**3GPP TSG RAN WG1 #106bis-e R1-2110492**

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

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#2 for multi-beam enhancement: ROUND 1

**Document for:** Discussion and Decision

## Introduction

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

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| 1. Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:
	1. Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management for intra-cell and inter-cell scenarios to support higher UE speed and/or a larger number of configured TCI states:
		1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA
		2. Unified TCI framework for DL and UL beam indication
		3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)
		4. For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done). This includes L1-only measurement/reporting (i.e. no L3 impact) and beam indication associated with cell(s) with any Physical Cell ID(s)
			1. The beam indication is based on Rel-17 unified TCI framework
			2. The same beam measurement/reporting mechanism will be reused for inter-cell mTRP
			3. This work shall only consider intra-DU and intra-frequency cases
	2. Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection
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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 | Max number of configured TCI states | **Define max # configured TCI states:*** **Joint/DL TCI apart from UL TCI:** 128 (Docomo, …)
* **Total number across all types of TCI (joint, DL, and UL):** 256 (Docomo, Samsung …)

**Define max # configured TCI states per BWP/CC**:* **Yes**: ...
* **No**: Docomo, Samsung
 |
| 1.9 | For separate TCI, UL TCI state poolAlt1: Shared pool with joint/DL TCI stateAlt2: Separate pool Note: Strictly speaking, this could be decided in RAN2. Therefore, if there is no consensus, this will be left to RAN2 | **Alt1:*** **Support (12)**: vivo, Spreadtrum, Samsung, Xiaomi, ZTE, Qualcomm, MTK, Convida, NTT Docomo, Intel, CATT, TCL
* **Concern**:

**Alt2**: * **Support** (11): CMCC, Ericsson, Futurewei, Huawei/HiSi, Fraunhofer IIS/HHI, IDC, Sony, Apple, AT&T
* **Concern**:
 |
| 1.10 | 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 (9):** Spreadtrum, OPPO, Intel, Apple, Sony, Ericsson, Huawei/HiSi, Futurewei, Docomo

SRS for BM, optionally with TRS as QCL Type-A source RS* **Yes (8):** ZTE, IDC, Spreadtrum, Samsung, Convida, Nokia/NSB, vivo, Xiaomi
* **No (11):** Sony, OPPO, Fraunhofer IIS/HHI, MTK, Intel, Ericsson, Huawei/HiSi, LG, Futurewei, Docomo
 |
| 1.11 | BFR enhancement for unified TCI: X symbols after the UE receives the BFRR, the new/updated QCL source RS applies to both UE-dedicated PDCCH and PDSCH | **Yes**: Apple, NEC, Docomo**No**: |
| 1.12 | BFR enhancement for unified TCI: can BFD RS share the same indicated Rel-17 TCI state as UE-dedicated PDSCH/PDCCH? | **Yes**: NEC, NTT Docomo, Convida, Apple (only CSI-RS without QCL indication, but we suggest to make it in a general way), Huawei, HiSilicon**No**:  |
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Based on the above observation, the following moderator proposals can be made:

**Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states (including joint TCI state(s), DL-only TCI state(s), and/or UL-only TCI state(s)) ... [after more discussion]

**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

**Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, a list of 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) is configured via RRC.

**Proposal 1.G**: On path-loss measurement for Rel.17 unified TCI framework, at least for discussion purposes, when both PL-RS and UL TCI spatial relation RS are not the same CSI-RS for BM, “beam alignment” also pertains to the following events:

* The PL-RS is identical to the QCL Type-D or spatial relation RS of UL or (if applicable) joint TCI spatial relation RS
* The QCL Type-D RS of PL-RS is identical to the UL or (if applicable) joint TCI spatial relation RS
* The QCL Type-D RS of PL-RS is identical to the QCL Type-D or spatial relation RS of UL or (if applicable) joint TCI spatial relation RS
* [When UL spatial relation RS of UL TCI spatial relation RS is a BM SRS resource, the PL-RS or the QCL Type-D RS of PL-RS is identical to the configured PL-RS of the SRS resource]

**Proposal 1.H**: On Rel.17 unified TCI framework, 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 can be associated with an UL or (if applicable) joint TCI state per BWP via RRC

Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | **1) Check and update your view Table 1****2) Share your inputs on the above FL proposals esp re*** **New proposals 1.B.1, 1.B.2**
* **Wording refinement for proposals 1.G and 1.H (changed ‘is’ to ‘can be’). We have already discussed these two for 4 weeks!**
 |
| NTT Docomo | **Issue 1.1/Proposal 1.A**: at least 128 TCI states should be supported for joint TCI states, same as Rel. 15 TCI states. For separate TCI states, 128 DL TCI states should be supported for DL, and 64 or 128 UL TCI states should be supported for UL. For max # configured TCI states per BWP/CC, if we follow Rel.15, max number of configured TCI state per CC and max number of active TCI states per BWP per CC should be reported (as below). We don’t see necessity to define configured TCI states per BWP per CC.

