**3GPP TSG RAN WG1 #104-e R1-210xxxx**

**e-Meeting, January 25th – February 5th, 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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| * Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:
	+ Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management to support higher intra- and L1/L2-centric inter-cell mobility 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)
	+ 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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## Summary and proposals

The summary and proposals are based on the content of the first FL summary R1-2101185.

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

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 1.4 | Additional applicability of the common DL QCL information Note: UE-dedicated reception on PDSCH and all/subset of CORESETs have been agreed | CSI-RS resource for CSI:* **Yes**: OPPO, Spreadtrum, Ericsson, vivo, MTK, AT&T, Convida, Samsung, Qualcomm, Lenovo/MoM, Xiaomi, Sony, CATT, NTT Docomo, ZTE (AP-CSI-RS for CSI only), Nokia/NSB, APT
* **No**: Apple, Huawei/HiSi, Futurewei (need further discussion)

Some CSI-RS resource(s) for BM:* **Yes**: OPPO (some), Ericsson (all), AT&T(some), Samsung (some), Qualcomm, Xiaomi(some), Sony, CATT, Convida, NTT Docomo ZTE (AP-CS-RS for BM only) , Nokia/NSB, APT (for CSI-RS-BM with repetition “on”)
* **No**: Huawei/HiSi, vivo, Apple, Futurewei (need further discussion, depending on whether the resource is repeated or not)

CSI-RS for tracking:* **Yes**: Spreadtrum, AT&T, Qualcomm, Sony, Ericsson (aperiodic), Nokia/NSB, APT
* **No**: Huawei/HiSi, Apple, MTK, vivo, ZTE, Ericsson (periodic) OPPO, Futurewei
 |  |
| 1.5 | Additional applicability of the common UL TX spatial filter reference to SRS  | Some SRS (resource set(s)) for BM:* **Yes**: OPPO, Samsung, Sony, CATT, ZTE (also need support for SRS beam sweeping)
* **No**: Huawei/HiSi, APT, Qualcomm, MTK, vivo, Spreadtrum, Convida, Futurewei (need further discussion)
 | Note: SRS for CB/NCB/antenna switching is already agreed as optional |
| 1.6 | PL-RS in relation to UL TCI state and channels  | Alternatives:* **PL-RS included in UL TCI state:** IDC, Ericsson (optional for DL RS), Apple (only valid when SRS is configured for beam indication), vivo (in case of DL RS in TCI state), MTK (for no PL-RS configured, and DL CSI-RS or SSB), Intel, AT&T, OPPO (separate RS), Fraunhofer IIS/HHI (separate RS), Qualcomm, Lenovo/MoM, Xiaomi, NTT Docomo, OPPO, Nokia/NSB (QCL-TypeD RS if periodic and no PL-RS configured /associated), LG
* **PL-RS associated with UL TCI state:** Futurewei, Spreadtrum, Nokia/NSB, Huawei/HiSi, MTK, Sony, Qualcomm (separate field in the same DCI), CATT, NTT Docomo, ZTE, CMCC
* **PL-RS not associated with UL TCI state:** Ericsson (in case of UL RS in TCI state)
* **Use Rel-16 PL-RS framework:** vivo (for UL RS in TCI state)

MAC CE configures association between activated TCI states and PL-RS/PC: CATT, MTK(PL-RS only), Sony(only PL-RS) |  |
| 1.7 | UL parameters (PC, other than PL-RS) in relation to UL TCI state and channels  | Alternatives:* **Other UL parameters included in UL TCI state:** ID, Apple, LGE, Intel
* **Other UL parameters associated with UL TCI state:** Nokia/NSB, ZTE, Samsung, CATT, Lenovo/MoM
* **Other UL parameters associated with channel and UL TCI state:** Nokia/NSB, ZTE, Sony, Samsung, Qualcomm, Spreadtrum, ZTE, OPPO (not for SRS), Futurewei, NTT Docomo
* **Other UL parameters not associated with UL TCI state:** Ericsson, Huawei/HiSi, vivo, MTK, Fraunhofer IIS/HHI OPPO (this option is for SRS only)
* **Use Rel-16 framework:** CMCC, MTK

