**3GPP TSG RAN WG1 #105-e R1-210xxxx**

**e-Meeting, May 10th – 27th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

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

**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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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

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 – note: for intra-cell beam management)

UL PC

**Proposal 1.1A:** On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework, for PUSCH and PUCCH, the setting is either included in UL TCI state or (if applicable) joint TCI state or associated with UL TCI state or (if applicable) joint TCI state.

* Whether it is ‘included in’ or ‘associated with’ (including the manner it is performed and the signaling) is up to RAN2

Note: It has been agreed that the setting of (P0, alpha, closed loop index) is associated with UL channel or UL RS (therefore the setting is channel- and signal-specific)

**OR**

**Proposal 1.1B:**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.
	+ 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.
	+ Details of the association (including the manner it is performed and the signaling) is up to RAN2
* If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal is independent the UL or (if applicable) joint TCI states
* FFS: If 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

Table 1 Additional inputs: issue 1 – UL PC

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| **Company** | **Input** |
| Mod V0 | **(Last attempt per Mr. Bo’s request) Since technical arguments have been made, please complete the following. If you want to present some new or summarize your arguments, or suggest a compromise, please use the rows below:****Proposal 1.1A:*** **Support: ...**
* **Concern: ...**

**Proposal 1.1B:*** **Support: Apple**
* **Concern: ...**

**If there is no consensus in selecting either 1.1A or 1.1B (or a compromise between the two acceptable to all), the proposed conclusion in the chairman notes will be the outcome.**  |
| Apple | We are ok with majority view – 1.1B.  |
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M>1 or N>1 support:

**Proposal 1.2**: On Rel-17 unified TCI, in RAN1#106-e, for M>1 and/or N>1:

* Identify and agree on use cases
* Identify feasible candidate schemes for beam indication signaling mechanism (including TCI state activation)
* Decide whether to support M>1 and/or N>1, and if so, the maximum value of M and/or N

Table 2 Additional inputs: issue 1 – M/N>1

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| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your input on the above proposal**  |
| Apple | Use cases: mTRP only and we have strong concern to use it for sTRPBeam indication signaling mechanism: TCI codepoint mapped to 2 DL/UL TCI or 2 joint TCIMaximum value: M=2, N=2 |
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### Issue 2 (L1/L2-centric inter-cell mobility)

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### Issue 3 (signaling medium)

Below is the current outcome of the offline discussion.

**Proposal 3.3A**: On Rel-17 unified TCI, for a UE configured with both joint TCI and separate DL/UL TCI, TCI states can be activated via MAC-CE-based TCI state activation for either only joint DL /UL TCI or only separate DL /UL TCI

* When TCI states are activated for joint TCI, the TCI field in DCI formats 1\_1/1\_2 used for beam indication can update only a TCI state associated with joint TCI
* When TCI states are activated for separate DL/UL TCI, the TCI field in DCI formats 1\_1/1\_2 used for beam indication can update only a TCI state associated with either DL-only TCI or UL-only TCI, or update a pair of TCI states associated with DL TCI and UL TCI, respectively
* Detailed MAC-CE-based design is up to RAN2

FFS: the cases of M/N > 1

**Proposal 3.3B:**

On Rel-17 unified TCI framework, for a UE configured with both joint TCI and separate DL/UL TCI, an activated TCI state (via MAC-CE-based TCI state activation) can be a TCI state associated with either joint TCI or separate DL/UL TCI

* Activation of TCI states where at least one activated TCI state is associated with joint TCI and at least another activated TCI state is associated with separate DL /UL TCI is an optional UE capability
* Detailed MAC-CE-based design for the above functionality is up to RAN2
* FFS: the cases of M or N > 1
* FFS: Other related UE capabilities on the number of active QCL and/or UL spatial relation assumptions

Table 3 Additional inputs: issue 3 – switching

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| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Since technical arguments have been made, please complete the following. If you want to present some new or summarize your arguments, or suggest a compromise, please use the rows below:** **Proposal 3.3A:*** **Support:** ...
* **Concern: ...**

