**3GPP TSG RAN WG1 #103-e R1-2009499**

**e-Meeting, October 26th – November 13th, 2020**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

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

**Document for:** Discussion and Decision

**Change history – Moderator versions**

|  |  |  |
| --- | --- | --- |
| **Version** | **Add companies’ inputs** | **Moderator changes** |
| 14 | Qualcomm, LG, Apple, Samsung, MediaTek, IDC, OPPO, NTT Docomo, ZTE, vivo, Sony, Xiaomi |  |
| 24 | APT, Ericsson, Convida, IDC2, MediaTek2, Nokia, Samsung2, Fraunhofer, Lenovo |  |
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1. Introduction

Picking up from where the group left off in the 1st moderator summary R1-2008147 and the 1st GTW session, below are the summaries and moderator proposals.

1. Summary of companies’ inputs based on the issue category

The listed issues are structured primarily to facilitate some progress on pending issues identified in the agreements made in RAN1#103-e.

* 1. Issue 1 (unified TCI framework)

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 1.1 | Additional applicability of the common QCL information | CSI-RS resource for CSI:   * **Yes**: vivo, OPPO, Nokia/NSB, Spreadtrum, Convida, Samsung, Qualcomm, ZTE, NTT Docomo, MediaTek, APT, Intel, CATT, LG, Sony, Sharp, AT&T * **No**: Huawei/HiSi   Some CSI-RS resource(s) for BM:   * **Yes**: OPPO, Samsung, Qualcomm, ZTE, NTT Docomo, Intel, CATT, Sony, APT (with repetition “on”), Nokia/NSB (repetition “ON”) Convida * **No**: Huawei/HiSi, vivo, MediaTek, APT (other than repetition “on”), Lenovo/MoM   CSI-RS for tracking:   * **Yes**: vivo, Nokia/NSB, Spreadtrum, Convida, Qualcomm, ZTE (for AP-TRS only), APT, Intel, CATT, Sony, Sharp * **No**: Huawei/HiSi, MediaTek, OPPO   Periodic CSI-RS:   * **Yes**: Qualcomm (separate update) * **No**: ZTE, Apple | For common QCL:   * Some CSI-RS resource(s) for BM can be used for RX beam refinement (P3), with repetition “on” * CSI\_RS for tracking: need to clarify if this is intended for all tracking CSI-RS   Blue highlighted aspects show good majority view |
| 1.2 | Additional applicability of the common UL spatial filter to SRS for BM | Some SRS (resource set(s)) for BM:   * **Yes**: OPPO, Samsung, Apple, Qualcomm, Intel (with BC), CATT, ZTE, Sony * **No**: Huawei/HiSi, APT, Spreadtrum, Convida, NTT Docomo, MediaTek, Intel (without BC) | Intended for UL RX beam refinement (U2)  Note: Beam correspondence (BC) is assumed. Can Intel’s preference be understood as when separate UL is configured? |
| 1.3 | Maximum value of M (DL) and N (UL) | **Max=1 for sTRP**: CATT, OPPO, MediaTek, Spreadtrum, Convida, Nokia/NSB, Samsung, Fraunhofer IIS/HHI, Apple (M=1, N=1 for non-MPE and M=1, N=2 for MPE), ZTE, APT, Sony  **Max=2 for mTRP**: Nokia/NSB, Fraunhofer IIS/HHI, Apple (M=2), AT&T, APT, Sony  **Max>1**: Sharp, Futurewei, IDC, vivo (multiple beams per TRP, Max=4), ZTE, Qualcomm, Lenovo/MoM, LG | Some companies favoring Max>1 (including Max=2) suggest to progress on unified TCI design for Max=1 to an extent before considering Max>1: Samsung, Nokia/NSB, Fraunhofer IIS/HHI, ZTE  The discussion can progress as follows: 1) Decide first whether to support mTRP, if so, what’s the max #. 2) Decide max # TCIs per TRP (discussion includes use cases).  It is assumed that M and/or N TCIs will be updated together in one beam indication (also cf. 1.4, 1.5)  Blue highlighted aspects show good majority view |
| 1.4 | TCI state applicability to a subset of CORESETs (in addition to all CORESETs) | **Yes**: LGE, Nokia/NSB, Ericsson, Qualcomm, NTT Docomo, APT, Intel, Sharp  **No**: ZTE | Need discussion to clarify potential use cases other than mTRP. For mTRP, it is obvious that one of the M TCI states applies only to a subset of UE-dedicated CORESETs. |
| 1.5 | TCI state applicability to a subset of PUCCHs (in addition to all PUCCHs) | **Yes**: LGE, Nokia/NSB, Ericsson, Qualcomm, APT  **No**: ZTE |
| 1.6 | Support for common TCI state for intra-band and inter-band CA | **Yes**: Futurewei, vivo, CATT, Samsung, OPPO, LGE, Qualcomm, Ericsson, Sony, NTT Docomo, MediaTek, APT (for intra-band only), Intel, ZTE, Nokia/NSB, AT&T  **No**: -- |  |
| 1.7 | Separate UL and DL beam indication (for, e.g. MPE mitigation):  Alt1. Joint TCI including non-corresponding DL QCL and UL spatial filter reference, common pool  Alt2-1. Separate UL TCI, common TCI pool with DL TCI  Alt2-2. Separate UL TCI, separate TCI pool from DL TCI | **Alt1**: OPPO, ZTE, CATT, Convida, Samsung, NTT Docomo, Apple  **Alt2-1**: Xiaomi, Nokia/NSB, Intel, APT, MediaTek  **Alt 2-2**: Futurewei, CMCC, Nokia/NSB, Sony, Fraunhofer IIS/HHI, Xiaomi, APT, Ericsson, AT&T, Qualcomm, MediaTek, Lenovo/MoM | Before concluding this issue, the use case for separate UL beam indication needs to be discussed and understood better. Thus far, the only use case is MPE mitigation (since BC is mandatory).  Blue highlighted aspects show good majority view |
| 1.8 | Additional source RS types for UL TX spatial filter | Non-BM CSI-RS   * **Yes**: Huawei/HiSi, vivo, Nokia/NSB, Ericsson, Qualcomm, ZTE, Sony * **No**: Convida, Apple   Non-BM SRS   * **Yes**: Spreadtrum, Qualcomm, ZTE, Nokia/NSB * **No**: Convida, Apple   DL channels: Fraunhofer IIS/HHI | Note: SSB has been agreed in RAN1#102-e – no need to be discussed again  Blue highlighted aspects show good majority view |
| 1.9 | SRS for BM as source RS for DL RX spatial filter | **Yes**: IDC, vivo, Samsung, Sony, Nokia/NSB, Convida, CATT, Apple (OK with DL RS configured as source RS for SRS for BM, in another word, SRS is a bridge)  **No**: Ericsson, ZTE | Need further discussion if this entails some joint use of SRS with a DL RS to ensure it is functional when UE orientation changes (and whether it will resolve concern)  Blue highlighted aspects show good majority view |
| 1.10 | Additional parameters included in or concurrent with (but not included in) in unified TCI | UL PC parameters (P0/alpha, CL index)   * **Yes**: IDC, Lenovo/MoM, Futurewei, CMCC, Samsung, Qualcomm, ZTE, MediaTek, Intel (for PUCCH), LG, Apple * **No**: Huawei/HiSi   PL RS:   * **Yes**: IDC, vivo, ZTE, OPPO, Lenovo/MoM, Qualcomm, Fraunhofer IIS/HHI, Futurewei, Samsung, MediaTek, Intel, LG, Apple, Sharp * **No**:   UL timing parameters   * **Yes**: LGE (panel-specific) * **No**: Apple, OPPO, MediaTek (should be discussed in MTRP AIs) | At least two factors need to be discussed: 1) common vs separate UL/DL beam indication (cf. NTT Docomo input), 2) whether the parameters are included in the unified TCI or (analogous to Rel.15/16) defined separately from unified TCI (cf. MediaTek input)  It is quite clear that companies see the need for at least the UL PC parameters and PL RS references for the unified TCI framework. But as pointed out by MediaTek, the main question is whether these parameters should be included in the unified TCI framework (as a part of the UL spatial reference) or simply defined concurrently. |
| 1.11 | Support default QCL/spatial relation for joint/common TCI | **Yes**: Huawei/HiSi, vivo (extend R15/R16), Fraunhofer IIS/HHI, NTT Docomo, Ericsson (CORESET with lowest ID), Sharp, Spreadtrum, Qualcomm, Xiaomi, Lenovo/MoM, Intel  **No (not needed)**: Nokia/NSB, MediaTek, OPPO, Apple, Convida, Samsung | Note: If supported, for separate DL and UL beam indication (MPE), whether one default QCL/spatial relation is sufficient (for DL and UL) may need to be discussed  It has been pointed out the that the need is unclear for unified TCI framework. So further discussion seems needed before we can proceed. |
| 1.12 | How to provide QCL information for signals where the common QCL (cf. #1.1, #1.2) is not applicable | **Alt1. Reuse Rel.15/16 TCI/spatial relation:** ZTE, Apple, Sony, Nokia/NSB  **Alt2. NW association with common TCI states:** MediaTek, Samsung | Although this may need to wait until #1.1. and #1.2 progress, listing alternatives for further down selection can help. |

