCI.Proposal 2.A.3, after double thinking, it may be relevant to on-going discussion in 8.1.2.2. So, we suggest to wait for the conclusion/agreement in 8.1.2.2[Mod: No reason to wait for 8.1.2.2 since WID clearly states this is based on Rel-17 framework while 8.1.2.2 Rel-15/16.] Proposal 2.A.5, ‘at least for UE-dedicated PDSCH and UE-dedicated PDCCH’ is unclear. May I assume to use the same wording in Proposal 2.A.1, like ‘for the same channels as for intra-cell beam management configured to the same cell’. Then, we prefer to consider direct QCL reference herein. [Mod: Correct. But direct QCL is opposed by many companies as I have repeatedly said in previous rounds.] |
| Sony | Proposal 2.A.3: we are okay with the direction. We just would like to ask a clarification question regarding the ‘note’. That is if UE reports only 1 cell can be associated with active TCI state(s), should the cell be serving cell, rather than a non-serving cell? If not, NW can only activate TCI states associated with non-serving cell, but not the serving cell. This seems not the intention of the proposal here. Perhaps I get something wrong, please let me know, if any. Thanks in advance.[Mod: Please check MTK’s response] |
| Convida Wireless | Fine with the proposals, but an editorial suggestion: “On Rel.17 beam indication enhancements for inter-cell beam management”[Mod: Thanks for the catch] |
| OPPO | Considering the CORESET#0, we realize that proposal 2.A.1 might not work if it requires the rel-17 indicated TCI state to apply on all CORESET#0.The reason is that as specified in 213, when a CORESET#0 is indicated with a TCI state, the CSI-RS resource in that TCI state must be QCLed with a SSB and the UE use that SSB to derive the monitoring occasions for PDCCH candidate of Type0/0A/2 CSS. Apparently, in rel-17 inter-cell BM, the UE can not be provided with a TCI state with a CSI-RS QCLed to non-serving cell SSB to the CORESET#0 because the UE is not able to derive CSS monitoring occasions based on any SSB associated with a PCID that is different from that of the serving cell.Prefer to change it as follows to preclude the CORESET#0:**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels as for intra-cell beam management configured to the same cell
* CORESET#0 is not included here.

[Mod: please latest versions (which should resolve your concern) and also check responses from MTK, Ericsson, ...]  |
| MediaTek | Proposal 2.A.1: Support. According to the latest Proposal 1.B-3, this will not conflict with Scenario 1 agreed in RAN2. We also fine to add restriction under Proposal 2.A.1to strictly align the WID, e.g., PDCCH reception associated with Type0/1/2 CSS set cannot be associated a CORESET if the if the CORESET is associated with any USS set, if this can address the concern on both Proposal 1.B-3 and Proposal 2.A.1. [Mod: Added]Proposal 2.A.3: Support with minor change to align the wordings of the first and second bullet.* Note: If UE reporting supports one physical cell ID, the NW can activate TCI states associated with a physical cell ID either the same as or different from that of the serving cell

[Mod: Done]Re the question from Sony: We think NW can activate TCI states associated with only one non-serving cell for the channels included in Rel.17 beam indication enhancements for inter-cell management (i.e., according to Proposal 2.A.1). For other channels not included, NW can activate TCI states associated with the serving cell based on Rel-15/16 mechanism. Proposal 2.A.5: Support |
| Apple | Proposal 2.A.1: Response to vivo and Huawei: RAN reverted this agreement and define the WID as follows:* + 1. 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