**Proposal 3.3B:*** **Support: Apple**
* **Concern: ...**

**If there is no consensus on selecting either proposal 3.3A or 3.3B (or a compromise between the two), the proposed conclusion (RRC configuration) in the chairman notes will be the outcome.** |
| Apple | Support majority view – 3.3B |
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### Issue 4 (MPUE)

**Proposal 4.2**: At least for FR2, support configuring a UE with two SRS resource sets by RRC having different numbers of ports for codebook-based UL transmission

* FFS: Whether SRS resource set is signalled by gNB based on UE reported information
* FFS: Whether to support different SRS ports within a same SRS resource set if more than one SRS resources are configured in the set
* FFS: this can be applied to non-codebook-based UL transmission
* This feature is UE optional

Table 4 Additional inputs: issue 4 – SRS for MPUE

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| **Company** | **Input** |
| Mod V0 | **Please share your input on the above proposal**  |
| Apple | We have concern for this proposal. We think the panel selection should not be in per channel level, otherwise UE may face the situation to activate more panels or simultaneous transmission from multiple panels from multiple CCs. Since unified TCI is applied for multiple channels across CCs, to maintain the same understanding on panel entity based on unified TCI between gNB and UE would be a better way. The intention for the proposal is to support different number of ports for different panels. Then the two sets should be for two panels, but it seems only 1 panel is valid for transmission based on the indicated TCI. In addition, it may not be necessary to configure 2 sets, but another possible way is to configure 1 SRS resource set and to dynamically update the configuration for the SRS.With that we suggest the following as a starting point.**Proposal*** **Down-select one of the following options to facilitate UL panel selection for CB based PUSCH transmission at least for FR2 in sTRP mode:**
	+ **Option 1: gNB can configure 2 SRS resource sets for CB with different number of ports**
		- **Only 1 resource set is valid to be triggered for SRS transmission and SRI indication for PUSCH**
		- **UE does not transmit SRS in the invalid SRS resource set no matter whether it is triggered or not**
		- **FFS: How to determine an SRS resource set is valid or invalid**
	+ **Option 2: gNB can configure only 1 SRS resource set for CB**
		- **The number of ports for the SRS resources in the set can be dynamically updated**
			* **FFS: signaling details**
		- **The number of SRS ports should be aligned with reported UE capability for the corresponding panel entity for SRS/PUSCH**
* **The panel entity for the uplink channel is determined based on the RS used to provide spatial relation indication in the indicated unified UL/joint TCI**
	+ **This applies for PUSCH/PUCCH/SRS**
	+ **The panel entity for a RS is based on a L1-RSRP report instance**
		- **FFS: details**
* **Support UE reports maximum number of ports/layers per panel entity**
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### Issue 5 (MPE)

**Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, support [one of] the following schemes [(to be down-selected in RAN1#106-e)]:

* Opt1A. Rel.16 P-MPR based (TCI or SSBRI/CRI-specific) together with Virtual PHR (or a modified version)
	+ The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.
	+ The reporting reuses the event-driven mechanisms from the Rel-16 P-MPR reporting
	+ FFS: Definition of virtual PHR and how it is used
* Opt2A. Reporting at least {SSBRI(s)/CRI(s)} (beam/panel level) to indicate gNB beam(s) that are preferred for UL transmission in NW-initiated CSI-report on PUCCH/PUSCH
	+ Down-select one option from the followings by RAN1#106-e:
		- Alt1: In a single reporting instance, reporting SSBRI(s)/CRI(s) to indicate gNB beam(s) that is preferred for UL transmission + offsetting L1-RSRP that accounts for MPE effect associated with the SSBRI(s)/CRI(s)
			* FFS: how the offsetting L1-RSRP is calculated with regard to MPE effect
		- Alt2: In a single reporting instance, reporting SSBRI(s)/CRI(s) to indicate gNB beams that is preferred for UL transmission, DL reception (only), or both + L1-RSRP associated with the SSBRI(s)/CRI(s) + virtual PHR or a modified version
			* For each reported SSBRI/CRI, UE determines whether virtual PHR (or a modified version) is reported along with the SSBRI/CRI is reported or not
			* For virtual PHR or a modified version, reuse the same definition in Opt1A
			* FFS: how to inform NW whether a virtual PHR or a modified version is reported or not
		- Alt3: In a single reporting instance, reporting SSBRI(s)/CRI(s) to indicate gNB beams that is preferred for UL transmission, DL reception (only), or both + L1-RSRP associated with the SSBRI(s)/CRI(s) for DL reception
			* FFS: how to inform NW whether a reported SSBRI/CRI is preferred for UL transmission or preferred for DL reception (only)
			* FFS: whether/what to report using bit field for L1-RSRP for UL transmission
* Note:  The determination of power backoff due to power management is the same for Opt2A as for Opt1A