From moderator perspective, concluding on the following matters would facilitate much better discussion not only in this issue (issue 1), but also in other issues in multi-beam enhancements:

* Proposal 1.A has been stable
* Proposal 1.B (issue 1.7): TCI design for separate UL and DL beam indication. Concluding on this would resolve ambiguity in issue 3, 4, and 5
* Proposal 1.C (issue 1.3): maximum value of M (DL) and N (UL): the key questions are (1) whether mTRP should be supported in item 1 design work and if so the maximum # TRPs (DL and UL), (2) maximum # TCIs for a single TRP (analogous to the so-called single-DCI/single-PDCCH approach in Rel.16 mTRP)
  + Better clarity on (2) would lead to better clarity on 1.4 and 1.5
* Proposal 1.D (issue 1.1, 1.2, and 1.12): when the common QCL and common UL spatial filter in joint TCI are applicable (in addition to what have been agreed in RAN1#102-e), and when they are not
* Proposal 1.E (issue 1.8 and 1.9): additional types of source RSs, related to the a/symmetry between DL and UL in terms of QCL and UL spatial reference
* Issue 1.10 needs to be reformulated for further discussion:
  + On UL PC parameters (P0/alpha, CL index), decide among 3 alternatives:
    - Alt1. Include as a part of unified TCI framework (as a part of the UL spatial reference)
    - Alt2. Include concurrently with but outside unified TCI framework
    - Alt3. Not include
  + On PL RS, decide among 2 alternatives
    - Alt1. Include as a part of unified TCI framework (as a part of the UL spatial reference)
    - Alt2. Include concurrently with but outside unified TCI framework

**Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state update and activation to provide common QCL information and/or common UL TX spatial filter(s) across a set of configured CCs:

* The above applies to intra-band CA
* The above applies to joint DL/UL and separate DL/UL beam indications
* FFS: The above also applies to inter-band CA
* FFS: sharing a single RRC TCI state pool for the set of configured CCs

**Proposal 1.B**: 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
* For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):
  + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all of CORESETs in a CC
* For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):
  + 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 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
* FFS: Whether the UL TCI state is taken from a common or separate TCI state pool from DL TCI state
* FFS: Whether Rel.17 supports TCI configured for single channel (e.g. PDSCH only, single CORESET)
* Note: This does not preclude the type of UE supporting only 1 beam tracking loop, i.e. UE reports value of 1 in UE FG 2-62.

**Proposal 1.C**: On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate DL/UL TCI:

* For single-TRP scenarios:
  + The source reference signal(s) in one TCI provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC (i.e. M=1 in this case)
  + The source reference signal in one TCI provides a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all of dedicated PUCCH resources in a CC (i.e. N=1 in this case)
  + FFS: The support for M>1 and/or N>1 for single-TRP
* FFS: the support for mTRP
* Note: This does not preclude that the source reference signal(s) in one TCI can provide common QCL/spatial filter info for both DL and UL signals.

