**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, NTT Docomo **Not support:** Ericsson, Huawei/HiSi, Apple, OPPO (already supported), QC, ZTE |
| 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, Apple (for DCI with data)
* **Not support:** MTK, ZTE, LG, OPPO, Ericson, Huawei/HiSi (clarify), IDC, QC

**Unclear, need TP to discuss**: vivo (both)  |
| 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, Ericsson**Not support:** Intel, Samsung, Qualcomm, MTK , CATT, Nokia/NSB, Lenovo/MotM, , 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, Apple, ZTE, Lenovo/MotM, MTK**Not support (UE does not expect to be configured with this CORESET if UE does not support the feature)**: Huawei/HiSi, vivo, LG, Ericsson |

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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| Qualcomm | For Proposal 1.G, after checking the TP, we think it is not needed, since the current spec below already supports the proposal t to our understanding. For a CORESET with index 0, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with - the one or more DL RS configured by a TCI state, where the TCI state is indicated by a MAC CE activation command for the CORESET, if any, or- a SS/PBCH block the UE identified during a most recent random access procedure not initiated by a PDCCH order that triggers a contention-free random access procedure, if no MAC CE activation command indicating a TCI state for the CORESET is received after the most recent random access procedure, or a SS/PBCH block the UE identified during a most recent configured grant PUSCH transmission as described in clause 19.For Proposal 1.I, the proposal/TP seems not needed. The behavior is same as legacy system, where the TCI codepoint refers to the TCI configured for the scheduled CC. No need to mention the legacy rule just for unified TCIFor Proposal 1.L, we are also fine for not supporting CORESET C (HW/Vivo/LG’s understanding). But this is our 2nd preference since NW vendors mentioned that CORESET C is important to them. So our 1st preference is Proposal 1.L. If both are not acceptable, we propose another alternative, which is our fundamental need. The motivation is for UE to indicate support of R15/16 TCI signaling for CORESET 0, while other channels/RSs still always follow the indicated unified TCI. Because to our understanding, CORESET 0 must not follow the indicated TCI in case of inter-cell BM, based on the latest agreement where CORESET 0 should always have QCL source from serving SSB.Alternative of Proposal 1.L* Support of indication/configuration of R17 TCI states for CORESET 0 and the respective PDSCH reception reusing the Rel-15/16 signaling/configuration design(s)
* Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s), except for CORESET 0 and the respective PDSCH reception
 |
| Apple | 1.11: We do not think this is necessary. All CORESET #0 related issues were fixed based on previous agreements.1.13: OK with the TP at least for DCI with data.1.15: We would like to clarify the motivation again that current spec makes virtual PHR meaningless, since it is always measured based on a default beam.

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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 $l=0$. |

1.16: OK |
| ZTE | 1.11: If our understanding is correct, the proposed TP is not aligned with proposal 1.G: in 1.G, only CORESET#0 related QCL determination is mentioned, but for the proposed TP, it seems that we try to consider the PDSCH/PUSCH/PUCCH associated with the CORESET#0? In our views, for other channel, e.g., PDSCH, it may be relevant to default beam determination, and we prefer to use the legacy solution.1.13: It may not be needed. The above TP is common-understanding in our views, and as a default assumption, for all DCI fields in cross CC scheduling, the codepoint of the DCI fields should be interpreted in the scheduled CC. If really needed, we can have conclusion for issue.1.15: The legacy parameter may not be configured in unified TCI framework, considering that the all parameter(s) for power control will be handled by new Rel-17 RRC parameters. So, eitherway, we need to further review the solution for virtual PHR, based on the new RRC list for unified TCI framework.1.16: We are fine with moderator’s proposal.  |
| Lenovo | 1.11: Enough has been discussed regarding this issue. The reason for companies not supporting this is they believe it is already covered by previous agreements. We propose to add the following to Proposal 1.G: “it is up to the editor to decide whether new specification is needed and how to capture this”. 1.13: We support Proposal 1.I. Although the behaviour is similar to legacy behaviour, there is no TCI in DCI in R16, so it is necessary to clarify this.1.15: This new feature should not be introduced in R17 as a CR. We are open to discuss it in R18.1.16: Support Proposal 1.L |
| Mod V07 | **No revision in proposals** |
| MediaTek | P1.G: We prefer to have the agreement and leave the spec implementation to editors.P1.L: We are fine with current proposal. Even CORESET ‘C’ always applies the indicated TCI state if UE reports it doesn't support the configurability, NW still has the flexibility to decide whether to configure CORESET ‘C’. If UE reports CORESET ‘C’ is not supported, there is no flexibility for NW. |
| vivo | **For 1.I, not needed.****Issue 1.15**: We think it is necessary to align the understanding for current spec 38.213 section 7. Maybe companies can share understanding on this issue. We need common understanding on this issue. The following is copied for reference.In 38.213 section 7 of Rel-17 spec as follows, if the unified TCI is configured and indicated for PUSCH, the remaining parameters mentioned above in 7.1.1 should be determined based on the PC parameters associated the indicated TCI state. This means that the PC parameters associated with the indicated Rel-17 TCI state is used instead of the parameters defined in Rel15/16 as above.