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| ***tci-StatePDSCH* (TS38.306)**Defines support of TCI-States for PDSCH. The capability signalling comprises the following parameters:- *maxNumberConfiguredTCIstatesPerCC* indicates the maximum number of configured TCI-states per CC for PDSCH. For FR2, the UE is mandated to set the value at least to 64 (i.e. value 128 is an optional value). For FR1, the UE is mandated to set these values at least to the maximum number of allowed SSBs in the supported band;- *maxNumberActiveTCI-PerBWP* indicates the maximum number of activated TCI-states per BWP per CC, including control and data. If a UE reports X active TCI state(s), it is not expected that more than X active QCL type D assumption(s) for any PDSCH and any CORESETs for a given BWP of a serving cell become active for the UE. The UE shall include this field.Note the UE is required to track only the active TCI states. |

**Proposal 1.B.1**: Support. It is aligned with existing Rel.15 QCL chain.**Proposal 1.B.2**: Does it imply that “a list of DL channels/signals”, which is target RS of Rel.17 TCI state is configured? Originally, we assumed that Rel.17 TCI states are configured for each DL/channel/signals (similer as Rel.15 TCI state configuration). In that case, the “list of DL channels/signals” seems not needed. Could you clarify why “a list of DL channels/signals” is needed?**Proposal 1.G**: Support. **Proposal 1.H**: We don’t see much difference between “is” and “can be”. **@Qualcomm**, could you repeat what is the intention of the update?**Issue 1.10 (Additional source RS type for DL QCL):** Considering the limited remaining workload of Rel.17, we think this is low priority.**Issue 1.11/12 (BFR):** We believe the discussion for the relation between unified TCI and BFR is important and essential.  |
| vivo | **Proposal 1.A**: In Rel-17 unified TCI framework, 3-bits TCI field in beam indication DCI is reserved to indicate common beam. There is no motivation to increase the number of active TCI codepoints considering M=N=1 case. The number of configured TCI states by RRC in Rel-15/Rel-16 is enough. We support:**Revised Proposal 1.A**: On Rel.17 unified TCI framework, for Rel-17 unified TCI, the largest number of configured TCI states (including joint TCI state(s), DL-only TCI state(s), and/or UL-only TCI state(s)) is 128.**Proposal 1.B.1:** We prefer to agree on 1.B.2 first before we touch this issue since it would be confusing if the source RS needs to follow the indicated joint TCI.**Proposal 1.B.2:** Agree in principle, but both DL and UL channels/signals need to be included, e.g. aperiodic CSI-RS for CSI, aperiodic CSI-RS for BM, aperiodic SRS for BM. The application of Rel-17 TCI state for aperiodic CSI-RS and aperiodic SRS can be flexibly configured via RRC per resource set or per usage.**Revised Proposal 1.B.2:** On Rel.17 unified TCI framework, for Rel-17 unified TCI, a list of DL channels/signals that share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH and UL channels/signals that share the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources (via Rel-17 MAC-CE/DCI TCI state update) are ~~is~~ configured via RRC.* FFS: configuration per resource set, per resource or per usage.

**Proposal 1.G**: We still believe this is overdesign especially considering there is no RAN1 specifcation impact for this. These cases can be discussed in UE feature. Otherwise, RAN4 could find out the best way for dealing with this.**Proposal 1.H**: the following agreement was achieved in RAN1 #105e, which explicitly states that each of the TCI state should be associated with one of the settings. We prefer not to discuss the case that some of the TCI states are associated with PC settings while some others are not associated with PC settings.**Agreement**On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework,* For each of PUSCH and PUCCH, the setting of (P0, alpha, closed loop index) can be associated with UL or (if applicable) joint TCI state per BWP.
	+ In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.
	+ (Working Assumption) In this case, for each of the PUSCH and PUCCH, each of the activated UL or (if applicable) joint TCI states is associated with one of the settings.
* If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal per BWP is independent of the UL or (if applicable) joint TCI states
* FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.
* FFS: (to be decided in RAN1#106-e) whether to configure the same setting of (P0, alpha, closed loop index) per TCI state across channels and apply a channel dependent component, or configure a channel dependent setting of (P0, alpha, closed loop index) per TCI state

**Revised Proposal 1.H**: On Rel.17 unified TCI framework, 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 associated with each of the UL or (if applicable) joint TCI states in a BWP via RRC
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| MediaTek | Proposal 1.A: We think we should define the max number per CC, as the UE capability *maxNumberConfiguredTCIstatesPerCC* in Rel-15 where the max value is 128, and we prefer to keep the same number.Proposal 1.B.1: No strong preference, but we are okay.Proposal 1.B.2: We are fine to use RRC to indicate whether the DL channel/signal share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update). However, we prefer to configure this per RS resource/resource set or per CORESET, instead of using a list.Proposal 1.G: Regarding the main bullet, it is unclear what does “the same CSI-RS for BM” mean. Also, accoriding to the comment from HW, the definition of “TCI spatial relation RS” may not be clear, we can use “the spatial relation RS in the UL or (if applicable) joint TCI state” instead, which is used in the previous agreement.Thus, we suggest the following changes:**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, “beam alignment” also pertains to the following events:* The PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state
* The QCL Type-D RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state
* The QCL Type-D RS of PL-RS is identical to the QCL Type-D RS of the spatial relation RS in the UL or (if applicable) joint TCI state
* [When UL spatial relation RS of UL TCI spatial relation RS is a BM SRS resource, the PL-RS or the QCL Type-D RS of PL-RS is identical to the configured PL-RS of the SRS resource]