**Proposal 1.D**:

* On Rel.17 unified TCI framework, based on the RAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate DL TCI:
  + The source reference signal(s) in M TCIs can also provide common QCL information for one or more CSI-RS resources for CSI, some CSI-RS resource for BM with repetition ‘ON’, and aperiodic CSI-RS for tracking, where the target CSI-RS resource(s) are determined by NW configuration
    - FFS: Support for some aperiodic CSI-RS resource for BM with repetition ‘OFF’

FFS (RAN1#104-e): select a scheme to provide the the QCL information or the UL TX spatial filter for other channels, signals, or CORESETs not included in the Rel.17 unified TCI framework

**Proposal 1.E**: On Rel.17 unified TCI framework, for both joint DL/UL TCI and separate DL/UL TCI:

* Support the use of CSI-RS for tracking as source RS to determine a UL TX spatial filter
* [Support the use SRS for BM as a source RS to represent a DL RX spatial filter, configured together with either a CSI-RS for BM, SSB, or DL TRS as the QCL source (or spatial relation) for the SRS ]

**Conclusion 1**: On Rel.17 unified TCI framework, in RAN1#103-e, there is no consensus on supporting the use of SRS for BM as a source RS to represent a DL RX spatial filter, whether configured together with a DL RS (either a CSI-RS for BM, SSB, or DL TRS) or not

Interested companies are encouraged to provide their inputs on the above proposals and reformulated issue 1.10:

Table 2 Additional inputs for round-2 discussion: issue 1 proposals 1.A, 1.B, 1.C, 1.D, 1.E