MAC CE configures association between activated TCI states and PL-RS/PC: CATT  |  |
| 1.11 | TCI State pool for CAAlt1: Shared among CCsAlt2: Individually configured per CC | **Alt1 (14)**: Spreadtrum, Xiaomi, ZTE, vivo, MTK, Intel, Sony, NTT Docomo, Samsung, Qualcomm, Lenovo/MoM, Ericsson (UL TCI), IDC**Alt2 (12)**: OPPO, Nokia/NSB, CMCC, Huawei/HiSi, CATT, APT, TCL, Ericsson (DL TCI), Futurewei, LG**QCL Type-A implicitly determined based on CC:** Intel, Samsung, MTK, CATT, ZTE |  |
| 1.12 | For separate TCI, UL TCI state poolAlt1: Shared pool with joint DL TCI stateAlt2: Separate pool  | **Alt1 (11)**: Spreadtrum, Xiaomi, ZTE, CATT, vivo, MTK, Intel, Convida, Qualcomm, Samsung, NTT Docomo**Alt2 (15)**: Futurewei, OPPO, Lenovo/MoM, Nokia/NSB, CMCC, Ericsson, Huawei/HiSi, AT&T, Sony, Lenovo/MoM, APT |  |

**Proposal 1.1**: On Rel.17 unified TCI framework:

* DL large scale QCL properties are inferred from one (qcl-Type1) or two RSs (qcl-Type1 and qcl-Type2) analogous to Rel.15/16
* For joint DL/UL TCI, UL spatial filter is derived from one RS of DL QCL Type D

**Proposal 1.2**: On Rel.17 unified TCI framework, down select or modify by RAN1#104bis-e from the following alternatives:

* Alt1. A UE can be dynamically switched between joint DL/UL TCI and separate DL/UL TCI, if UE is capable of both joint DL/UL TCI and separate DL/UL TCI.
	+ Details are FFS, e.g. whether dedicated L1 signaling is needed for the dynamic switching
* Alt2. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via RRC signaling
* Alt3. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via MAC CE signaling
	+ Details on how this is signaled in relation to TCI activation are FFS

**Proposal 1.3**: On Rel.17 unified TCI framework, decide by RAN1#104bis-e:

* Whether DL TCI also applies to the following:
	+ CSI-RS resources for CSI
	+ Some CSI-RS resources for BM, if so, which ones (e.g. aperiodic, repetition ‘ON’)
	+ CSI-RS for tracking
* Whether DL TCI also applies to the following:
	+ Some SRS resources or resource sets for BM

**Proposal 1.4**: On Rel.17 unified TCI framework:

* When an UL RS is in the UL TCI state, reuse Rel-16 PL-RS framework
* When a DL RS is in the UL TCI state, select one of the following alternatives by RAN1#104bis-e:
	+ Alt1. PL-RS is included in UL TCI state
	+ Alt2. PL-RS is associated with (but not included in) UL TCI state

**Proposal 1.5**: On Rel.17 unified TCI framework:

* The setting of UL PC parameters is at least associated with UL channel
* Select one of the following alternatives by RAN1#104bis-e:
	+ Alt1. The setting of UL PC parameters is also associated with UL TCI state
	+ Alt2. The setting of UL PC parameters is not associated with UL TCI state

Table 2 Inputs: issue 1

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| **Company** | **Input** |
| Moderator | 1.1: Including Xi’s edit. Re Intel’s and LG’s comment on separate DL/UL, UL TX spatial filter reference has been defined in previous agreements, especially in RAN1#103-e:* *For the separate UL TCI:*
	+ *The source reference signal(s) in N TCIs provide a reference for determining common UL TX spatial filter(s) at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC*
	+ *Optionally, this UL TX spatial filter can also apply to all SRS resources in resource set(s) configured for antenna switching/codebook-based/non-codebook-based UL transmissions*

The pool design for separate DL/UL TCI should not cause a new definition of UL TCI. Re applicability of QCL Type-D to FR1/FR2 vs FR2 only, this proposal doesn’t address this. Note that this was already agreed in RAN1#102-e:*On Rel-17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL:** *Utilize two separate TCI states, one for DL and one for UL.*
	+ *FFS: Contents of separate UL TCI state*
	+ *Note:* ***For FR1, UE does not expect UL TCI to provide a reference for determining common UL TX spatial filter(s), if UL TCI is supported*** *for FR1*