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| In the remaining of this clause, if a UE is provided *TCI-State\_r17* and for an indicated *TCI-State\_r17* as described in [6, TS 38.214] - in clauses 7.1.1, 7.2.1, and 7.3.1, the RS index $q\_{d}$ for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission is provided by *PL-RS* associated with or included in the indicated *TCI-StateID\_r17*- in clause 7.1.1, if *p0-Alpha-CLID-PUSCH-Set* is provided, the values of $P\_{O\\_UE\\_PUSCH,b,f,c}\left(j\right)$, $α\_{b,f,c}\left(j\right)$, and the PUSCH power control adjustment state $l$ are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the indicated *TCI-StateID\_r17*- in clause 7.2.1, if *p0-Alpha-CLID-PUCCHSet* is provided, the values of $P\_{O\\_PUCCH,b,f,c}\left(q\_{u}\right)$ and the PUCCH power control adjustment state $l$ are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the indicated *TCI-StateID\_r17*- in clause 7.3.1, if *p0-Alpha-CLID-SRS-Set* is provided, the values of $P\_{O\\_SRS,b,f,c}\left(q\_{s}\right)$, $α\_{SRS,b,f,c}\left(q\_{s}\right)$, and SRS power control adjustment state $l$ are provided by *p0-Alpha-CLID-SRS-Set* associated with the indicated *TCI-StateID\_r17* |