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | For 1A, we prefer more direct wording  • Working assumption: The above also applies to inter-band CA (~~pending further confirmation from, e.g. RAN4~~ send LS to RAN4 for confirmation)  For 1B, add the following clarification  FFS: Whether R17 allows TCI configured for single channel (e.g. PDSCH only, single CORESET). If allowed, whether the separate DL/UL TCI pool includes TCI configured for single channel  For 1C, add a note  Note: This does not preclude that the source reference signal(s) in one TCI can provide common QCL/spatial filter info for both DL and UL signals.  For 1D, we prefer to keep the last bullet to be FFS, or replaced with the following FFS. We don’t think spatial relation should be used when unified TCI is used. Unified TCI should also handle the single UL channel case.  • ~~For other channels, signals, or CORESETs not included in the Rel/17 unified TCI framework, the QCL information or the UL TX spatial filter is provided from Rel.15/16 TCI or Spatial Relation~~  FFS: Whether separate DL/UL TCI in unified TCI framework can be extended to indicate TCI for single channel (e.g. PDSCH only, individual CORESET, individual PUCCH resource)  For 1F, add TRS. Otherwise, we don’t think it works well   * Support the use SRS for BM as a source RS to represent a DL RX spatial filter, configured together with either a CSI-RS for BM or SSB as SRS’s QCL source, and configured together with a DL TRS in the TCI state containing the SRS   For both 1C, 1D, 1F, add DL, which is also introduced in R17  “for both joint DL/UL TCI and separate DL/UL TCI: |
| LG | **Proposal 1.A:** Fine in general although we prefer to support inter-band CA as well, analogous to Rel-16.  **Proposal 1.B:** As commented earlier, we prefer to discuss this proposal after UL TCI contents is determined (e.g. issue1.10). With current proposal, it is unclear on the difference between UL TCI and spatial relation in Rel-15/16.  {FL comment: With separate UL TCI from DL, the concern on the content is not an issue anymore, unlike with Alt1.}  **Proposal 1.C:** The intention for M,N>=1 is also to provide the flexibility to operate common QCL or UL TX spatial filter for CORESETs or PUCCH resources, which is not only for mTRP scenario. For example, it can be considered that the common QCL indication with a relatively narrow beam for UE-dedicated control/data channel while providing a relatively wide beam for UE group-specific channels/RSs such as CORESET#0 and CSI-RS even in sTRP scenario, which can capture the benefits on both common beam indication and a certain Tx/Rx operation case. Hence, it is concerned to fix M=N=1 for sTRP scenario. We prefer more flexible framework to be applicable for any scenario, which of course supports M=N=1 but supports a larger values of M and N based on gNB configuration.  {FL comment: FFS is added}  **Proposal 1.D:** Fine in general. Since this feature would not be always possible, e.g. CSI-RS from other TRP, we propose to revise wording a bit   * + The source reference signal(s) in M TCIs can also provide common QCL information for one or more CSI-RS resource(s) for CSI, [some CSI-RS resource for BM [with repetition ‘ON’], and CSI-RS for tracking], where the target CSI-RS resource(s) are determined by gNB configuration   **Proposal 1.E:** We are not supportive on the second bullet.  {FL comment: please check if Qualcomm’s revision (already added) resolves your concern} |
| Apple | **Proposal 1.B:**  Similar to spatial relation, we think UL TCI is not applicable for FR1, and for FR2, we think UE FG 2-62 (total number of active TCI + spatial relation) should also be applicable for UL TCI. Further, we think the DL TCI can provide the functionality to determine the spatial relation for UL signal as well, so it may be possible that UL TCI can be optional. There, we suggest the following changes:  **Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL, support Alt2-2 as described in the RAN1#102-e agreement, that is:   * Utilize two separate TCI states, one for DL and one for UL.   + The UL TCI is optionally indicated, and when it is not provided, the spatial relation is provided by RS configured for QCL-typeD in DL TCI * For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC * For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + 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 UL TCI state is taken from another pool of TCI states than the DL TCI state * Note: UL TCI is not applicable for FR1 * Note: This does not preclude the type of UE supporting only 1 beam tracking loop, i.e. UE reports value of 1 in UE FG 2-62.   **Proposal 1.C:**  We made some editorial changes to clarify simultaneous multi-panel transmission is not the intention for UL side.  **Proposal 1.C**: On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate UL TCI:   * For single-TRP scenarios:   + The source reference signal(s) in one TCI provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC (i.e. M=1 in this case)   + The source reference signal in one TCI provide a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC (i.e. N=1 in this case) * Up to 2 TRPs can be supported in DL and/or UL. In case of two TRPs:   + The source reference signal(s) in up to two TCI states provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC (i.e. M can be up to 2 in this case)   + The source reference signal(s) in up to two TCI states, where each TCI state provides a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources associated with one TRP in a CC (i.e. N can be up to 2 in this case)   **Proposal 1.E:**  We can be open to include TRS to determine UL spatial relation, since anyway TRS should be configured. We are ok to include SRS for BM as the source for DL when there is a SSB/CSI-RS configured in its spatial relation for further UE beam tracking.  **Proposal 1.E**: On Rel.17 unified TCI framework, for both joint DL/UL TCI and separate UL TCI:   * Support the use of CSI-RS for tracking as source RS to determine a UL TX spatial filter * Support the use SRS for BM as a source RS to represent a DL RX spatial filter, configured together with either a CSI-RS for BM or SSB in the spatial relation of the SRS |
| Samsung | **Proposal 1.A:**  We are supportive of proposal 1.A. We suggest to update the proposal such that the common TCI state is across a subset of all CCs.  On Rel.17 unified TCI framework, support common TCI state update and activation across multiple CCs in a set of configured CCs:   * The above applies for intra-band CA * Working assumption: The above also applies to inter-band CA (pending further confirmation from, e.g. RAN4) * FFS: details such as multiple CCs being a subset of or all CCs in the set of configured CCs   {FL comment: Since this proposal has not been proposed by a number of companies, this can be kept FFS for now}  **Proposal 1.B:**  Note that the TCI pool for joint TCI is still an open issue per RAN1#102-e agreement, this should be taken into account by the moderator as well. This FFS is taken from the agreement:  *FFS: When used for the purpose of joint beam indication for UL and DL, whether a joint TCI pool for DL and UL dedicated for the purpose is used, or the same TCI pool as that used for the purpose of separate DL/UL beam indication is used*  {FL: Good point, in that case the pool for separate UL TCI should be kept FFS and decided together with the joint TCI}  **Proposal 1.C:**  We are supportive of proposal 1.C.  **Proposal 1.D:**  We are supportive of proposal 1.D. The square brackets in sub-bullet of first bullet can be removed.  **Proposal 1.E:**  We are supportive of proposal 1.E. |
| MediaTek | **On Proposal 1.A**, support FL proposal.  **On Proposal 1.B,** support FL proposal.  **On Proposal 1.C,** support FL proposal. If NW wants more flexibility on DL/UL beam indication, R15/16 TCI/spatial relation can be used.  **On Proposal 1.D,** support the 1st bullet if the bracketed RSs are removed or put them in FFS. For the last bullet, we have concern on using two (or three) different QCL frameworks on a same BWP/CC, it would be quite redundant to configure so many TCI states and spatial relations. We prefer using a common pool (or two if separate pools are used for DL and UL) for all channels and signals. That is, for other channels, signals, or CORESETs supported neither joint DL/UL TCI nor separate UL TCI, the QCL information or the UL TX spatial filter is provided from the same TCI pool(s) used for joint DL/UL TCI or separate UL TCI. The association can be configured by NW using separate signalings. We are also fine to discuss in the later meeting and keep the last bullet as FFS as follows:  **Proposal 1.D**:   * On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate UL TCI:   + The source reference signal(s) in M TCIs also provide common QCL information for CSI-RS resource for CSI, [some CSI-RS resource for BM [with repetition ‘ON’], and CSI-RS for tracking] * FFS: For other channels, signals, or CORESETs not applied/supported neither joint DL/UL TCI nor separate UL TCI, how to provide the QCL information or the UL TX spatial filter for them.   **On Proposal 1.E,** support FL proposal with Apple’s modifications. |
