**3GPP TSG RAN WG1 #108-e R1-2202762**

**e-Meeting, February 21th – March 3rd, 2022**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator Summary#4 for Maintenance on Rel-17 Multi-Beam: ROUND 3

**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** |
| 1.11 | **Proposal 1.G**: For Rel-17 unified TCI framework, for CORESET 0 configured by RRC to apply the indicated Rel-17 TCI state associated with the serving cell, the UE assumes DM-RS antenna port for PDCCH receptions in the CORESET is QCLed with an SSB on the UE identified during a latest RA procedure, not initiated by a PDCCH order that triggers a contention-free random access procedure [if no MAC-CE or DCI indicating a TCI state after the RA procedure.]TP for TS38.214:5.1.5 Antenna ports quasi co-location<omitted parts>The UE with activated [*TCI-State]* configured with [*tci-StateId\_r17]* receives DCI format 1\_1/1\_2 providing indicated *TCI-State* with[*tci-StateId\_r17]* for a CC or all CCs in the same CC list configured by *[simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2]*. The DCI format 1\_1/1\_2 can be with or without, if applicable, DL assignment. If the DCI format 1\_1/1\_2/ is without DL assignment, the UE can assume the following:- …If a UE is provided [*followUnifiedTCIstate-r17]* for a CORESET with index 0* After a random access procedure not initiated by a PDCCH order that triggers a contention-free random access procedure, if no DCI Format or MAC CE indicating a TCI state is received, the UE assumes that DM-RS of PDCCH and DM-RS of PDSCH associated with the CORESET with index 0 are quasi co-located with the SS/PBCH block the UE identified during the random access procedure, and the UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant based PUSCH and PUCCH associated with the CORESET of index 0 is the same as that for a PUSCH transmission scheduled by a RAR UL grant during the initial access procedure.
* After the UE receives a DCI Format or MAC CE indicating a TCI state, and after a beam application delay as described in this clause; the UE obtains the QCL assumptions from the indicated [*DLorJoint-TCIState-r17]* TCI state for DM-RS of PDCCH and DM-RS of PDSCH associated with the CORESET with index 0, and the UE determines an UL TX spatial filter, if applicable, from the indicated [*DLorJoint-TCIState-r17]* or [*UL-TCIState-r17]* for a dynamic-grant based PUSCH and PUCCH associated with the CORESET with index 0.
 | **Support/fine**: Samsung, CATT, Xiaomi, ZTE, Intel, CMCC, Nokia/NSB, Lenovo/MotM, Qualcomm, NTT Docomo **Not support:** Ericsson, Huawei/HiSi, Apple, OPPO (already supported) |
| 1.13 | For cross-carrier scheduling **Proposal 1.I**: If a UE is configured with *CrossCarrierSchedulingConfig* for a serving cell the value of the DCI field ‘*carrier indicator*’ corresponds to the value indicated by *CrossCarrierSchedulingConfig.* The codepoint indicated by the DCI field ‘*Transmission Configuration Indicator*’ is applied to the carrier indicated by the DCI field ‘*carrier indicator*’ and corresponds to TCI state configured for that carrierTP for TS38.214:5.1.5 Antenna ports quasi co-location<omitted parts>The UE with activated [*TCI-State]* configured with [*tci-StateId\_r17]* receives DCI format 1\_1/1\_2 providing indicated *TCI-State* with[*tci-StateId\_r17]* for a CC or all CCs in the same CC list configured by *[simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2]*. The DCI format 1\_1/1\_2 can be with or without, if applicable, DL assignment. If the DCI format 1\_1/1\_2/ is without DL assignment, the UE can assume the following:- …If a UE is configured with *CrossCarrierSchedulingConfig* for a serving cell the value of the DCI field ‘*carrier indicator*’ corresponds to the value indicated by *CrossCarrierSchedulingConfig.* The codepoint indicated by the DCI field ‘*Transmission Configuration Indicator*’ is applied to the carrier indicated by the DCI field ‘*carrier indicator*’ and corresponds to TCI state configured and activated for that carrier. | **Proposal 1.I:*** **Support/fine:** Samsung, CATT, Xiaomi, Intel, Nokia/NSB, CMCC, NTT Docomo, Lenovo/MotM
* **Not support:** MTK, ZTE, LG, OPPO, Ericson, Huawei/HiSi (clarify), IDC, Apple