Proposal 1.H: In the main bullet, it is already mentioned “when”, and one setting need to be associated with each of the UL or (if applicable) joint TCI states according to previous agreement. Thus, we prefer the following change:**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 associated with each of the UL or (if applicable) joint TCI states in a BWP via RRC
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| Lenovo/MotM | Proposal 1.A: It needs to be clarified whether the number of configured TCI states under discussion is on per carrier, per band, or per UE basis.Proposal 1.B.1: Support. The R16 QCL rule for PDSCH/PDCCH should be reused.Proposal 1.B.2: Does this mean the channels/signals in the list are all in the same CC, or can they be in different CCs?Proposal 1.G: Support.Proposal 1.H: Support. |
| Qualcomm | For 1.A, support max # of 128 per BWPFor 1.B.1, fineFor 1.B.2, supportFor 1.G, support, prefer to keep the bracket for more clarificationFor 1.H, support. To our understanding, for TCIs not associated with any setting, they will use the default setting |
| Samsung | **Proposal 1.A:** Rel-15/16 supports 128 TCI states for DL beam indication within one cell. In Rel-17, the unified TCI framework is expanded to support, joint DL/UL TCI state indication, separate DL TCI state indication, separate UL TCI state indication, as well as intra-cell and inter-cell beam management. Therefore, we think that it is reasonable to increase the number of RRC configured TCI states to 256. This would reduce the number of required RRC reconfigurations for TCI states.**Proposal 1.B.1:** While supporting CSI-RS for CSI as a source RS is not an essential aspect for completing this work item, we are fine to support given that this is already supported in Rel-15/16 and for progress.**Proposal 1.B.2:** We are fine to have a list of channels/signals that follow the TCI state of UE dedicated channels. This should be for DL as well as UL channels/signals. **Proposal 1.G:** We see no need for the last bullet (in square bracks). If a the source RS of the UL or Joint TCI state is SRS for beam management, the beam alignment can be covered by case 1 or case 3.**Proposal 1.H:** We suggest the following update for clarity:**Proposal 1.H**: On Rel.17 unified TCI framework, when the setting of (P0, alpha, closed loop index) for PUSCH, PUCCH, and/or SRS are associated with UL or (if applicable) joint TCI state per BWP:* for PUSCH, an UL or (if applicable) joint TCI state can be associated with one setting per BWP via RRC
* for PUCCH, an UL or (if applicable) joint TCI state can be associated with another setting (possibly the same or different from PUSCH and/or SRS) per BWP via RRC
* for SRS, an UL or (if applicable) joint TCI state can be associated with another setting (possibly the same or different from PUSCH and/or PUCCH) per BWP via RRC

We think that Yan’s (Qualcomm) concern has been resolved by changing “is” to “can be”We also think that the WA in the following agreement (from RAN1#105-e) is no longer needed when we agree to proposal 1.H.**Agreement**On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework,* For each of PUSCH and PUCCH, the setting of (P0, alpha, closed loop index) can be associated with UL or (if applicable) joint TCI state per BWP.
	+ In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.
	+ (Working Assumption) In this case, for each of the PUSCH and PUCCH, each of the activated UL or (if applicable) joint TCI states is associated with one of the settings.
* If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal per BWP is independent of the UL or (if applicable) joint TCI states
* FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.
* FFS: (to be decided in RAN1#106-e) whether to configure the same setting of (P0, alpha, closed loop index) per TCI state across channels and apply a channel dependent component, or configure a channel dependent setting of (P0, alpha, closed loop index) per TCI state
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### Issue 2 (inter-cell beam management)

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.5 | Whether to support event-driven inter-cell beam reporting and if so the event definition* Alt1. Support L1-based event-driven beam reporting for inter-cell beam management and inter-cell mTRP
* Alt2. Support MAC CE based event-driven beam reporting for inter-cell beam management and inter-cell mTRP
* Alt3. In Rel-17, event-driven beam reporting is not supported for inter-cell beam management and inter-cell mTRP

Note: Since it was agreed to finalize this issue in RAN1#106bis-e, if there is no consensus or if Alt1 and Alt2 proponents cannot converge, Alt3 is by default the outcome for Rel-17 | **Alt1**: * Support (9): Huawei/HiSi, Xiaomi, Intel, Sony, LG, Samsung, Qualcomm (2nd preference), Futurewei
* Concern:

**Alt2**: * Support (11): ZTE, Lenovo/MotM, CATT, Xiaomi, NTT Docomo, Nokia/NSB, Apple, Qualcomm (1st preference), Convida
* Concern: Samsung

**Alt3 (4)**: OPPO, vivo, Ericsson, MTK |
| 2.6 | UCI design for L1-RSRP reporting: Reuse Rel-15 L1-RSRP table | **Yes:** Samsung, MTK, Qualcomm, Ericsson, ZTE, FGI/APT, Huawei, HiSilicon, CATT**No:**  |
| 2.7 | UCI design for L1-RSRP reporting: For K>1, reuse (K-1) Rel-15 differential L1-RSRP() relative to the first L1-RSRP value | **Yes:** Samsung, MTK, Qualcomm, Ericsson, Docomo**No:** ZTE (Differential L1-RSRP per non-serving cell/serving cell), CMCC (same as ZTE) |
| 2.8 | QCL assumption for paging reception after being activated with only one TCI state associated with PCI different from serving cell [2]Alt-1: UE to monitor paging in USS with the newly activated TCI state [11]Alt-2: UE to monitor paging in CSS configured for paging with the newly activated TCI state [offline] | Alt-1: Huawei, HiSilicon, Ericsson, DocomoAlt-2: Huawei, HiSilicon, Docomo |

Proposals 2.A and 2.B are taken from the final outcome of the offline discussion [1].

The following observation can be made:

* 2.3: There is no consensus in adding the additional restriction
* 2.4: Alt1 represents the super-majority view
* 2.5: Among the proponents of event-driven reporting, there is no consensus on whether to support L1-based or MAC-CE-based solution

Based on the above observation, the following moderator proposals can be made:

**Proposed conclusion 2.A**: On Rel-17 beam indication enhancements for inter-cell beam management, the supported number of physical cell IDs different from that of the serving cell that are associated with activated TCI states 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) will be decided as a part of UE feature discussion.

* Decide in conjunction with inter-cell mTRP, where the candidate value(s) include at least 1

**Proposed conclusion 2.B**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, for Rel-17 discussion purpose, RAN1 assumes that the reception of signals from TRPs with PCIs different from the serving cell compared to that for serving cell is within one CP length associated with the SCS of the active DL BWP.

* [For the case when the Rx signals from TRPs with PCIs different from the serving cell are within SMTC, legacy UE behavior remains]

**Proposal 2.D**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, NMAX (the maximum number of RRC-configured PCIs different from the serving cell for measurement/reporting) is up to UE capability with candidate values of 1 and X.

* Note: X as agreed in AI 8.1.2.2
* When NMAXis configured to be X, the UE is RRC-configured for L1-RSRP measurement with up to X PCIs different from the serving cell PCI
* Additional restriction may be added by RAN4
* FFS: UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability

**Proposal 2.E**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, [event-driven – after more discussion]

**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 beam indication does not apply) comprise:

* All PDCCH receptions on CORESET(s) along with the respective PDSCH receptions if the CORESET(s) is associated with any Type0/0A/1/2 CSS set

**Proposal 2.G**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP:

* The L1-RSRP reporting reuses Rel-15 L1-RSRP table
* 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 7-bit L1-RSRP

Table 4 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | **Proposals 2.A, 2.B, 2.D are relatively stable apart from some minor issues****1) Check and update your view in Table 3 (esp issue 2.5 per proponents’ strong request to continue discussion)****2) Share your inputs on the above FL proposals, especially re*** **Red text in proposed conclusion 2.B**
* **Any refinement needed for proposal 2.D**
* **New proposal 2.F (on the definition of non-UE-dedciated channels/signals raised by MTK)**
* **New proposal 2.G (on L1-RSRP reporting format)**
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| NTT Docomo | 2.A: Support.2.B: Support.2.D: Support.2.E: Support MAC CE based event triggered beam reporting. One drawback of beam reporting for non-serving cell would be larger UCI overhead (including higher reporting frequency). If event based beam reporting is supported, in addition to regacy beam reporting, gNB can configure legacy beam reporting in low frequency. For UCI based, since both gNB and UE should have the common understanding of UCI payload, it is difficult to use UCI for event based beam reporting. On the other hand, UE can send MAC CE whenever UE wants. Hence, we believe MAC CE is more suitable for the event triggered beam reporting.2.F: As agreed “Combo” proposal in RAN1#106e, “non-UE dedicated” is not supported for inter cell beam indication. Hence the intention of 2.F is to preclude “All PDCCH reception…”, is this correct understanding?