| InterDigital | We support original proposal 1.A and 1.E. |
| OPPO | For 1A, suggest to change it as follows. It does not make sense to only support it from the perspective of signalling. Common TCI state for CA means common QCL and common UL Tx filter for CA.  **Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state update and activation to provide common QCL information and common UL TX spatial filter(s) across a set of configured CCs:   * The above applies for intra-band CA * Working assumption: The above also applies to inter-band CA (pending further confirmation from, e.g. RAN4)   For 1B: suggest to make the following change. We are not ok for subset of CORESETs and subset of PUCCH. As described in WI, it is common TCI state for control and data. Thus all the CORESETs and PUCCHs shall be included here.  **Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL, support Alt2-2 as described in the RAN1#102-e agreement, that is:   * Utilize two separate TCI states, one for DL and one for UL. * For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all ~~or subset of~~ CORESETs in a CC * For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + 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 UL TCI state is taken from another pool of TCI states than the DL TCI state   {FL comment: will put square brackets around subset. One motivation mentioned for “subset” is co-existence with Rel.15/16 reception}  For 1C:  **Proposal 1.C**: On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate UL TCI:   * For single-TRP scenarios:   + The source reference signal(s) in one TCI provide common QCL information at least for UE-dedicated reception on PDSCH and all ~~or subset of~~ CORESETs in a CC (i.e. M=1 in this case)   + The source reference signal(s) in one TCI provide a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all ~~or subset of~~ dedicated PUCCH resources in a CC (i.e. N=1 in this case) * Up to 2 TRPs can be supported in DL and/or UL. In case of two TRPs:   + The source reference signal(s) in each one of up to two TCI states provide common QCL information at least for UE-dedicated reception on PDSCH and all ~~or subset of~~ CORESETs of one TRP in a CC (i.e. M can be up to 2 in this case)   + The source reference signal(s) in each of up to two TCI states 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 of one TRP in a CC (i.e. N can be up to 2 in this case)   For 1.D, we do not support including CSI-RS for tracking and we support to include CSI-RS for BM with repetition = On.  **Proposal 1.D**:   * On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate UL TCI:   + The source reference signal(s) in M TCIs also provide common QCL information for CSI-RS resource for CSI, ~~[~~some CSI-RS resource for BM ~~[~~with repetition ‘ON’]~~, and CSI-RS for tracking]~~ * For other channels, signals, or CORESETs not included in the Rel/17 unified TCI framework, the QCL information or the UL TX spatial filter is provided from Rel.15/16 TCI or Spatial Relation   For 1.E: we do not support use of non-BM CSI-RS as source RS for UL Tx spatial filer.  **Proposal 1.E**: …:   * ~~Support the use of non-BM CSI-RS as source RS to determine a UL TX spatial filter~~ |
| NTT Docomo | 1.A: support in principle. We prefer to agree inter band CA in FR1 also, because we assume the companies concern for inter band CA is in FR2. On the other hand, our most interest is inter band CA in FR1 (3.7GHz + 4.5 GHz). Also, note that Rel.15/16 RAN1/RAN2 spec. have no restriction of inter band CA. In RAN1, we are discussing from signaling perspective, and we believe there is no need to preclude inter band CA in RAN1 spec.  1.B Although our preference is Alt. 2-1, we are fine with the proposal.  1.C Support. We would like to discuss and clarify, whether all combinations of (M, N) = (1, 1), (1, 2), (2, 1), (2, 2) are possible. Our understanding is yes.  {FL comment: correct}  1.D Support.  1.E Support. |
| ZTE | **Proposal 1.A:**  In general we share the same views with OPPO. Specifically, we need to further clarify whether we need to provide separate RRC pools for each of CC or reuse the same pool for the set of configured CCs. Based on the motivation of unified TCI framework, sharing a same TCI state pool for all CC is preferred.  **Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state update and activation across a set of configured CCs:   * The above applies for intra-band CA * FFS: sharing a single RRC TCI state pool for the set of configured CCs.Working assumption: The above also applies to inter-band CA (pending further confirmation from, e.g. RAN4)   **Proposal 1.B:**  We can NOT support this proposal and share the same views with LGE and Samsung. For better understanding this current proposal 1.B   * Could any proponent clarify why we can NOT directly use QCL Type-D RS for UL spatial relation indication? * Is there any difference between Rel-15/16 spatial relation and this unified TCI state pool? * Meanwhile, if we have two separate RRC pool for unified TCI, how to achieve a joint beam indication by a single command, e.g., DCI format 1\_1/1\_2?   Even considering the separate beam indication, we may only need to consider a separate activated pool in MAC rather than both RRC+MAC-CE. Consequently we have the following proposals.  **Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL, support a common RRC pool for both DL and UL TCI   * In MAC level,   + For joint DL and UL TCI indication, a common TCI state pool selected from the common RRC pool is activated   + For separate DL and UL TCI indication, two separate activated TCI state pools from the common RRC pool are activated.     {FL comment: The proposal is based on the super-majority view – it looks like OPPO and Samsung do not have concern. Hopefully this is acceptable to ZTE for the sake of progress ☺ The pool issue is left for FFS}  **Proposal 1.C:**  We are okay for single TRP case, but multi-TRP case should be FFS. We have one question for clarification: how “the source reference signal(s) in up to two TCI states” are applied to DL and UL channels?  {FL comment: “up to two” is used since one TCI can still be used for 2 TRPs}  **Proposal 1.D:**  We only support to update the TCI state for aperiodic TRS rather than periodic TRS. Please find the minor update as follows.  **Proposal 1.D**:   * On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate UL TCI:   + The source reference signal(s) in M TCIs also provide common QCL information for CSI-RS resource for CSI, [some CSI-RS resource for BM [with repetition ‘ON’], and aperiodic CSI-RS for tracking]   **Proposal 1.E:**  We can support the first bullet but NOT for second one. Benefits for using SRS for BM are not clear. Why not just use CSI-RS for BM or SSB herein.  **Proposal 1.E**: On Rel.17 unified TCI framework, for both joint DL/UL TCI and separate UL TCI:   * Support the use of non-BM CSI-RS as source RS to determine a UL TX spatial filter |
| vivo | On Proposal 1.A, issues for inter-band CA case is currently under discussion in Rel-17 CA in RAN4. Prefer not touch the inter-band case before we have clearer understanding.  On Proposal 1.B, whether we use one pool or separate pools in RRC can be determined later based on further design.  On Proposal 1.C, we share similar understanding as LGE. M>=1 is not only for the case of MTRP, but also for the case when the beam for data and control are different. We would like to further ask how would the following choices in “all or subset of CORESETs in a CC (i.e. M=1 in this case)” and “all or subset of dedicated PUCCH resources” be addressed?  {FL comment: To address the above comments, the respective parts are now FFS}  On Proposal 1.D, the “and separate UL TCI” part is not necessary for the first sub-bullet. We are supportive of the second bullet.  On Proposal 1.E, we are supportive of the FL proposal. |
| Sony | **Proposal 1.A.** Support the FL proposal.  Though we believe the Rel.17 unified TCI framework can be applied to both intra-band and inter-band CA, we are fine to leave the inter-band case as working assumption at current stage and to rely on RAN4’s further investigation on it. Perhaps as QC mentioned, an LS to RAN4 about the inter-band case might be necessary.  **Proposal 1. B.** Support the FL proposal.  **Proposal 1. C.** Support the FL proposal in general.  It seems still controversial that the source RS in one or up to 2 TCI state(s) provides QCL information for all CORESETs or subset of CORESETs. We would like to suggest following change   * + The source reference signal(s) in one TCI provide common QCL information at least for UE-dedicated reception on PDSCH and ~~all or subset of~~ CORESETs in a CC (i.e. M=1 in this case)     - FFS the above applies to either all or subsets of CORESETs   + The source reference signal(s) in up to two TCI states provide common QCL information at least for UE-dedicated reception on PDSCH and ~~all or subset of~~ CORESETs in a CC (i.e. M can be up to 2 in this case)     - FFS the above applies to either all or subsets of CORESETs   Moreover, the same issue holds for PUCCH as well. So corresponding wording change can be expected.  **Proposal 1. D.**  One question popped up in our mind is that why does literally separate UL TCI provide QCL information for DL RS, i.e. CSI-RS in this case? If it is either joint TCI or DL TCI, we have no concern. But if it is UL TCI state, a little clarification would be appropriated.  {FL comment: This proposal is about DL RS as a source RS for UL TCI, i.e. the other way around}  **Proposal 1. E.**  Support the first bullet with the modification from Apple that “non-BM CSI-RS” changed to “CSI-RS for tracking”.  Support the second bullet from FL. |