**Unclear, need TP to discuss**: vivo (both), Qualcomm (1.I),  |
| 1.15 | Support to report virtual PHR based on the power control parameters associated with indicated TCI state for PUSCH/PUCCH transmission. | **Support/fine:** Apple, ZTE, NTT DOCOMO, OPPO**Not support:** Intel, Samsung, Qualcomm, MTK , CATT, Nokia/NSB, Lenovo/MotM, Ericsson, vivo, Huawei/HiSi |
| 1.16 | **Proposal 1.L**: For Rel-17 unified TCI framework, on applying the indicated Rel-17 TCI state to PDCCH reception and the respective PDSCH reception for a CORESET other than CORESET#0 that is associated with both UE-dedicated and non-UE-dedicated reception on PDCCH in a CC and its respective PDSCH reception,* Whether to apply the indicated Rel-17 TCI state associated with the serving cell is configured per CORESET by RRC – if not applied, use the legacy MAC-CE/RRC/RACH signalling mechanism
* Note: The CSI-RS associated with the Rel-17 TCI state applied to this CORESET should be QCLed with an SSB associated with serving cell PCI (same as Rel-15)
* The support of this feature is UE optional
	+ If not supported, UE always applies the indicated Rel-17 TCI state to CORESET(s) other than CORESET#0 that is associated with both UE-dedicated and non-UE-dedicated reception on PDCCH in a CC and its respective PDSCH reception

**FL Note**: The green highlighted part has been agreed and not up for discussion | **Support/fine:** Qualcomm, NTT Docomo, Samsung, Ericsson, CATT**Not support (UE does not expect to be configured with this CORESET if UE does not support the feature)**: Huawei/HiSi, vivo, LG |

Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 1**
	1. **@Those opposing 1.15, please check Apple’s argument below and see if you change your mind**
	2. **1.H: still opposed by many companies despite arguments from main proponent**
	3. **TPs are provided for 1.G and 1.I. Those opposing please check and see if you change your mind.**
2. **Share more inputs here if needed**
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| Apple | **1.15:** @vivo, I guess you ignored the words in spec – just after the sentence you highlighted. I highlighted it the sentence.

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| If the UE determines that a Type 1 power headroom report for an activated serving cell is based on a reference PUSCH transmission then, for PUSCH transmission occasion $i$ on active UL BWP $b$ of carrier $f$ of serving cell $c$, the UE computes the Type 1 power headroom report as  [dB]where $\tilde{P}\_{CMAX,f,c}(i)$ is computed assuming MPR=0 dB, A-MPR=0 dB, P-MPR=0 dB. TC = 0 dB. MPR, A-MPR, P-MPR and TC are defined in [8-1, TS 38.101-1], [8-2, TS38.101-2] and [8-3, TS 38.101-3]. The remaining parameters are defined in clause 7.1.1 where $P\_{O\\_PUSCH,b,f,c}(j)$ and $α\_{b,f,c}\left(j\right)$ are obtained using $P\_{O\\_NOMINAL,PUSCH,f,c}\left(0\right)$ and *p0-PUSCH-AlphaSetId* *=* 0, $PL\_{b,f,c}(q\_{d})$ is obtained using *pusch-PathlossReferenceRS-Id =* 0, and $l=0$. |

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

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
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| 2.8 | For UE with activated with more than one TCI state, 1. if the symbols of paging/short message/SI from serving cell are **not overlapped** with the symbols of DL signals from non-serving cell, UE receives both.

For PDSCH in TS38.214:

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| 5.1        UE procedure for receiving the physical downlink shared channel[…]When receiving PDSCH scheduled with SI-RNTI, P-RNTI, G-RNTI for broadcast or MCCH-RNTI, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the associated SS/PBCH block with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.For UE with activated [TCI-State] configured with [tci-StateId\_r17],* if UE is activated with one TCI state, and the active TCI state is associated with a PCI different from the PCI of the serving cell, UE is not required to receive PDSCH scheduled by DCI with CRC scrambled by P-RNTI.
* elseif UE is activated with more than one TCI states, and at least one active TCI state is associated with a PCI different from the PCI of the serving cell, UE receives both PDSCH scheduled by DCI with CRC scrambled by P-RNTI and PDCCH/PDSCH/CSI-RS with TCI state associated with associated with a PCI different from the PCI of the serving cell on different symbols.
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For PDCCH in TS38.213:

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| 10.1            UE procedure for determining physical downlink control channel assignment[…]A UE does not expect to detect, in a same PDCCH monitoring occasion, a DCI format with CRC scrambled by a SI-RNTI, RA-RNTI, MsgB-RNTI, TC-RNTI, P-RNTI, C-RNTI, CS-RNTI, or MCS-RNTI and a DCI format with CRC scrambled by a SL-RNTI or a SL-CS-RNTI for scheduling respective PDSCH reception and PSSCH transmission on a same serving cell.For UE with activated [TCI-State] configured with [tci-StateId\_r17],* if UE is activated with one TCI state, and the active TCI state is associated with a PCI different from the PCI of the serving cell, UE is not required to monitor PDCCH CRC scrambled by P-RNTI.
* elseif UE is activated with more than one TCI states, and at least one active TCI state is associated with a PCI different from the PCI of the serving cell, UE monitors both PDCCH CRC scrambled by P-RNTI and PDCCH/PDSCH/CSI-RS with TCI state associated with associated with a PCI different from the PCI of the serving cell on different symbols.
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1. if at least one symbol of paging/short message/SI from serving cell **is overlapped** with the symbol of DL signals from non-serving cell, UE receives paging/short message/SI.

For PDSCH in TS38.214:

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| 5.1        UE procedure for receiving the physical downlink shared channel[…]When receiving PDSCH scheduled with SI-RNTI, P-RNTI, G-RNTI for broadcast or MCCH-RNTI, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the associated SS/PBCH block with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.For UE with activated [TCI-State] configured with [tci-StateId\_r17],* if UE is activated with one TCI state, and the active TCI state is associated with a PCI different from the PCI of the serving cell, UE is not required to receive PDSCH scheduled by DCI with CRC scrambled by P-RNTI.
* elseif UE is activated with more than one TCI states, and at least one active TCI state is associated with a PCI different from the PCI of the serving cell, UE receives both PDSCH scheduled by DCI with CRC scrambled by P-RNTI and PDCCH/PDSCH/CSI-RS with TCI state associated with associated with a PCI different from the PCI of the serving cell on different symbols.
* elseif UE is activated with more than one TCI states, and at least one active TCI state is associated with a PCI different from the PCI of the serving cell, and if both PDSCH scheduled by DCI with CRC scrambled by P-RNTI and PDCCH/PDSCH/CSI-RS with TCI state associated with associated with a PCI different from the PCI of the serving cell are received on the same symbol, UE receives PDSCH scheduled by DCI with CRC scrambled by P-RNTI.
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For PDCCH in TS38.213:

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| 10.1            UE procedure for determining physical downlink control channel assignment[…]A UE does not expect to detect, in a same PDCCH monitoring occasion, a DCI format with CRC scrambled by a SI-RNTI, RA-RNTI, MsgB-RNTI, TC-RNTI, P-RNTI, C-RNTI, CS-RNTI, or MCS-RNTI and a DCI format with CRC scrambled by a SL-RNTI or a SL-CS-RNTI for scheduling respective PDSCH reception and PSSCH transmission on a same serving cell.For UE with activated [TCI-State] configured with [tci-StateId\_r17],* if UE is activated with one TCI state, and the active TCI state is associated with a PCI different from the PCI of the serving cell, UE is not required to monitor PDCCH CRC scrambled by P-RNTI.
* elseif UE is activated with more than one TCI states, and at least one active TCI state is associated with a PCI different from the PCI of the serving cell, UE monitors both PDCCH CRC scrambled by P-RNTI and PDCCH/PDSCH/CSI-RS with TCI state associated with associated with a PCI different from the PCI of the serving cell on different symbols.
* elseif UE is activated with more than one TCI states, and at least one active TCI state is associated with a PCI different from the PCI of the serving cell, and if both PDCCH CRC scrambled by P-RNTI and PDCCH/PDSCH/CSI-RS with TCI state associated with associated with a PCI different from the PCI of the serving cell are received on the same symbol, UE receives PDCCH CRC scrambled by P-RNTI.
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 | **For 1),****Support/fine:** NTT Docomo, CATT, Xiaomi, ZTE, CATT, Ericsson, Nokia/NSB, Samsung, OPPO**Not support:** vivo, MTK, Apple, Lenovo.MotM (clarification on UE cap)**For 2),****Support/fine:** NTT Docomo, Xiaomi, ZTE, Ericsson, Nokia/NSB, CATT**Not support:** vivo, MTK (Rel-15 dropping rule suffices), Qualcomm, Apple, OPPO, Lenovo/MotM (clarification on UE cap) |