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| **Agreement**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 (to be concluded in RAN1#106bis-e): Non-UE-dedicated PUCCH and non-UE-dedicated PUSCH

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 channels and signals as for intra-cell beam management except for non-UE dedicated channels/signals
* For the aforementioned applicable channels and signals, SSB associated with a physical cell ID different from that of the serving cell is used as an indirect QCL reference for DL TCI (in case of separate DL/UL TCI) or joint TCI, or an indirect/direct QCL reference for UL TCI (in case of separate DL/UL TCI)
	+ 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
* For inter-cell beam management, the support of more than one Rel-17 active DL TCI state / QCL per band is a UE capability
	+ If UE does not support such capability, MAC-CE based beam indication (activation of one TCI state) can be used to switch between two different DL receptions along two different beams
		- Note: The serving cell does not change when beam selection is done
	+ Note: This does not preclude the possibility for TA update on non-serving cell
	+ FFS: For a UE supporting Rel.17 beam indication feature for inter-cell beam management, up to 5 CORESETs can be configured per BWP
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Proposal 2.G: For K>1, we can reuse (K-1) Rel-15 differential L1-RSRP, where the first L1-RSRP value is the largest L1-RSRP among serving cell/non-serving cell, and remaining K-1 L1-RSRP (includes both serving cell/non-serving cell) can be differential L1-RSRP. |
| vivo | For Proposed conclusion 2.B, RAN4 LS already says: For the case when the measurement RS from the non-serving cell is within SMTC in FR1, legacy measurement behavior based on L3 measurement may be reused from RAN4 perspective. So we propose the following revision:**Revised Proposed conclusion 2.B**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, for Rel-17 discussion purpose, RAN1 assumes that the reception of signals from TRPs with PCIs different from the serving cell compared to that for serving cell is within one CP length associated with the SCS of the active DL BWP.* For the case when the Rx signals from TRPs with PCIs different from the serving cell are within SMTC at least for FR1, legacy measurement UE behavior is reused.

For Proposal F, we are fine.For Proposal G, we are ok with the first bullet. But for the second bullet, we don’t understand the benefit of differential L1-RSRP within each cell, which has the larger UCI payload size compared to legacy report format. Therefore, we suggest removing the second bullet. **Revised Proposal 2.G**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP: * The L1-RSRP reporting reuses Rel-15 L1-RSRP table
* ~~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 7-bit L1-RSRP~~
 |
| MediaTek | Proposed conclusion 2.B: It is unclear for us what “legacy UE behavior” mean in this proposal. From our understanding, performing L1-RSRP measurement/reporting on SSBs with PCID different from the one of the serving cell is a new feature in Rel-17, and there is no legacy UE behavior corresponding to this featue. Thus, we prefer to remove the sub-bullet.Proposal 2.F: Re question from DCM, yes, your understading is correct. Proposal 2.G: In a L1-RSRP reporting instance, whether themore than one SSBRI/L1-RSRP pairs are associated with a same PCID or different PCIDs, we prefer to use differential reporting for all of them. If the L1-RSRP of a beam is out of range of differential reporting, it means the beam quality is really bad where the reported beam will not be used as serving BPL.**Proposal 2.G**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP: * The L1-RSRP reporting reuses Rel-15 L1-RSRP table
* Rel-15 L1-RSRP reporting format is used for all SSBRI-RSRP pairs in one L1-RSRP reporting instrance, i.e. 4-bit differential L1-RSRP(s) calculated relative to the 7-bit L1-RSRP
 |
| Lenovo/MotM | Proposal 2.A: SupportProposal 2.B: SupportProposal 2.D: SupportProposal 2.E: If event-driven reporting is not supported, the dedicated UL resource required for CSI reporting will be significant. This is because the number of RS transmitted by non-serving cell and need to be measured for CSI will be at least as many as, or even more, than those transmitted by the serving cell. To reduce the total CSI-report overhead, event-driven report shall be supported. Proposal 2.F: SupportProposal 2.G: Support |
| Qualcomm | For 2.A, supportFor 2.B, support, except for the contents in bracket. There is no legacy UE behavior for L1 measurement based on SSB from non-serving PCI in SMTC window. For 2.D, support. For the FFS, support TDMed measured SSBs as baselineFor 2.E, support MAC-CE based event driven report. Can also live with L1 basedFor 2.F, Type3 CSS can schedule group common DCI and hence should also be includes => This proposal may not be needed, since non-UE dedicated includes all CSS and corresponding PDSCH by definition, to our understandingFor 2.G, fine |
| Samsung | **Conclusion 2.A:** Support.**Conclusion 2.B**: Support without the sub-bullet. The purpose of this conlusion is reception of DL channels and signals from different TRPs. The sub-bullet seems to be for measurements, which is beyond the scope of this conclusison.**Proposal 2.D**: Support.**Proposal 2.E:** OK to support L1 event driven reporting (Alt1). We have concern on using MAC CE for beam reporting given that in Rel-15/16 beam reporting has been done by L1. Shifting this now to RAN2, would require RAN2 to design a new MAC CE which might not be feasible given the short time left in Rel-17. We suggest the following for proposal 2.E:**Proposal 2.E**: On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, ~~[event-driven – after more discussion]~~ support L1-based event-driven beam reporting for inter-cell beam management and inter-cell mTRP.**Proposal 2.F:** This is OK, but to clarify that this definition only applies for inter-cell beam managenment. In case of intra-cell beam management, UE dedicated channels can be received on CCS.**Proposal 2.G:** Support.**Issue 2.8:** It is not clear what is the use case for this functionality. A UE is configured with TCI state having a source RS associated with the a neighbouring cell PCI when it has dedicated traffic to receive/transmit. In this case, it is not expect that a UE would receive a paging message. Further more, the network can signal the UE to use a TCI state associated with the serving cell before sending a paging message.  |
|  |  |