| Xiaomi | **On Proposal 1.A**  We support the proposal in principle. But as agreed in Issue#3, it uses ‘joint or separate DL/UL beam’, thus it is better to change ‘common TCI state’ to ‘joint or separate DL/UL beam’. The changes can be seen as follows.  **Proposal 1.A**: On Rel.17 unified TCI framework, support joint or separate DL/UL beam update and activation across a set of configured CCs:   * The above applies for intra-band CA * Working assumption: The above also applies to inter-band CA (pending further confirmation from, e.g. RAN4)   {FL comment: Added}  **On Proposal 1.B**  We support the proposal  **On Proposal 1.C**  We support the proposal in principle. And we have one point to clarify. If it is for joint DL/UL TCI, my understanding is that there is only one joint DL/UL TCI. And for single-TRP scenarios:   * The source reference signal(s) in this joint DL/UL TCI provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC (i.e. M=1 in this case) * The source reference signal(s) in this joint DL/UL TCI provide a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC (i.e. N=1 in this case)   If it is for separate DL/UL TCI, there is one DL TCI and one UL TCI. And for single-TRP scenarios:   * The source reference signal(s) in this DL TCI provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC (i.e. M=1 in this case) * The source reference signal(s) in this UL TCI provide a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC (i.e. N=1 in this case)   If my understanding is right, could we describe joint DL/UL TCI and separate DL/UL TCI separately in Proposal 1.C?  {FL comment: The understanding is correct. But the current wording already implies this without using different descriptions for joint from separate – since QCP refers to FL and spatial filter to UL}  **On Proposal 1.D**  We support to include CSI-RS resource for CSI and CSI-RS for BM with repetition = On.  **On Proposal 1.E**  We have concern on use of non-BM CSI-RS as source RS to determine a UL TX spatial filter. |
| APT | 1A: we are supportive of intra-band CA. For inter-band CA, we need clarification on feasibility of TCI cross-CC reference, for example, which QCL types can apply such cross-CC reference. Before clarification, we do not consider “working assumption” is proper. Hence, changing WA to FFS would be fine to us.  1B: for the note related to UL TCI, we think it may dependent if we introduce further parameters discussed in Issue 1.10. Hence, we suggest the following change.  **Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL, support Alt2-2 as described in the RAN1#102-e agreement, that is:   * Utilize two separate TCI states, one for DL and one for UL.   + The UL TCI may be optionally indicated, and when it is not provided, the spatial relation is provided by RS configured for QCL-typeD in DL TCI * For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all [or subset] of CORESETs in a CC * For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + 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 * FFS: Whether the UL TCI state is taken from a common or separate TCI state pool from DL TCI state * FFS: Whether Rel.17 supports TCI configured for single channel (e.g. PDSCH only, single CORESET) and, if so, whether the separate DL/UL TCI pool includes TCI configured for single channel * [Note: UL TCI is not applicable for FR1] * Note: This does not preclude the type of UE supporting only 1 beam tracking loop, i.e. UE reports value of 1 in UE FG 2-62.   1C: we would like to echo QC’s comment about the applicability of common beam to DL/UL signals. We also think that for sTRP/mTRP, common beam is applied to all PUCCH resources of a TRP.  **Proposal 1.C**: On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate UL TCI:   * For single-TRP scenarios:   + The source reference signal(s) in one TCI provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC (i.e. M=1 in this case)   + The source reference signal in one TCI provides a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all ~~[or subset] of~~ dedicated PUCCH resources in a CC (i.e. N=1 in this case)   + FFS: The support for M>1 and/or N>1 for single-TRP * [FFS: the support for mTRP] * [Up to 2 TRPs can be supported in DL and/or UL. In case of two TRPs:   + The source reference signal(s) in each one of up to two TCI states provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs associated with one TRP in a CC (i.e. M can be up to 2 in this case)   + The source reference signal(s) in each one of up to two TCI states, where each TCI state provides a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all ~~[or subset] of~~ dedicated PUCCH resources associated with one TRP in a CC (i.e. N can be up to 2 in this case)] * Note: This does not preclude that the source reference signal(s) in one TCI can provide common QCL/spatial filter info for both DL and UL signals.   1D: we support the first bullet item and propose to remove the brackets. We have concern on the second bullet item, which was not discussed in the group before. Hence, we may remove the second bullet. |
| Ericsson | 1.A: Support. We see no reason to limit the signaling to intra-band.  1.B: Support with the following comment:  - The main bullet states alt 2-2. This means separate pools, so we do not understand the FFS on “common or separate TCI state pool”  1.C: Support  1.D: It is important for us to also include CSI-RS for BM with repetition ‘off’, at least for aperiodic CSI-RS (same as is supported in R16)  1.E: Support CSI-RS for tracking as source RS to determine a UL TX spatial filter. Do not support SRS for BM as a source RS to represent a DL RX spatial filter – the use case is unclear |
| Convida Wireless | **Proposal 1.A:**  Support.  **Proposal 1.B:**  Support.  **Proposal 1.C:**  Support.  **Proposal 1.D:**  Support without the revision from ZTE, i.e. support common beam update for both aperiodic and periodic TRS.  **Proposal 1.E:**  Support, including the second bullet without brackets, i.e. SRS for BM as source RS for DL. |
| InterDigital | We don’t support the updated proposal 1.E. We don’t support the first bullet as we don’t see any clear benefits while we support the second bullet without brackets. |
| MediaTek2 | **On Revised Proposal 1.A**   * For the last FFS bullet, it is unclear why do we need to define such partial common TCI state update and activation, which can be implemented by configuring two separate sets of CCs.   **On Revised Proposal 1.B**   * We don't see the motivation to make UL TCI optional. It is unreasonable that single-beam operation is needed only for DL but not UL, and support of using DL TCI for UL transmission causes additional workload. We also has concern that this configuration will complicate UE implementation since UL transmission following UL TCI and DL TCI may dynamically change. Therefore, we suggest to remove the sub-bullet. * According to this proposal, it seems whether to use a common or separate RRC TCI state pool from DL TCI state has to be further studied. Thus, only Alt2 is supported in this proposal, down-selection between Alt2-1 and Alt2-2 is still pending. Thus, the main bullet has to be corrected. * If our understanding is correct, the FFS “Whether Rel.17 supports TCI configured for single channel (e.g. PDSCH only, single CORESET) and, if so, whether the separate DL/UL TCI pool includes TCI configured for single channel” is the same as the FFS in the revised Proposal 1.D. If so, suggest to merge them in one place, e.g., in Proposal 1.D. * Agree with comments from OPPO and Sony, all the CORESETs and dedicated PUCCH resource shall apply the common QCL. We don't see the need to apply the common QCL on a subset of control channels. * According to the comments above, suggest some minor changes as follow:   **Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL, support Alt2 as described in the RAN1#102-e agreement, that is:   * Utilize two separate TCI states, one for DL and one for UL.   + [The UL TCI is optionally indicated, and when it is not provided, the spatial relation is provided by RS configured for QCL-typeD in DL TCI] * For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all [or subset] of CORESETs in a CC * For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + 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 * FFS: Whether the UL TCI state is taken from a common or separate RRC TCI state pool from DL TCI state * FFS: Whether Rel.17 supports TCI configured for single channel (e.g. PDSCH only, single CORESET) and, if so, whether the separate DL/UL TCI pool includes TCI configured for single channel * Note: UL TCI is not applicable for FR1 * Note: This does not preclude the type of UE supporting only 1 beam tracking loop, i.e. UE reports value of 1 in UE FG 2-62. |