**For 1.L, we are also fine with the following UE capability from QC.*** Support of indication/configuration of R17 TCI states for CORESET 0 and the respective PDSCH reception reusing the Rel-15/16 signaling/configuration design(s)
* Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s), except for CORESET 0 and the respective PDSCH reception
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| OPPO | Re 1.G: The motivation of 1.G can be understood. In unified TCI framework, we shall reset both PDCCH/PDSCH beam to align the unified TCI framework operation. However, it seems that only resetting the CORESET#0 and associated PDSCH/PUSCH/PUCCH is not sufficient. We shall re-set the TCI of all the PDCCH/PDSCH/PUSCH/PUCCH that follows the rel17 indicated TCI state.Re 1.I: we can be ok with the proposal and the corresponding TP. The current specification does specify the cross-carrier scheduling but is more about dynamic PDSCH scheduling. For DCI-based TCI state indication, it is good to have some dedicated clarification.Re 1.15: @vivo, for the understanding on the text of 38.213, our understanding is that the PC setting parameters associated with the indicated TCI states are applied in the calculation of Tx power of PUSCH.1.L: we are ok. |
| LG | 1.G: As mentioned that the behaviour is already in part of legacy behaviour, it seems redundant where the proposal is to determine initial beam as similar to the agreement in the last week.1.I: Not needed. We have a similar view with ZTE since the TCI codepoint should be related to the activated TCI states in scheduled CC.1.L: Not support. The application flexibility is already given by RRC configuration on CORESET C as similar to CORESET B where gNB can choose whether to use the UE specific beam RS for those PDCCH transmitted via CORESET C. In this sense, it seems natural for UE not supporting this feature that it is not to be configured with this CORESET type. |
| NTT DOCOMO | **Proposal 1.G**: Support.**Proposal 1.I**: Support.1.15: OK1.16: support FL proposal. The benefit of the proposal is that gNB can configure CORESET C irrespective of the UE capability. CORESET C is already deployed in commercial network, we should not preclude CORESET C by UE capability. Also, we think the proposal is aligned with UE behaviour for CORESET B when UE does not support “sharing with indicated Rel.17 TCI”. Another alternative commented by Huawei/vivo in the online last week, was “UE does not expect to be configured with CORESET (other than CORESET0) with both CSS and USS, if UE does not support the FG”. However, in this case, gNB vendors and operators, who already deploy CORESET C, will need to require UE vendors to implement this FG. |
| Xiaomi | Proposal 1.I: we agree that for legacy spec, it is common understanding that the codepoint of the DCI should be interpreted in the scheduled CC for cross carrier scheduling. We are fine with the TP to clarify it. But in addition, it is better to also consider all CCs configured in a same CC list as the carrier indicated by the DCI field “carrier indicator”. So we suggest the revision below: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 all CCs configured in a same CC list as that carrier, and corresponds to TCI state configured and activated for that carrier and all CCs respectively.Proposal 1.L: support  |
| Ericsson | 1.G: We don’t see why this is needed.1:I: Don’t support. The TCI codepoint is applied to the CC where the DCI was transmitted. Issue 1.15: It would seem that virtual PHR is currently not supported, since pusch-PathlossReferenceRS-Id may not be defined when the Rel-17 TCI state framework is used.Proposal 1.L: The default behaviour if the UE is unable to comply with (part of) the configuration included in the RRCReconfiguration message is to reject the RRC reconfiguration. We do not see a reason to deviate from this behaviour. |
| Samsung | **Proposal 1.G**:We have agreed that CORESET#0 can follow the unified TCI state. When CORESET#0 follows the unified TCI state and a CBRA procedure occurs, how does CBRA impact the beam used for CORESET#0. In Rel-15/16 the beam associated with CORESET#0 is reset to the beam found with CBRA until a new TCI state is activated by MAC CE. We believe that we should agree on a similar behaviour in Rel-17 for the unified TCI state framework. At least the following options are possible:1. Option 1: After a CBRA, only the beam associated with the PDCCH DMRS of CORESET#0 and associated channels (e.g., PDSCH, PUCCH, PUSCH being scheduled by CORESET#0) are reset to the beam found during CBRA until a new beam is indicated. Other CORESETs and associated channels continue to use the unified TCI state. This is the text described in the TP.
2. Option 2: After a CBRA, the beam for all channels using the unified TCI state is reset to the beam found during CBRA until a new beam is indicated.

We think that either option is reasonable option for system operation as it follows the unified TCI framework design principle of common beam for data and control and allows the system to benefit from the beam found during CBRA. **Proposal 1.I:**We previously mentioned, we have agreed to include the “carrier indicator” field in DCI Format 1\_1 and 1\_2 used for beam indication and without DLA. For companies that are saying that this is already covered in the specs, can you please point to where this is already include. We think that this behaviour is unspecified in the specs.We are fine with the proposed update by Xiaomi.**Proposal 1.L:** Support |
| Nokia | 1.11: Ok with Proposal 1.G, not OK with the TP, it is up to the editor to implement the agreement!1.13: Ok with Proposal 1.I, not OK with the TP, it is up to the editor to implement the agreement!1.15: We don’t support.  |

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

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 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), QC**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), QC, Xiaomi |