If current proposal is not agreeable, we suggest we think about option 2 from proposal 1.B-3 we proposed above.Proposal 2.A.5: Maybe this can be reformulated as follows to avoid the dedicated vs common discussion.**Proposal 2.A.5**: On Rel.17 beam indication enhancements for inter-cell management, SSB associated with a physical cell ID different from that of the serving cell can be indicated as the QCL source of the periodic TRS based on legacy QCL rule |
| Ericsson | We understand that RAN2 is preparing an LS to RAN1 that includes among other things the issue on common channels. As we see it, the UE can never be requested to read common channels from the other cell – this would mean that we (partly) change serving cell.We note that Proposal 1.B-3 states that CORESET(s) that are not associated with any USS set are excluded. If this limitation is kept also for the inter-cell case, it is possible for the NW to avoid any issue by configuration. Simply configure all common channels to use CORESET#0 and all USS transmissions to use CORESET#1. We note that already in Rel-15, successful reception of common channels require proper configuration regarding the TCI states.[Mod: The current version of 1/B-3 keeps this limitation FFS since several companies raised concern. But please check latest version of 2.A-1 based on MTK’s comment]With this understanding we propose to shorten Proposal 2.A-1:**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels as for intra-cell beam management

[Mod: Done]The statement related to the “same cell” seems to be confusing, so it would be good to avoid it.Proposal 2.A.3: SupportProposal 2.A.5: Support |
| Lenovo/MotM | Proposal 2.A.1: The word “configured to the same cell” shall be removed as it causes confusion. It is clear what channels are configured for intra-cell beam management.Proposal 2.A.3: Support MediaTek’s change.Proposal 2.A.5: Support. |
| LG | Proposal 2.A.1: Given the discussion, we feel that it will be safer to spell out the list of channels applicable for inter-cell BM considering a possibility to agreeing on other channels for intra-cell BM later, which may not be applicable for inter-cell BM. |
| ZTE2 | Proposal 2.A.5: Besides that we can NOT live with ‘UE-dedicated XXX’, we further identify one issue that from UE perspective, it may assume the SSB with same ID from different cell have same QCL assumption. It may be serious issue for inter-cell mobility. So, we think that the clarification on inter-cell SSB linkage should be discussed firstly. [Mod: Please check latest version] |
| Qualcomm | For Proposal 2.A.1, share the same view with LG. The channels should be clearly listed. **Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The PDCCH/PDSCH/PUSCH/PUCCH ~~same channels as for intra-cell beam management~~ configured to the same cell

[Mod: Please check current version]For Proposal 2.A.3, please remove the last Note. If UE only supports 1 PCI, only serving cell TCI should be activated. Otherwise, NW cannot configure TCI for CORESET 0 on the serving cell. * ~~Note: If UE reporting supports one physical cell ID, the NW can activate TCI states associated with either a serving cell or a non-serving cell~~

[Mod: Actually this is a very valid point. I put this text in brackets for now to be discussed further. If we can agree to what you said, we need to clearly state it in the proposal to avoid misunderstanding]For Proposal 2.A.5, support |
| Samsung | **Proposal 2.A.1**: Support. It is our understanding that in the case of inter-cell beam management, the CORESET configured for UE-dedicated channels with TCI state with a source RS from the neighboring cell (with a PCI different from that of the serving cell) can’t be used for CSS. Hence, common channels continue to be received/transmitted from/to the serving. The same channels and signals of intra-cell beam management apply to inter-cell beam management, with the above restriction. If it helps we can add:**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels and signals as for intra-cell beam management configured to the same cell. A CORESET configured with a TCI state with a source RS from the neighboring cell (with a PCI different from that of the serving cell), can only be used for USS and can’t be used for CSS.

[Mod: Please see latest version]**Proposal 2.A.3**: Support**Proposal 2.A.5**: Support. Our understanding of “at least” is that his can apply to other signals (e.g. those of agreement/proposal 1.B-1) |
| InterDigital | As mentioned in Issue 1, it is important for resolution that Proposal 1.B-3 and Proposal 2.A.1 should be concluded simultaneously (not one-by-one approach), as some companies suggest resolving Proposal 2.A.1 first, and others suggest addressing Proposal 1.B-3, but they are strictly correlated in terms of CSS/USS.We share the same views with DOCOMO, Ericsson, and Lenovo/MotM in terms of the confusion by “configured to the same cell” in the sub-bullet of Proposal 2.A.1. So, we also suggest removing that expression, but we see the removal is okay as long as we agree both of Proposal 1.B-3 and Proposal 2.A.1 simultaneously (in an aligned way) and make it clear by adding a Note on the Proposal 2.A.1 as shown below:In short, we are fine with the following updates (in red) for both Proposal 1.B-3 and Proposal 2.A.1:===========**Proposal 1.B-3**: On Rel.17 unified TCI framework, for intra-cell beam indication, the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC: * DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH, if the CORESET(s) is associated with any USS set
	+ FFS: if the CORESET(s) is not associated with any USS set