| Nokia, NSB | **Proposal 1.A:** support FL proposal.  **Proposal 1.B:** support FL proposal in principle. It could be also clarified that whether the pool of TCI states mean RRC configured or MAC filtered pool. Our understanding is the former. Though, QCL-TypeD RS in a TCI state should be able to be used as spatial source for UL. Thus, TCI state can be used for both DL and UL. On the other hand, for the UL it would be beneficial to associate UL power control parameters to spatial source, i.e. to the TCI state used for UL. We are not fine with the addition   * + The UL TCI is optionally indicated, and when it is not provided, the spatial relation is provided by RS configured for QCL-typeD in DL TCI   On the noteNote: UL TCI is not applicable for FR1, we think the specification itself would not make such mentioned but rather the QCL-typeD would be used, where applicable, hence like we wrote things so far...  **Proposal 1.C:** In principle we support FL proposal. Is it correct understanding that in case of M=1 (and N=1) there would not be DCI based TCI switch available given the MAC activates only one TCI state? We also wonder if the MTRP agreement is not too early w.r.t the MTRP discussion, shall this happen in MTRP anyway? As an extension of what we agree in BM?  {FL comment} It is now FFS  **Proposal 1.D:** We are fine with the first bullet. Regarding the second bullet we are also fine to consider using TCI state in general for single UL channel. The separate operation incorporate the joint, so joint should be deleted   * is supported for both ~~joint DL/UL TCI and~~ separate DL~~/~~UL TCI:   **Proposal 1.E:** Support the FL proposal. We are not OK with the square brackets on SRS used as spatial source. There is majority support for this, just two companies not having a strong view but not making a case for objection.  {FL comment: 4 companies have raised concern: Ericsson, ZTE, LG, Xiaomi} |
| Samsung2 | For the updated proposals, we have the following additional comments:  **Proposal 1.B:** With the new FFS “FFS: Whether the UL TCI state is taken from a common or separate TCI state pool from DL TCI state”, we suggest to replace Alt2-2 in the stem of the proposal with Alt2-1 or Alt2-2. The decision to follow Alt2-1 or Alt2-2 can be decided by the outcome of the FFS.  We would like to update the following:  “The UL or DL TCI is optionally indicated, ~~and~~   * + FFS: when UL TCI it is not provided, the spatial relation is provided by RS configured for QCL-typeD in DL TCI”   Rationale for update is that the UL beam can either follow the DL TCI or continue to follow a previously indicated UL TCI.  Add new FFS:  FFS: How to configure or indicate joint or separate DL/UL beam indication |
| Fraunhofer | **Proposal 1.B:** Agree with Ericsson’s comment on the proposal  **Proposal 1.E:** The motivation for the second bullet is unclear to us.   * [Support the use SRS for BM as a source RS to represent a DL RX spatial filter, configured together with either a CSI-RS for BM, SSB, or DL TRS as the QCL source (or spatial relation) for the SRS ]   SRS for BM need not be configured with a spatial relation; it may be used for UL sounding when there is no beam correspondence. Hence, making an indirect reference to a DL RS for DL Rx spatial filter using SRS for BM is confusing to us. |
| Lenovo/MoM | **Proposal 1.A:** support  **Proposal 1.B:** We support this proposal. But have separate UL and DL TCI states does not preclude jointly configuring UL and DL TCI together. We like to add this bullet to 1.B:  FFS: whether the UL and DL TCI states are configured separately or jointly.  **Proposal 1.C:**  We support this proposal. The brackets in the 2nd and 3rd bullets should be removed.  **Proposal 1.D:** With this in the proposal “some CSI-RS resource for BM with repetition ‘ON’, and [aperiodic CSI-RS for tracking],”, it is correct to understand that it is also possible for CSI-RS for BM and aperiodic CSI-RS for tracking not to share the common TCI?  {FL comment: Correct}  **Proposal 1.E:** We support this proposal in principle. We want to clarify when the joint DL/UL TCI has both an SRS for BM and another DL RS as QCL source, only the SRS apply to the UL TCI. |
| AT&T | Proposal 1.A: Support FL proposal  Proposal 1.B: Support FL proposal, remove Alt.2-2 from the main bullet.  Proposal 1.C: Can we clarify what is the intention from the square brackets on the multi-TRP case.  [FL comment: mTRP is now FFS per comments from some companies] |
| FUTUREWEI | **Revised Proposal 1.A:** We support FL’s proposal in principle. We suggest changing the term “TCI state update and activation” to “beam indication”.  {FL comment: since functionally this is equivalent only for QCL Type D, keeping it TCI state update and activation is more suitable since other QCL Types will be included}  **Revised Proposal 1.B:** We suggest adding a note stating that the TCI state pool is RRC configured. And for putting “or subset” in brackets, we’d like to understand the intention. Is the intention to say that every time the DCI indicates M TCI states, all CORESETs of the UE are updated with these M TCI states? We don’t think this is necessary and suggest to remove the brackets.  {FL comment: “subset” was disputed by several companies}  **Revised Proposal 1.C:** We do not support the proposal. In Rel. 17, FeMIMO targets at further enhancement on the support for multi-TRP deployment, enhancement on multi-beam operation should also support multi-TRP scenario. We suggest removing the bullet “FFS: the support for mTRP” and the bracket on the third bullet “Up to 2 TRPs …”. In addition, for single TRP cases, there is also no need to limit M and N equal to 1. Beam diversity is a very important feature to continue supported in Rel.17.  {FL comment: There is some concern on this from companies. We plan to revisit in later time next week}  **Revised Proposal 1.D:** We support FL’s proposal. |
| Intel | **Proposal 1.B –** The main may not list Atl-2-2 since the common/separate pool issue is FFS. The sub-bullet on UL TCI being optional is not okay for us at this point since its not clear what the UL TCI contains i.e., if power control and pathloss RS related parameters are included in the separate UL TCI or not. Once this detail has been agreed, we can further discuss optional or not. Therefore, our suggestion is to either remove the sub-bullet or have an FFS on this point. Additionally, for the common or separate pool discussion, we would like to have the option of a common pool of separate UL, DL and joint DL/UL TCI state since this is for further study. For the FFS on single channel, since the concept of TCI state pools is FFS, we do not prefer having separate DL/UL TCI pool in the agreement yet. It is possible that single TCI pool is agreed.  On the note for applicability of UL TCI, we want to have this as FFS. UL TCI is still being discussed for HST and we should not preclude it in FR1.  **Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL, ~~support Alt2-2 as described in the RAN1#102-e agreement, that is~~:   * Utilize two separate TCI states, one for DL and one for UL.   + ~~The UL TCI is optionally indicated, and when it is not provided, the spatial relation is provided by RS configured for QCL-typeD in DL TCI~~   + FFS: Contents of separate UL TCI state   + FFS: If UL TCI is optionally indicated and QCL assumption if not indicated * For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all [or subset] of CORESETs in a CC * For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):   + 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 * FFS: Whether the UL TCI state is taken from a common or separate TCI state pool from separate DL or joint DL/UL TCI states * FFS: Whether Rel.17 supports TCI configured for single channel (e.g. PDSCH only, single CORESET) ~~and, if so, whether the separate DL/UL TCI pool includes TCI configured for single channel~~ * FFS: Whether UL TCI is applicable for FR1 * Note: This does not preclude the type of UE supporting only 1 beam tracking loop, i.e. UE reports value of 1 in UE FG 2-62.   **Proposal 1.C:** Since the support for mTRP is FFS, our preference is to remove the mTRP bullets for now. Based on current specification, UL transmission is only enabled for single TCI state and current mTRP discussion is focused on UL transmission on two TCI states with repetition (URLLC). Therefore, it is pre-mature to have such wording in current agreement. Also, note that simultaneous UL multi-panel transmission is precluded. |
| InterDigital | As we commented earlier, we don’t support the current proposal 1.E. For the first bullet, we think that using SRS and CSI-RS for BM for UL TX spatial filter is better indication method. In addition, we also see the majority support on SRS for DL TX spatial filter. So, we propose following update:  On Rel.17 unified TCI framework, for both joint DL/UL TCI and separate DL/UL TCI:   * Support the use SRS for BM as a source RS to represent a DL RX spatial filter, configured together with either a CSI-RS for BM, SSB, or DL TRS as the QCL source (or spatial relation) for the SRS |