Table 4 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 3**
	1. **2.1, 2.5, 2.7: still opposed by many companies despite explanation from the main proponents.**
	2. **Focus ROUND 3 discussion on 2.8: TP is provided. Those opposing please check if you change your mind.**
2. **Share more inputs here if needed**
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### Issue 3 (signaling medium)

Table 5 Summary: issue 3

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| **#** | **Issue** | **Companies’ views** |
| 3.5 | **Proposal 3.D:** For DCI format 1\_1 and 1\_2 with PDSCH assignment indicating TCI state, the acknowledgement to the TCI state update is the ACK of the PDSCH* FFS which one of indicated TCI states to be updated in case of HARQ-ACK multiplexing
	+ For example, the TCI state(s) indicated in DCI corresponding to last position with ACK value in the HARQ-ACK codebook

TS 38.214:5.1.5 Antenna ports quasi co-location\*\*\* Unchanged text is omitted \*\*\*When the UE would transmit the last symbol of a PUCCH with HARQ-ACK information having ACK value corresponding to the DCI carrying the *TCI-State* indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the TCI -State indication, and if the *indicated TCI-State* is different from the previously indicated one, the indicated *[TCI-State]* with[*tci-StateId\_r17]* should be applied starting from the first slot that is at least $BeamAppTime\\_r17$ symbols after the last symbol of the PUCCH. The first slot and the $BeamAppTime\\_r17$ symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The UE can assume one indicated *[TCI-State]* with[*tci-StateId\_r17]* for DL and UL, for DL only, or for UL only at a time.\*\*\* Unchanged text is omitted \*\*\* | **Support/fine:** OPPO, Qualcomm, NTT Docomo, NEC, Xiaomi, TCL, CMCC, Intel, ZTE, vivo, Futurewei, Lenovo/MotM, Spreadtrum, Qualcomm (NACK doesn’t work), Apple, LG, Nokia/NSB, **Not support:** Huawei/HiSi (add “or NACK”), Samsung, MTK, CATT, Ericsson (no spec impact) |
| 3.9 | **Proposal 3.F**: Regarding TCI indication by DCI without DL assignment, for type-1 HARQ-ACK codebook determination, virtual PDSCH is assumed in the same slot of the DCI by UE.TS 38.213 9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel-----------------------Unchanged part is omitted-------------------------------------------For the set of slot timing values$K\_{1}$, the UE determines a set of $M\_{A,c}$ occasions for candidate PDSCH receptions or SPS PDSCH releases or TCI state update according to the following pseudo-code. A location in the Type-1 HARQ-ACK codebook for HARQ-ACK information corresponding to a single SPS PDSCH release is same as for a corresponding SPS PDSCH reception. A location in the Type-1 HARQ-ACK codebook for HARQ-ACK information corresponding to multiple SPS PDSCH releases by a single DCI format is same as for a corresponding SPS PDSCH reception with the lowest SPS configuration index among the multiple SPS PDSCH releases. If a UE provides HARQ-ACK information corresponding to detection of a DCI format that provides TCI state update without scheduling PDSCH reception, as described in [6, TS 38.214], a location in the Type-1 HARQ-ACK codebook for the HARQ-ACK information is same as when the DCI format schedules a PDSCH reception with CBGs or with transport blocks that are correctly decoded. In such case, UE assumes that the PDSCH reception is in a same slot as the DCI format.-----------------------Unchanged part is omitted----------------------------------------- | **Support/fine**: ZTE, Nokia/NSB, Lenovo/MotM (discuss), Apple, MTK (discuss)**Not support:** OPPO, TCL, CATT, Intel, vivo, Samsung, CATT, LG |
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Table 6 Additional inputs: issue 3

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 5**
	1. **3.G: still opposed by many companies despite arguments from the main proponent**
	2. **Focus ROUND 3 discussion on 3.D and 3,F: TPs are provided. Those opposing please check and se eif you change your mind**
2. **Share more inputs here if needed**
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### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** |
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Table 8 Additional inputs: issue 4

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| **Company** | **Input** |
| Mod V0 | **No more proposals to be discussed in ROUND 3 unless there is consensus on issue 4.G. Else we will conclude no consensus at the end of the meeting** |

### Issue 5 (MPE)

Table 9 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** |
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Table 10 Additional inputs: issue 5

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| **Company** | **Input** |
| Mod V0 | **No more proposals to be discussed in ROUND 3****Status:*** 1. **5.1, 5.2, 5.3, 5.4: Still opposed by many companies despite arguments from main proponents**
	2. **5.5: resolved during GTW that it’s not needed**
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# References