1.2: Not yet discussed in GTW, but stable1.3: Just as the source RS issues, we need to conclude this by RAN1#104bis-e1.4/1.5: Based on the summary in issue 1.6/1.7, this is a reasonable starting point. Please note we need to narrow down alternatives in this meeting for better decision making in the next meeting. |
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### Issue 2 (L1/L2-centric inter-cell mobility)

**Proposal 2.1**: On Rel.17 enhancements for L1/L2-centric inter-cell mobility:

* Intra-DU only is assumed (i.e. no inter-DU)
* The following issues will be discussed in RAN2 (FL to send an LS to RAN2 when the time comes):
	+ Whether RRC reconfiguration is needed
	+ Whether a change in serving cell can occur
	+ Whether C-RNTI can change

**Proposal 2.2**: On Rel.17 multi beam measurement/reporting enhancements:

* A quality of up to K beams associated with non-serving cell(s) can be reported in a single CSI reporting instance
	+ For each beam, the UE can report at least: (1) a Measured RS Indicator, and (2) a Beam Metric associated with the Measured RS Indicator
	+ FFS: Maximum value of K
	+ FFS: If K is fixed, configured, reported by UE capability, or dynamically selected
	+ FFS: The type of beam metric (e.g. L1-RSRP, L3-RSRP, or hybrid L1/L3-RSRP)
	+ FFS: Activation/deactivation for the CSI-reportConfig
* FFS: Whether beam reporting associated with non-serving cell(s) can be mixed with that with serving-cell in one reporting instance

Table 3 Inputs: issue 2

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| **Company** | **Input** |
| Moderator | 1.1: Not yet discussed in GTW, but stable. Also added the more controversial RAN2-specific issues in the second bullet. Note that the inter-DU will require not only RAN2, but also RAN3 * Implication: RAN1 can focus on completing measurement/reporting and QCL issues

1.2: Not yet discussed in GTW, but stable |
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### Issue 3 (beam indication signaling medium)

Table 4 Summary: issue 3

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 3.1 | Beam application time definition:Alt1: Measured from DCI receptionAlt2: Measured from ACK transmission | **Alt1 (DCI) (7):** Spreadtrum, Xiaomi, Ericsson, CATT, MTK, NEC, Samsung**Alt2 (ACK) (17):** IDC, Lenovo/MoM, Fujitsu, Nokia/NSB, CMCC, Apple, Huawei/HiSi, ZTE, vivo, Intel, Sony, Qualcomm, NTT Docomo, APT **Alt1 and Alt 2:** OPPO (Since Alt1 considers the requirement of UE and Alt2 considers the requirement of gNB side), LG | Other aspects mentioned for next-level details: when TCI state is unknown, panel activation/deactivation, PUCCH repetition  |
| 3.2 | Configurability of beam application timeAlt1: UE capabilityAlt2: Fixed in spec | **Alt1 (UE capability) (21):** IDC, Fujitsu, Nokia/NSB, Xiaomi, Ericsson, Apple, ZTE, CATT, vivo, MTK, Intel, Qualcomm, NTT Docomo, Samsung, Sony, Spreadtrum, Lenovo/MoM, LG, NEC**Alt2 (fixed):** Lenovo/MoM, Huawei/HiSi**Alt1+Alt2:** OPPO (The application time is determined based on both Alt1 and Alt 2 in 3.1. Therefore for Alt1 of 3.1: fixe in Spec and Alt2 of 3.1: UE capability) |
| 3.4 | Support for additional DCI formats for Rel.17 unified TCI framework beam indication (TCI state update) | DCI formats 1\_1/1\_2 without DL assignment:* **Yes (18)**: OPPO, Fujitsu, Spreadtrum, Nokia/NSB, CATT, vivo (at least for UL-only TCI), MTK, Qualcomm, Samsung, Apple (ACK/NACK mechanism is needed), vivo, Lenovo/MoM, Convida, NTT Docomo, ZTE (ACK/NACK is needed), NEC (ACK/NACK needed)
* **No (4)**: Ericsson, Huawei/HiSi, LG

DCI formats 0\_1/0\_2 with UL grant:* **Yes (10)**: IDC, Nokia/NSB, Xiaomi (at least for UL-only TCI), ZTE (at least for UL-only TCI), MTK, LGE, Intel, Sony (Study), Qualcomm
* **No (12)**: OPPO, CMCC, Ericsson, Huawei/HiSi, Convida, Apple, vivo, Spreadtrum, CATT, NTT Docomo, NEC