### Issue 3 (beam indication signaling medium)

Table 5 Summary: issue 3

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 3.1 | BAT (Y) for CA:* Alt1: The first slot and the Y symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication
* Alt2: The first slot and the Y symbols are both determined on the carrier with smallest SCS among the carrier(s) applying the beam indication and the UL carrier carrying the acknowledgment
* Alt3: The first slot and the Y symbols are both determined on the UL carrier carrying the acknowledgment.
 | **Alt1**: OPPO, Lenovo/MotM, Ericsson, CATT, CMCC, Xiaomi, NTT Docomo, Nokia/NSB, Huawei/HiSi, Spreadtrum, MTK, Intel, Apple, Qualcomm, Samsung (2nd pref), TCL, **Alt2**: vivo, Samsung (1st), APT/FGI**Alt3**: ZTE, Sony |
|  |  |  |

**Proposal 3.A**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication for CA, the first slot and the Y symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication.

* [Note: For Rel-17 MAC-CE based beam indication (when only a singleTCI state is activated), following the Rel-15 MAC-CE ACK timeline, the single activated TCI state is applied starting from the first slot that is 3ms after the ACK corresponding to the PDSCH carrying the MAC-CE, wherein the first slot is based on the UL carrier carrying the acknowledgment]
* [Value(s) of Y are configured per SCS and dependent on SCS of target BWP, one of the configured Y symbols is used]

Table 6 Additional inputs: issue 3

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **1) Share your inputs on the above FL proposal 3.A especially on the red texts** |
| NTT Docomo | 3.A: Support. We are fine with the 1st bullet. For the 2nd bullet, when multiple values of Y are configured per SCS, how to select the one value of Y?* [Value(s) of Y are configured per SCS and dependent on SCS of target BWP, one of the configured Y symbols is used]
 |
| vivo | The brackets of the second subbullet should be removed. Cells are activated and deactivated dynamically. BWPs are also switched dynamically. Is it correct understanding that all SCS would use the same value based on the configured worst case if all the SCS uses the same Y value? This would make the DCI based beam switch much slower. |
| MediaTek | For the first sub-bullet, we are fine to clarify the timeline for MAC-CE-based TCI update. Some minor changes and we don't think we need to repeat the corresponding spec in the proposal.* Note: For Rel-17 MAC-CE based beam indication (when only a single TCI codepoint is activated), following the Rel-15 application timeline of MAC-CE activation

For the second sub-bullet, it is unclear how this related to the main bullet. Thus, we suggest the following change:* Y is configured per SCS and one of the configured Y symbols is used depending on the SCS of the active BWP on the reference carrier
 |
| Lenovo/MotM | MediaTek’s change is OK to us. |
| Qualcomm | Support the 1st bracket with the following red added based on current spec. Also fine for the 2nd bracket.* [Note: For Rel-17 MAC-CE based beam indication (when only a singleTCI state is activated), following the Rel-15 MAC-CE ACK timeline, the single activated TCI state is applied starting from the first slot that is 3ms after the slot containing the ACK corresponding to the PDSCH carrying the MAC-CE, wherein the first slot is based on the UL carrier carrying the acknowledgment]

213:if the UE receives a MAC CE activation command for one of the TCI states, the UE applies the activation command in the first slot that is after slot $k+3N\_{slot}^{subframe,μ}$ where $k$ is the slot where the UE would transmit a PUCCH with HARQ-ACK information for the PDSCH providing the activation command and $μ$ is the SCS configuration for the PUCCH. |
| Samsung | We are fine with the main bullet.For the first sub-bullet. We should follow the Rel-15 timeline as described in TS 38.133 section 8.10.3. We are fine with the change proposed by MediaTekThe intention of the second sub-bullet is not clear. We suggest the following update:[A Value~~(s)~~ of Y ~~are~~ is configured per SCS ~~and dependent on SCS of target BWP~~, ~~one of~~ the configured ~~of~~ Y symbols corresponding to the smallest SCS among the carrier(s) applying the beam indication is used] |
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### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 4.1 | Proposal 4.A | **Support**: Huawei/HiSi, IDC, Spreadtrum, vivo, Fujitsu, Lenovo/MotM, Fraunhofer IIS/HHI, NTT Docomo, Sony, AT&T, Apple, LG, Qualcomm, ZTE, Xiaomi, Samsung, Nokia/NSB, MTK, CMCC, **Not support**: Ericsson, OPPO, Intel |
| 4.2 | Multiple SRS resource sets with different SRS #ports | **#SRS resource sets*** **2**: Samsung, OPPO, Fraunhofer IIS/HHI, ZTE
* **3**: Samsung, Qualcomm