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**
 |
| Qualcomm | For 2.8* For 1st TP in 214: not support.
	+ The 1st bullet does not work because UE needs at least 2 active TCI for inter-cell BM, since CORESET 0 cannot follow the indicated TCI.
	+ The 2nd bullet is the legacy behaviour, i.e. TDMed receptions with different TCIs are supported even in R15. So no need to mention just for R17 unified TCI
* For 1st TP in 213, not support.
	+ The 1st bullet does not work same above reason.
	+ For 2nd bullet, no need such restriction. PDCCH from serving and non-serving PCIs can overlap, but just prioritize one based on existing prioritization rule.
* For 2nd TP in 213 and 214, not support
	+ For new 3rd bullet, not support. It is not aligned with the following agreement to our understanding. The agreement says if there is PDSCH from non-serving PCI, then UE should drop the paging PDSCH on the same symbol for inter-cell BM

**Agreement**With regards to the below question in RAN2 LS, provide the following response.

|  |
| --- |
| If UE is receiving DL data from *TRP with different PCI* on dedicated channels, is the UE still able to receive short message (e.g. paging) and system information from *serving cell TRP*at the same time? |

**Answer: No, it is not.** |
| Apple | 2.8: We also do not think any TP is needed. |
| ZTE | 2.8: It may be relevant to Issue 2.5. The main issue is how the UE realizes the corresponding transmission for paging/SIB when the scheduling offset is less than a threshold. If this issue can not be solved, the above rule can not be achieved. For instance, 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, but if the scheduling offset of PDSCH carrying paging/short message/SI is less than a threshold, how the UE makes sure that the PDSCH is received? Straightforward, we may have a requirement for prioritizing the reception of serving cell if there might be some candidate non-dedicated PDSCH transmission. |
| Lenovo | 2.8: We think it should be discussed jointly with UE capability. |
| Mod 07 | **No revision on proposals** |
| MediaTek | We still think these TPs are not necessary. Moreover, it seems these TPs may cause more issues. |
| vivo | 2.8：For the following wording, we would like to understand whether the slot/symbol for the TCI state reception is pre-determined? If still following the DCI indication in the PDCCH for paging signal, before UE decodes the corresponding PDCCH, how could UE apply the TCI to the paging PDSCH? “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.” |
| NTT DOCOMO | 2.8: We are ok to focus on case 1) only, i.e. TDM.**Re Qualcomm/Apple**, we have following questions/comments:* For the 1st bullet, for UE with one active TCI state, and if the active TCI state is associated with non-serving cell PCI, UE cannot receive paging. gNB needs to switch the one active TCI state to serving cell, so that UE can receive paging. This is our understanding of the consequence of the previous agreement. Regarding to CORESET 0, CORESET 0 without TCI state activation (i.e. QCLed with SSB) is not counted as the number of active TCI states, as same as Rel.15. So, as long as CORESET 0 is not activated with TCI state, gNB can indicate one (other) active TCI state for non-serving cell, for UE supporting one active TCI state. To clarify that UE still receives paging if it is QCLed with CORESET0 without TCI state indication, we updated the TP below.
* For 2nd bullet, indeed the TDM is allowed in Rel.15/16. However, there was no TCI state associated with non-serving cell in legacy. Also, we have agreement as shown in Qualcomm’s comment. The agreement is not clear and the worst consequence is that even TDM is not allowed, if UE is activated with TCI state associated with non-serving cell. We believe we should clarify that at least TDM operation is allowed.

**Re ZTE**, we are fine to discuss issue 2.5 later. We see there would be issue of default QCL assumption of PDSCH (<timeDurationForQCL) in inter-cell case. For issue 2.8, let’s focus on TP1) which is non-overlapped case.**@vivo:** The default QCL assumption of PDSCH (<timeDurationForQCL) can be discussed in issue2.5. We think your question is more general question how to assume default QCL assumption of PDSCH (<timeDurationForQCL) for serving cell and non-serving cell. We think this issue is not specific issue for paging reception. As long as we determine default QCL assumption of PDSCH (<timeDurationForQCL) for serving cell and non-serving cell in issue 2.5, we think your questions are solved.**@Lenovo:** Could you clarify what is intended UE capability? Even if non-overlapped case, do you think UE capability is needed to indicate its support?**@Moderator**, after reviewing companies’ comments, we think we can focus on TP of PDSCH for 1) only. It is because for PDCCH, the previous agreement does not clearly prohibit reception of one PDCCH from non-serving cell and the other PDCCH from serving cell, regardless of overlapped and non-overlapped case. So, we suggest to focus on the following TP.For PDSCH in TS38.214:

|  |
| --- |
| 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, only if PDSCH is QCLed with CORESET 0 without TCI state indication..
* 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.
 |