Dedicated DCI format for beam indication, with dedicated ACK based on SPS PDSCH release:* **Yes (15)**: Futurewei, ZTE, CATT, Intel, Sony, NTT Docomo(keep the same DCI payload as existing DCI format), OPPO (based on format 1\_0 without DL assignment), Samsung, Nokia/NSB (based on format 0\_1/0\_2 without UL grant), Qualcomm, Lenovo/MoM, APT (based on SPS or CG release DCI), NEC
* **No (8)**: Ericsson, MTK, Convida, Apple, vivo, Huawei/HiSi, LG

**Support extending existing DCI formats for UL-only TCI**: APT |  |

**Proposal 3.1**: On the beam application time for Rel.17 DCI-based beam indication, the beam application time can be configured by the gNB based on UE capability

* Support a UE capability for the minimum value of beam application time
* FFS: the exact minimum values of beam application time supported by UE
* FFS: whether existing UE capability can be reused as this UE capability.
* FFS: whether different beam application time values are supported for uplink and downlink
* FFS: whether UE capability needs to be introduced for the maximum value of beam application time
* FFS: the reference for defining the UE capability (e.g. from DCI reception or ACK transmission)
* FFS: whether a UE is allowed to report more than 1 values in case of MPUE

**Proposal 3.2**: On the beam application time for Rel.17 DCI-based beam indication, support (cf. the definition of Alt1 and Alt2 as agreed in RAN1#102-e):

* Alt1 (defined after DCI reception) for PDSCH reception associated with the DCI that signals the TCI state update
	+ DCI-to-PDSCH time gap is determined by UE capability beamSwitchTiming (BST) analogous to Rel.15/16
* Alt2 (defined after acknowledgment transmission) for other channels/signals

**Proposal 3.3**: On the beam application time for Rel.17 DCI-based beam indication:

* Support using DCI formats 1\_1 and 1\_2 without DL assignment, applicable for joint TCI as well as separate DL/UL TCI
	+ Support DCI acknowledgment mechanism based on SPS PDSCH release
* No other additional DCI format is supported in Rel.17

Table 5 Inputs: issue 3

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| **Company** | **Input** |
| Moderator | 3.1: Not yet discussed in GTW, but stable3.2: Considering the pros and cons of Alt1 and Alt2, the proposal from LG could be a good starting point for compromise.3.3: We need to close the DCI format issue as soon as possible since there are detailed issues. Given the situation (pros and cons, as well as supporting companies) summarized in issue 3.4 (table), this is a good compromise.  |
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### Issue 4 (MP-UE)

Table 6 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 4.1 | Entity pertaining to an UL panel for the purpose of UE-initiated panel selection (of one) and activation (of ≥1)Note: support for UE-initiated panel selection/activation was agreed (but spec support is still FFS – see 4.2) | Alternatives:* Newly defined panel ID(s): Lenovo/MoM (study), LGE, Xiaomi, NTT Docomo, Qualcomm, Spreadtrum, ZTE, Huawei/HiSi (virtual concept without mandating physical UE panel implementation), IDC, APT, CMCC
	+ Not needed: AT&T, CATT, Ericsson, OPPO, Nokia/NSB
* SSBRI(s)/CRI(s) or CSI-RS resource set ID(s): IDC, Samsung, MTK(SSBRI(s)/CRI(s)), Xiaomi, CATT
* SRI(s) or SRS resource set ID(s): vivo, Qualcomm, Xiaomi, Sony (SRS resource set ID(s)), Fraunhofer IIS/HHI, Huawei/HiSi, APT
* Antenna port group: Apple, Qualcomm, Nokia/NSB
 |  |
| 4.2 | Spec support for UE-initiated panel selection and activation | Potentially new beam reporting format, including enhanced beam-group reporting (indicator(s) depending on the outcome of issue 4.1 + beam metric(s)):* **Yes**: ZTE, APT, NTT Docomo, Samsung, MTK, vivo, Qualcomm, Xiaomi, Spreadtrum, Nokia/NSB, Huawei/HiSi, LG, CMCC
* **No**: CATT, OPPO