**#SRS resources in each set:*** **UE reporting**: vivo, Qualcomm

**#SRS ports in each set*** **1, 2, 4**: Samsung, Qualcomm, ZTE
 |
|  |  |  |

The following observation can be made:

* 4.1: Scheme 1 still represents the majority view. Among the proponents of Scheme 2, it is unclear if there is any convergence on the option (note that Scheme 2 includes 3 different schemes). Given the current situation, it seems proper to proceed with Scheme 1 (previously supported by some supporters of Scheme 2 as well).

Based on the above observation, the following moderator proposals can be made:

**Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,

* At least one logical index is introduced that is associated with a UE capability
	+ Support UE reporting of a UE capability for each logical index
	+ FFS: Whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, or TPMI
	+ The logical index and the associated UE capability can be common across a set of BWPs/CCs based on UE capability
* The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance
	+ FFS: The need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report
	+ FFS: Detailed design
* Support multiple codebook –based SRS resource sets with different maximum number of SRS ports
	+ The indicated SRI is based on the SRS resources corresponding to one SRS resource set associated to a logical index, where the SRS resource set should be aligned with the UE capability for the logical index
	+ [Note: In Rel-17, from RAN1 perspective, there is no further enhancement on the simultaneous transmission for the SRS] vs. [UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain]

Table 8 Additional inputs: issue 4

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| --- | --- |
| **Company** | **Input** |
| Mod V0 | **1) Check and update your view in Table 7** **2) Share your input on proposal 4.A especially re*** **the red text between brackets**
* **There are too many FFSs (not including issue 4.2). Suggest how to resolve the FFSs (or remove them)**
 |
| NTT Docomo | For the red text, we think the key point is how to solve the issue that multiple SRS resources overlapped in time. However, instead of the solution in red text, we think it is better to define a collision handling rule for two CB SRS resources overlapped in time, e.g., if two CB SRS resources overlap in time, UE only transmits the SRS with lower SRS resource set ID.For the FFS regarding UE capability, we think at least number of SRS ports, number of UL transmission layers should be supported. And we are fine to further discuss the other parameters (coherent type).For the FFS regarding timeline, we are fine to leave it as FFS. Fow now we are not clear about how to define gNB acknowledgment for beam reporting. |
| vivo | Agree in principle. Based on the correspondence between a CSI-RS and/or SSB resource index and a logical index in beam report, it is necessary to clarify the valid time duration of the correspondence.If UE capability for each logical index is supported, the parameters of SRS resource set in Rel-15 can be reused. The number of SRS resource in SRS resource set can be included in UE capability for different UL measurement requirements. **Proposal 4.A**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, * At least one logical index is introduced that is associated with a UE capability
	+ Support UE reporting of a UE capability for each logical index
	+ FFS: Whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, or TPMI, number of SRS resources within one SRS resource set
	+ The logical index and the associated UE capability can be common across a set of BWPs/CCs based on UE capability
* The correspondence between a CSI-RS and/or SSB resource index and a logical index is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance
	+ The valid time duration of the correspondence is until the next reporting instance
	+ FFS: The need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report
	+ FFS: Detailed design
* Support multiple codebook –based SRS resource sets with different maximum number of SRS ports
	+ The indicated SRI is based on the SRS resources corresponding to one SRS resource set associated to a logical index, where the SRS resource set should be aligned with the UE capability for the logical index
	+ [Note: In Rel-17, from RAN1 perspective, there is no further enhancement on the simultaneous transmission for the SRS] vs. [UE shall not expect gNB to trigger the SRS in different resource sets overlapped in time domain]
 |
| MediaTek | Regarding the first FFS (whether the UE capability comprises the number of SRS ports, number of UL transmission layers, coherence type, or TPMI), we prefer either the number of SRS ports or the number of UL transmission layers. Regarding the second FFS (the need for specifying timeline for correspondence signaling, e.g. the correspondence is applied X symbols after receiving gNB acknowledgment for the report), we don't see the need to specify anything since the correspondence is applied when the reported beam(s) is acitivated/configured by NW for later UL transmission.Regarding the last note, we prefer the later one, which is more clear. |
| Lenovo/MotM | We support proposal 4.A in general. Regarding the last bullet, does it imply the same codebook is always used when the SRS resource sets have the same number of SRS ports?  |
| Qualcomm | Support 4.A |
| Samsung | We can support this proposal for progress. Some comments:Re 1st FFS, we prefer UE capability similar to Rel15 wherein number of SRS ports and coherence type are reported by the UE.Re 2nd FFS on the timeline, the need is unclear, and perhaps this can be solved by NW implementation |
|  |  |
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### Issue 5 (MPE mitigation)