**@OPPO (to comment for 2nd round):** We think the TCI state switching gap is more general issue. UE can be configured to receive two DL signals with different TCI state on consecutive symbols. Could you clarify why the gap is needed specifically for this case? |
| Xiaomi | The TPs related to 2) seem conflict with the agreement mentioned by QC. And we update our view about 2) in Table 3. |
| Samsung | **Issue 2.8**:We support the first TP.For the second TP, we would like to understand the reason for dropping the UE-dedicated channel rather than dropping the paging channel. The network can provide paging over the UE dedicated channel, but can’t provide UE dedicated information over the paging channel. |
| Nokia | We do not support the text proposal (one TCI state) |

### 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, Samsung**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, Apple, MTK (discuss), QC**Not support:** OPPO, TCL, CATT, Intel, vivo, Samsung, CATT, LG, Ericsson |

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**
 |
| Qualcomm | For Proposal 3.D, support the TPFor Propsal 3.F, fine with the TP |
| Apple | 3.5: Support the TP. In addition, in our Tdoc, we also proposed to clarify how to count “previously indicated one” in current spec. It can be interpreted as the one indicated in the most recent DCI or the one being applied for current communication. If this is the most recent DCI, it may be possible that UE missed the DCI so that there could be a potential beam mismatch between gNB and UE. Thus, it is better to change “the previously indicated one” into “the one being applied”.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 \*\*\*3.9: OK |
| ZTE | Support both 3.5 and 3.9Then, we also support the suggestion from Apple about ‘previously indicated one’. Alternatively, we can remove the condition of ‘and if the *indicated TCI-State* is different from the previously indicated one’. |
| Lenovo | Proposal 3.D: supportProposal 3.F: Support |
| Mod V07 | **No revision on proposals** |
| MediaTek | P3.D: We still think using ACK only is an overoptimization since this issue can be resolved by NW implementation. To avoid the possible ambiguity due to PDSCH decoding failure, NW can schedule the corresponding PDSCH with lower MCS. Moreover, if these scheduling DCIs carry the same TCI update, NW can confirm UE successfully receives the TCI update, whether these PDSCHs decoded correctly or not, it doesn't matter.We are fine to clarify what’s the UE behavior when beam indications associated with the same HARQ-ACL feedback carries different TCI updates. However, we notice that this issue may be resolved by current spec. According to current spec as follows, if a latter detected DCI indicating a TCI state different from the previous one, UE will apply the latter one.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 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 \*\*\*P3.9: We are fine with the TP |
| vivo | **Proposal 3.D:** Support. |
| OPPO | **3. D:** support. @MTK: this is not optimization. It is not about the PDSCH decoding failure, but about the DCI decoding failure. The NR system does not differentiate DTX and NACK bit in general. If the UE does not receive the DCI correctly, the UE feedbacks a NACK bit. In this case, the UE does not receive the beam indication but the gNB would assume the UE receives the beam indication if NACK bit is used as acknowledgement to the beam indication. |
| LG | 3.9: It is still unclear why this cannot be handled by NW implementation considering that TDRA for a location for the ACK info in the HARQ-ACK codebook and k indicated by the PDSCH-to-HARQ\_feedback timing indicator are in DCI altogether. |
| NTT DOCOMO | **Proposal 3.D:** Support. But we have one comment.HARQ-ACK can be transmitted on PUCCH or PUSCH. If HARQ-ACK is transmitted on PUSCH, the current Rel.17 spec. does not support BAT. Hence, we think we should add “or PUSCH” after “PUCCH”**Proposal 3.F**: OK. |
| Xiaomi | Proposal 3.D: support the TP and the sub-bullet. We also support the suggestion from apple to change “the previously indicated one” into “the one being applied”. |
| Ericsson | Proposal 3.D: We do not support the TP. If the UE receives the beam indication, it shall apply it. The timing is determined based on the corresponding PUCCH transmission. How to react on the PUCCH reception is up to the NW. |
| Samsung | **Proposal 3.D**:We understand the reason for only using ACK as an acknowledgement for beam indication, when the DTX and NACK can’t be distinguished. In this case, using ACK is only valid option.Maybe we can further discuss if there are cases where the gNB can differentiate between a NACK and a DTX and include additional conditions for that. But this seems as an optimization.**Proposal 3.F:**Not clear if this is really needed. It also seems that this is not aligned with the following agreement**Agreement**For beam indication with Rel-17 unified TCI, support DCI format 1\_1/1\_2 without DL assignment:* Use ACK/NACK mechanism analogous to that for SPS PDSCH release with both type-1 and type-2 HARQ-ACK codebook:
	+ Upon a successful reception of the beam indication DCI, the UE reports an ACK
		- Note that upon a failed reception of the beam indication DCI, a NACK can be reported.
		- For type-1 HARQ-ACK codebook, a location for the ACK information in the HARQ-ACK codebook is determined based on a virtual PDSCH indicated by the TDRA field in the beam indication DCI, based on the time domain allocation list configured for PDSCH
		- …