**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels and signals as for intra-cell beam management ~~configured to the same cell~~
	+ Note the same restriction for intra-cell beam management applies here, i.e., DMRS(s) associated with non-UE-dedicated reception on CORESET(s) and the associated PDSCH, if the CORESET(s) is associated with any USS set

===========[Mod: Some companies expressed concern with agreeing to the restriction in 1.B-3 and prefer to keep it FFS for now]For **Proposal 2.A.3**, support the update by MediaTek.For **Proposal 2.A.5**, considering still raised concerns by some companies, we are fine with Apple’s revision to directly mention that the TRS can have a source SSB with a different physical cell ID. |
| Mod V17 | Revised |
| Futurewei | **Proposal 2.A.1:** Thisproposal and Proposal 1.B-3 are related as it quotes “The same channels as for intra-cell beam management configured to the same cell”, which is discussed in Proposal 1.B-3. Also this proposal and the discussions are highly related to the topic of applicable channels/signals regarding “a UE can transmit to or receive from only a single cell” in inter-cell beam management, which is to be discussed in this meeting per conclusion from RAN#92-e, and which is listed as Issue #2.9 in the Round 0 discussion. If we could discuss this topic first and get a conclusion before touching the other proposals as we commented in Round 0, we could have avoided many confusions and unnecessary discussions. In our opinion, the applicable channels/signals regarding “a UE can transmit to or receive from only a single cell” should be the UE-specific data/control channel(s). Otherwise, if the applicable channels/signals also include the common channels, then it is against the WID as the transmission of common channels from a non-serving cell implies a change of the serving cell. With this understanding, we would like to make the following modifications:**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The UE-specific channels configured to the same cell

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| AT&T | Proposal 2.A.1: support. Editorial change “PCCCH -> PDCCH”Proposal 2.A.3: support. With the note from Mediatek. Proposal 2.A.5: support.  |
| FGI/APT | Proposal 2.A.1: Support in principle. Few comments following. Regarding the sub-bullet, we are not sure what it means by “PDCCH reception with a physical cell ID…”. Maybe proper to say “PDCCH reception associated with a physical cell ID…”. In addition, regarding the sub-sub-bullet, do we need to consider Type0A/3 CSS set as well? Proposal 2.A.3: For the Note bullet, it seems better to put a “**or**” between those two sentences with brackets. However, we are not a big fan of having a note involved with many brackets. Maybe we can try the following way? * Note: If UE reporting is configured for only one physical cell ID, the NW can do one of the followings:
	+ activate TCI states associated with either the same physical cell ID as or a different physical cell ID from that of the serving cell,
	+ only activate TCI states associated with the same physical cell ID as that of the serving cell

Proposal 2.A.5: Support  |
| Huawei, HiSilicon | Proposal 2.A.3: As the serving cell should remain unchanged, we suggest replacing “how many cells” as “how many physically cell IDs”. Also we failed to understand the meaning of “If UE reporting is configured for”...Proposal 2.A.1 and 2.A.5: We think there is some overlap between these two proposals, as they both mentioned “same channels and signals as for intra-cell beam management”. And it seems Proposal 2.A.1 still allows for changing QCL assumption for non-UE-dedicated CORESET (indirectly) to an SSB with an PCI that is different from the serving cell (as long as it is not associated with USS), which goes against the WID that the serving cell remains unchanged. To be on the safe side, we suggest changing to “UE-specific channel/signal(s)” in Proposal 2.A.1 and 2.A.5.  |
| Samsung | **Proposal 2.A.1:** OK for progress, with some minor updates:**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels and signals as for intra-cell beam management, with the following restriction for PDCCH and associated PDSCH reception with a physical cell ID different from the serving cell:
	+ If the P~~C~~DCCH reception is associated with Type0/0A/1/2 CSS set, it cannot be associated with a CORESET that is associated with a USS set