UE-initiated reporting mechanism (beyond NW-configured P/SP/AP reporting, including switching event):* **Yes**: Huawei/HiSi, Samsung, CATT, IDC, MTK, NTT Docomo, Fraunhofer IIS/HHI, Sony, Xiaomi, Apple, Lenovo/MoM, Qualcomm, Nokia/NSB, APT, AT&T, LG
* **No**: MTK, Spreadtrum, ZTE (motivation is unclear), Ericsson, OPPO

gNB confirmation (hand-shake) of UE panel choice:* **Yes**: IDC, Huawei/HiSi, Qualcomm (UE decides which panel to activate), NTT Docomo, LG
* **No**: MTK (confirmation according to TCI stat activation), Spreadtrum, CATT, ZTE (same views with MTK), Ericsson (same view as MTK), OPPO, Nokia/NSB
 |  |
| 4.3 | Support for NW-initiated UL panel selection and activation | NW-initiated UL panel selection (of one) and activation (of ≥1)* **Yes**: IDC, Huawei/HiSi, ZTE, LGE, NTT Docomo,CMCC
* **No**: OPPO, Fraunhofer IIS/HHI, CATT, MTK, Intel, Sony, Xiaomi, Qualcomm (NW can initiate selection within active panels but not activation), Spreadtrum, Nokia/NSB

NW-to-MPUE signaling of panel selection/activation:* **Yes**: NTT Docomo, Lenovo/MoM, Xiaomi, APT, IDC (panel ID in TCI state), Samsung (in case of MPE), CATT, APT, vivo, Qualcomm (NW can signal which active panel to use but not activation), Spreadtrum (select among active panels), Nokia/NSB, Huawei/HiSi (with UE confirmation/rejection), LG, CMCC
* **No**: OPPO
 |  |

**Proposal 4.1**: On Rel.17 enhancements to facilitate UL beam selection for MP-UE, the following terms are used at least for discussion and agreement purposes:

* ‘Panel activation’ (at least for DL/UL measurement): activating L out of P available UE panel(s) at least for the purpose of DL and UL beam measurements (e.g. reception of DL measurement RS, transmission of SRS)
* ‘Panel selection’ (for UL transmission): selecting 1 out of L activated UE panel(s) for the purpose of UL transmission
* Note: UE-initiated panel activation and selection have been agreed in RAN1#103-e

**Proposal 4.2**: On Rel.17 enhancements to facilitate UL beam selection for MP-UE, a ‘panel’ constitutes a group of antenna ports.

* [Relation with, e.g. CSI-RS resource set, SRS resource set]

Table 7 Inputs: issue 4

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| **Company** | **Input** |
| Moderator | 4.1: Not yet discussed in GTW, but stable4.2: Apple’s proposal is a good starting point, but so far supported only by 4 companies. I’d appreciate of other companies can comment on the proposal and build on it. |
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### Issue 5 (MPE mitigation)

Table 8 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 5.1 | Reporting of P-MPR report based on Rel.16 framework | Alternatives:* **Not supported**: Ericsson
* **Beam-level (7)**: Intel (already supported by RAN2/RAN4 PHR MAC-CE), Apple, Qualcomm, ZTE OPPO (for each activated UL TCI state), Nokia/NSB
* **Panel-level (12)**: vivo, Sony, Spreadtrum, NTT Docomo, ZTE, Lenovo/MoM, Huawei/HiSi (2nd preference), IDC, APT, NEC
 |  |
| 5.2 | Reporting SSBRI(s)/CRI(s) and/or indication of panel selection for the purpose of indicating:* Alt1: alternative UE panel(s) or TX beam(s) for UL transmission
* Alt2: feasible UE panel(s) or TX beam(s) for UL transmission taking the MPE effect into account
 | Alternatives:* **Not supported**: vivo, OPPO, Huawei/HiSi, APT
* **Beam-level (**with L1-RSRP/SINR**) (9)**: Ericsson, Intel (without L1-RSRP/SINR), MTK, Apple, Qualcomm, NTT Docomo, ZTE, Nokia/NSB
* **Panel-level (**with L1-RSRP/SINR**) (12)**: Samsung, IDC, CATT, Xiaomi, LG
	+ **Alt1**: Samsung, Qualcomm, LG
	+ **Alt2**: Nokia/NSB, Sony, MTK (but not limited to MPE mitigation), Apple, Qualcomm, Xiaomi, ZTE, LG
 |  |
| 5.3 | Any additional reporting content: * Alt0: no additional reporting content
* Alt1: Additional reporting content
 | **Alt0**: Ericsson, Intel, Xiaomi, MTK, Spreadtrum, Lenovo/MoM, Huawei/HiSi, APT **Alt1**:* CRI/SSBRI + L1-RSRP/L1-SINR + P-MPR: OPPO, MediaTek, Nokia/NSB, IDC
* CRI/SSBRI + L1-RSRP/L1-SINR + virtual PHR: Nokia/NSB, Apple, Convida, CMCC
* CRI/SSBRI + L1-RSRP/L1-SINR + panel ID: LG, CMCC
* CRI/SSBRI + virtual PHR: ZTE, Convida
* CRI/SSBRI + UL RSRP + panel ID: Qualcomm
* CRI/SSBRI + new/additional param. (indicating MPE): CMCC
* P-MPR + panel-ID: vivo, Sony (panel-specific), IDC
* P-MPR + alternative panel or UL TX beam: Nokia/NSB
* ID of preferred/non-preferred panel: LGE
 |  |

**Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation,

* On P-MPR report based on Rel.16 framework, decide in RAN1#104bis-e whether to focus study on either beam-level or panel-select reporting
* On SSBRI(s)/CRI(s) and/or indication of panel selection for the purpose of indicating, decide in RAN1#104bis-e whether to focus study on either of the following:
	+ Beam-level reporting of feasible UL TX beam(s) for UL transmission taking the MPE effect into account, with companion L1-RSRP/SINR
	+ Panel-level reporting of feasible UE panel(s) for UL transmission taking the MPE effect into account, with companion L1-RSRP/SINR

Table 9 Inputs: issue 5

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| **Company** | **Input** |
| Moderator | 5.1: We need to start narrowing down options for study. From the summary, this could be a good starting point |
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### Issue 6 (beam refinement/tracking)

Table 10 Summary: issue 6

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 6.1 | Group 1: beam measurement/reporting via RACH for initial access (e.g. RO for measurement and MSG3 for reporting, impact of MPE mitigation) | Perform study and, if needed, specify:* **Yes**: AT&T, Qualcomm, Nokia/NSB, Samsung, Xiaomi, Sony
* **No**: OPPO, ZTE, Huawei/HiSi, Apple, vivo, Convida, Ericsson, Futurewei, LG, NEC
 |  |
| 6.2 | Group 2: faster joint DL TX and RX beam refinement/tracking (P2+P3) | Perform study and, if needed, specify:* **Yes**: Apple (CSI-RS based), Samsung (CSI-RS based), Intel (using SRS/CRI), Nokia/NSB (P3 only), Futurewei
* **No**: vivo, Qualcomm, Ericsson, Huawei/HiSi, LG
 |  |
| 6.3 | Group 3: Beam management with reduced DL signaling (e.g. beam update based on reporting, beam measurement and report triggered by beam indication, multi-SSB indication, semi-static beam switch)  | Perform study and, if needed, specify:* **Yes**: Futurewei, MTK, Samsung, OPPO, Apple, Intel, NTT Docomo, Qualcomm, Ericsson, IDC
* **No**: vivo, Huawei/HiSi
 |  |
| 6.4 | Group 4: Reducing activation delay of TCI states (other WGs, e.g. RAN4) | Perform study and, if needed, specify:* **Yes**: Ericsson, ZTE, Samsung, Apple (RAN1), vivo (RAN1), NTT Docomo, Futurewei (RAN4), Huawei/HiSi (send to RAN4)
* **No**:
 |  |

**Proposal 6.1**: On Rel.17 enhancements based on the unified TCI framework, perform study and, if needed, specify the following:

* Beam management with reduced DL signaling (e.g. beam update based on reporting, beam measurement and report triggered by beam indication, multi-SSB indication, semi-static beam switch)
* Reducing activation delay of TCI states (including other WGs, e.g. RAN4)

Table 11 Inputs: issue 6

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| **Company** | **Input** |
| Moderator | 6.1: Based on the views on companies, this could be a good starting point for issue 6 |
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