Table 5 Additional inputs: issue 5 – MPE

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| **Company** | **Input** |
| Mod V0 | **Please share your view on the above proposal** **For proponents of Opt2, please state your preference (Alt1, 2, or 3). I would like to see if it is possible to remove the least supported alternative or, even better, down select** |
| Apple | For Opt2, we are open to Alt1/2.If acceptable, we would like to suggest a slim version.**Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, support [one of] the following schemes [(to be down-selected in RAN1#106-e)]:* Opt1A. Rel.16 P-MPR based (TCI or SSBRI/CRI-specific) together with Virtual PHR (or a modified version)
	+ The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.
	+ The reporting reuses the event-driven mechanisms from the Rel-16 P-MPR reporting
	+ FFS: Definition of virtual PHR and how it is used
* Opt2A. Reporting at least {SSBRI(s)/CRI(s)} (beam/panel level) to indicate gNB beam(s) that are preferred for UL transmission in NW-initiated CSI-report on PUCCH/PUSCH
	+ FFS: Whether the L1-RSRP is calculated with regard to MPE effect
* FFS: Whether/how to support connection for opt1A and opt2A, e.g. Opt1A/Opt2A is triggered/ reported by the same signaling, whether there should be some connections for the reported SSBRI(s)/CRI(s)
* Note:  The determination of power backoff due to power management is the same for Opt2A as for Opt1A
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## Appendix

Issue 1:

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Issue 2:

Proposal 2.1:

* Support/fine: Apple, AT&T, CATT, Ericsson, Intel, [Lenovo/MoM], LG, NTT Docomo, OPPO, [Nokia/NSB], Qualcomm, Samsung, Sony, Spreadtrum, vivo, Xiaomi, ZTE
* Concern: CMCC (postpone), Futurewei (postpone), Huawei/HiSi (no need)

Issue 3:

OptA (original proposal 3.3, chairman notes):

* Support: CATT, CMCC, Ericsson, Fraunhofer IIS/HHI, Fujitsu, Futurewei, Huawei, HiSi, IDC, LG, MTK, NEC, NTT Docomo, OPPO (fine), Qualcomm, Samsung, Spreadtrum, Xiaomi, ZTE

OptB (without UE-capability on mixed activation):

* Support: Apple, Convida, Intel, Lenovo/MoM, Nokia/NSB, Sony

Modified 3.3 – Modified OptB (with UE-capability on mixed activation):

* Support/fine: Convida, Ericsson, Fraunhofer IIS/HHI, Intel, MTK, Nokia/NSB, Qualcomm, Samsung, Sony, Spreadtrum, Xiaomi, ZTE
* Concern: Huawei/HiSi, vivo

**OptA (original proposal 3.3)**

On Rel-17 unified TCI, for a UE configured with both joint TCI and separate DL/UL TCI ~~(including DL-only TCI, UL-only TCI, or DL+UL TCI)~~, TCI states can be activated via MAC-CE-based TCI state activation for either only joint DL /UL TCI or only separate DL /UL TCI

* When TCI states are activated for joint TCI, the TCI field in DCI formats 1\_1/1\_2 used for beam indication can update only a TCI state associated with joint TCI
* When TCI states are activated for separate DL/UL TCI, the TCI field in DCI formats 1\_1/1\_2 used for beam indication can update only a TCI state associated with either DL-only TCI or UL-only TCI, or update a pair of TCI states associated with DL TCI and UL TCI, respectively
* Detailed MAC-CE-based design is up to RAN2
* FFS: the cases of M/N > 1, if supported

Issue 4:

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Issue 5:

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