**Proposal 2.A.3**: OK for progress. If we accept the second square bracket, i.e. only activate TCI states associated with the same physical cell ID as that of the serving cell]. This implies that when the number of candidate PCIs is 1, inter-cell beam management is not supported. We prefer that if inter-cell beam management is supportted that the number of candidate PCIs (including the serving cell PCI) is at least 2.**Proposal 2.A.5**: We can support with the following change. We are discussing QCL source for DL channels**Proposal 2.A.5**: On Rel.17 beam indication enhancements of DL channels and signals for inter-cell beam management, SSB associated with a physical cell ID different from that of the serving cell is used as an indirect QCL reference for the same channels and signals as for intra-cell beam management * Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel. Here, Rel-15/16 QCL rule is reused by replacing SSB with SSB associated with a physical cell ID different from that of the serving cell
 |
| Vivo | We are fine for the following direction, with the following update:**Proposal 2.A.1**: On Rel.17 beam indication enhancements for inter-cell beam management, the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation) applies to:* The same channels and signals as for intra-cell beam management, with the following restriction that Rel-17 MAC-CE-based and/or DCI-based beam indication is not applicable for PDCCH/PDSCH reception and PUSCH/PUCCH transmission with a physical cell ID different from the serving cell:
	+ PDCCH/PDSCH reception and PUSCH/PUCCH transmission scheduled by a CORESET associated with Type0/1/2 CSS set.
	+ If the PDCCH reception is associated with Type0/1/2 CSS set, it cannot be associated with a CORESET that is associated with a USS set

We are ok with this understanding: only activate TCI states associated with the same physical cell ID as that of the serving cell. But not ok with “activate TCI states associated with either the same physical cell ID as or a different physical cell ID from that of the serving cell”.**Proposal 2.A.3**: On Rel.17 beam indication enhancements for inter-cell beam management, for the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation):* Support a UE feature on how many cells (including the serving cell) can be associated with the activated TCI states, where the list of candidate values includes 1
* Note: If UE reporting is configured for only one physical cell ID, the NW can [activate TCI states associated with either the same physical cell ID as or a different physical cell ID from that of the serving cell] [only activate TCI states associated with the same physical cell ID as that of the serving cell]

For proposal 2.A.5, with the latest proposal 2.A.1, there is already restriction different from intra-cell BM, we prefer to refer to the channels in 2.A.1.**Proposal 2.A.5**: On Rel.17 beam indication enhancements for inter-cell beam management, SSB associated with a physical cell ID different from that of the serving cell is used as an indirect QCL reference for the applicable channels ~~the same channels and signals as for intra-cell beam management~~ * Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel. Here, Rel-15/16 QCL rule is reused by replacing SSB with SSB associated with a physical cell ID different from that of the serving cell
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### Issue 3 (beam indication signaling medium)

Round 3

### Issue 4 (MP-UE)

Round 3

### Issue 5 (MPE mitigation)

Round 3

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

Round 3

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| 5 | R1-2106640 | Remaining Details on Enhancements for Multi-beam Operation | IDC, Inc. |
| 6 | R1-2106666 | Enhancements on Multi-beam Operation | Lenovo, Motorola Mobility |
| 7 | R1-2106685 | Enhancements on Multi-beam Operation | Spreadtrum Communications |
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| 30 | R1-2106548 | Further details on Multi-beam and Multi-TRP operation | ZTE |
| 31 | R1-2106671 | HARQ feedback of SPS PDSCH reception in multi-DCI based multiple TRPs | Lenovo, Motorola Mobility |
| 32 | R1-2106872 | Additional enhancements for multi-beam | Samsung |
| 33 | R1-2107210 | Discussion on further enhancements for multi-beam operation | OPPO |
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