Table 9 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** |
| 5.1 | Proposal 5.A | **Support**: ZTE, Samsung, CATT, CMCC, Xiaomi, Intel, NTT Docomo, Ericsson, Sony, Nokia/NSB, Apple, Qualcomm, LG, IDC, MTK, Spreadtrum**Not support**: vivo, Huawei, HiSilicon |
| 5.2 | Proposal 5.B | **Support**: ZTE, Samsung, CATT, CMCC, Xiaomi, Intel, NTT Docomo, Ericsson, Sony, Nokia/NSB, Apple, Qualcomm, LG, IDC, MTK, vivo, Huawei, HiSilicon, Spreadtrum**Not support**:  |
| 5.3 | How to perform selection of N from a candidate SSB/CSI-RS resource pool and how the candidate resource pool is configured  | Selection of N is based on:* **TCI state quality**: OPPO
* **TCI state group quality**: IDC
* **L1-RSRP and P-MPR**: Ericsson, NTT Docomo, Qualcomm, MTK
* **Virtual PHR**: Nokia/NSB, ZTE, Convida

Candidate resource pool:* **Configured via RRC**: CATT, ZTE
* **Configured via RRC using CSI report config**: Samsung, [Nokia/NSB], MTK, IDC
 |
|  |  |  |

**Proposal 5.A**: On Rel.17 enhancements to facilitate MPE mitigation, confirm the following working assumption as an agreement with the following refinement (highlighted in red):

* *For each P-MPR value, up to M SSBRI(s)/CRI(s), where the SSBRI(s)/CRI(s) is selected by the UE from a candidate SSB/CSI-RS resource pool (FFS: how to perform the selection)*
	+ *~~FFS: The supported value(s) of M~~ Support only M=1*

**Proposal 5.B**: On Rel.17 enhancements to facilitate MPE mitigation, support N=1, 2, 3, and 4

* N is defined as the number of reported measurements
* UE reports supported largest N value as a UE capability

**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 two alternatives:
	+ Alt1. Based on L1-RSRP offset by P-MPR for each resource
	+ Alt2. Based on calculated Virtual PHR for each resource
* The candidate resource pool is configured vua RRC using CSI framework

Table 10 Additional inputs: issue 5

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | 1. **Check Table 9 (if your views are correctly captured)**
2. **If you have inputs on the wording of the proposals 5.A and 5.B**
3. **Share your view on the new proposal 5.C**
 |
| NTT Docomo | Support proposal 5A and 5BFor proposal 5.C, we think among the beams with no MPE issue, it is better to select the beam based on L1-RSRP. Because in case PCMAX-PMPR is larger than configured UL Tx power, P-MPR does not affect UL performance. So, we prefer to select beams with higher RSRP among the beams with P-MPR less than a threshold. We suggest adding another alternative for down-seletion. * Alt3. Based on L1-RSRP for each resource among the resources with PMPR less than a threshold.
 |
| vivo | **Proposal 5.A**: Don’t support the subbullet with only M=1. Beam report is dynamically reported while the P-MPR report is in MAC CE. If only one beam is selected for scheduling in the MAC-CE, it would be difficult to match the MAC CE report with the beam report in DCI.**Proposal 5.B**: Support **Proposal 5.C**: The N P-MPRs are determined by UE, e.g. including preferred P-MPRs. The logical index corresponding to CSI-RS and/or SSB resource index in beam report can also included in P-MPR report to ensure the alignment of the association between P-MPR and SSBRI(s)/CRI(s) and effectively avoid wrong beam selection by gNB due to the change of the association. Besides, the configuration of candidate resource pool needs further discussion.**Revised Proposal 5.C**: On Rel.17 enhancements to facilitate MPE mitigation, for selection of ~~N~~M from a candidate SSB/CSI-RS resource pool: * Down-select *by* RAN1#107-e between the two alternatives:
	+ Alt1. Based on L1-RSRP offset by P-MPR for each resource
	+ Alt2. Based on calculated Virtual PHR for each resource
	+ Alt3. Based on DL L1-RSRP without specification impact.
* FFS: The candidate resource pool is configured vua RRC using CSI framework

The following simulation results show that the performance is very similar/neglegible using L1-RSRP as the metric or using L1-RSRP minus MPR.* + 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 | Proposal 5.C: We are fine to down-select in the next meeting |
| Qualcomm | Support 5.A, 5.BFor 5.C, slightly prefer Alt1. Also can live with Alt2. For Alt2, suggest the following clarification* + Alt2. Based on calculated Virtual PHR for each resource
		- Virtual PHR is modified by considering actual P-MPR
 |
| Samsung | Support proposals 5.A and 5.B; and support Alt1 in Proposal 5.C |
|  |  |
|  |  |
|  |  |

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

Later round(s)