We prefer to determine the real need for this TP before agreeing to it. |
| Nokia | 3.5: Support Proposal 3.D |

### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** |
|  |  |  |

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** |
| 5.8 | **Proposal 5.A:** For *mpe-ResourcePool*, the maximum number of resources in this pool is 64**From R1-2202720 LS response to RAN2:****Question 1.7:** Please clarify the structure of the *mpe-ResourcePool*: Is it a list of SSB or CSI-RS resources (i.e. SSBRI or CRI), and what is the maximum number of resources configured in the pool?**Answer 1.7:** It should be a list/set of SSB or CSI-RS resources index. Each SSB or CSI-RS resource index must also be associated with a serving cell index. RAN1 doesn’t preclude the re-use of existing IEs for the CSI-RS/SSB resource sets.There is no RAN1 agreement, on the maximum number of resources in the pool. The maximum number of resources is 64.**FL Note:** Need to decide the maximum number of resources in this pool.  | **Support/fine:** QC, ZTE, Lenovo/MotM, MTK, Samsung, Ericsson, Nokia/NSB, LG, Intel, NTT Docomo, CATT, CMCC, Huawei/HiSi, vivo, IDC**Not support (alternative proposal?):** Apple (8),[OPPO (8)] |

Table 10 Additional inputs: issue 5

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| --- | --- |
| **Company** | **Input** |
| Mod V0 | **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**
	3. **5.6, 5.7: resolved during GTW**
 |
| Mod V02 | **Added proposal 5.A, please share your view and comment** |
| Qualcomm | For Proposal 5.A, support |
| Apple | In our view, it is challenging to measure too many beams. We think 8 should be enough, which is the same as maximum number of active TCI states. |
| ZTE | Support. In our views, it is just the maximum number from spec perspective, and of course, the exact value for a given UE is subject to UE capability signaling. |
| Lenovo | Support in principle. Is the number fixed or is subject to UE capability? Will it be easier for companies to support this if the number is a UE capability? |
| Mod V07 | **Updated number to 64 per LS response discussion summary** |
| MediaTek | P5.A, we are fine with 64. Since this is an RRC configured pool, which cannot be updated dynamically, a larger number of candidate beams would be required, like the pool for NBI of BFR.Regarding the UE capability, in addition to the maximum number in a set, we also prefer to count these resources in FG16-1g and FG16-1g-1. |
| vivo | **Proposal 5.A:** Support. |
| OPPO | **Re 5.A: ok** |
| Xiaomi | Support  |
| InterDigital | Proposal 5.A: Support |
| NTT DOCOMO | Support. |

# References