Table 3 Additional inputs: for round-2 discussion issue 1.10 reformulated

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 1.10 | Additional parameters included in or concurrent with (but not included in) in unified TCI   * Alt1. Include as a part of unified TCI framework (as a part of the UL spatial reference) * Alt2. Include concurrently with but outside unified TCI framework * Alt3. Not include | UL PC parameters (P0/alpha, CL index)   * **Alt1**: Qualcomm, LG, IDC * **Alt2**: NTT Docomo * **Alt3**: Huawei/HiSi, Ericsson   PL RS:   * **Alt1**: Qualcomm, LG, Samsung, Ericsson * **Alt2**: NTT Docomo |  |

* 1. Issue 2 (L1/L2-centric inter-cell mobility)

Table 4 Summary: issue 2

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 2.1 | Use cases: network architecture | **NSA with common LTE anchor**: Samsung, Ericsson, Qualcomm, ZTE  **SA**: Samsung, Qualcomm, ZTE | Use cases also need to take into account the limited TU allocation for Rel.17 NR FeMIMO. This implies that enhancements on handover and RRC reconfiguration are practically infeasible unless additional TUs are allocated (RAN level decision). |
| 2.2 | Use cases: CA aspects (in addition to non-CA) | **Include only intra-band CA**: IDC, Samsung, MediaTek, Sony, Sharp  **Include intra- and inter-band CA**: Qualcomm  **Include NR-PSCell**: Ericsson, Qualcomm |
| 2.3 | Use cases: intra- vs inter-frequency, inter-RAT | **Exclude inter-frequency and inter-RAT**: Ericsson, Samsung, ZTE (only for inter-RAT), NTT Docomo  **Include inter-frequency**: ZTE |
| 2.4 | Use cases: sTRP and mTRP | **Only sTRP**: Nokia/NSB, Samsung, OPPO, MediaTek |
| 2.5 | Use cases: DU aspect | **Only cells in the same DU**: Samsung, Qualcomm, ZTE |
| 2.6 | Scope of enhancements:  EG1. Minimum RAN2 impact: TCI and measurement/reporting  EG2. Timing offset issues, TA  EG3. RA/RACH | **EG1 only**: Ericsson, Nokia/NSB, Apple, OPPO, Xiaomi, MediaTek, Lenovo/MoM, ZTE, Sony, LG (for sTRP)  **EG1+EG2**: vivo, Qualcomm, Samsung, NTT Docomo, LG (for mTRP)  **EG1+EG2+EG3**: Intel, ASUSTeK, CATT, CMCC, Qualcomm, APT | See observation for 2.1-2.5  EG1: whether this also allows beam indication for non-serving-cell PCI(s) needs to be discussed. |
| 2.7 | Method(s) for incorporating non-serving cell info in TCI | **Indicate RS of non-serving cell as QCL source**: IDC, ZTE, Samsung, Nokia/NSB, Lenovo, ASUSTeK, Qualcomm, OPPO, Xiaomi, NTT Docomo, APT, MediaTek, Sharp  **Include PCI in TCI**: vivo, CATT, Sony, Xiaomi, Ericsson, NTT Docomo, APT, ZTE, Nokia/NSB, Sharp | Whether these two are competing alternatives or not may need some discussion.  With TCI enhancement, whether beam indication for non-serving-cell PCI(s) can be done needs to be discussed. |
|  |  |  |  |

From moderator perspective, proposal 2.A was stable. Some clarification, simplification, and terminology alignment with RAN2 are added below:

**Proposal 2.A**: On Rel.17 enhancements to enable L1/L2-centric inter-cell mobility:

* The following use cases are assumed:
  + Network architecture:
    - NSA, i.e. LTE PCell and NR-PSCell
    - SA
  + Intra-band CA
    - FFS: If inter-band CA is also included
  + Intra- RAT (excluding inter-RAT)
  + Intra-frequency scenario:
    - The SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell
    - An SSB of a non-serving cell is associated with a PCI different from the PCI of the serving cell
    - FFS: Support for inter-frequency scenario
  + Support scenarios where all CORESETs are configured without CORESETPoolIndex.
    - FFS: other scenarios
  + Intra-DU operation
    - FFS: If inter-DU operation is also included
* The following enhancement scope is assumed:
  + No RRC reconfiguration signaling is needed after handover when a TCI associated with non-serving cell RS is indicated
    - A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source
    - This implies no C-RNTI update during inter-cell mobility after handover
    - The reception of signals/channels associated with non-serving cell RS follows Rel.15/16 synchronization assumption between different cells
  + Facilitating L1/L2 measurement and reporting of non-serving RSs via associating non-serving cell info with some TCI(s) and/or Reporting/Resource Setting(s), along with the necessary measurement and reporting scheme(s)
    - FFS: Detailed/exact method(s)
    - FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s)
    - FFS: Metric for the measurement and reporting, e.g. L1-RSRP or L3-RSRP or time- or spatial-domain-filtered L1-RSRP
  + Facilitate serving cell to provide configurations for non-serving cell SSBs and/or other DL RS (e.g. CSI-RS for mobility) via RRC
    - FFS: details for the configurations of other DL RSs, e.g. time/frequency location, transmission power, etc.
  + Note: In RAN1's understanding, non-serving cell SSB and non-serving cell RS can be part of the serving cell configuration

Interested companies are encouraged to provide their (additional) inputs, if any, on proposal 2.A.

Table 5 Additional inputs for round-2 discussion: issue 2 proposal 2.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | Suggest to add the following FFS  o Facilitating measurement and reporting of non-serving cells/PCIRSs via incorporating non-serving cell info in TCI and/or Reporting/Resource Settings, along with the necessary measurement and reporting scheme(s)  FFS: Whether non-serving cell RS(s) include SSB only, CSI-RS only, or both. |
| LG | Please find the added view for some issues above and support FL’s proposal in general. We are not sure whether ‘To be verified by RAN2’ is needed on the proposed WA. |
| Apple | We think it is still unclear whether L1-RSRP is sufficient for inter-cell mobility, and we feel gNB can provide non-serving cell info but that should not be in every TCI. Therefore, we suggest the following changes for the measurement and reporting part.   * + Facilitating measurement and reporting of non-serving RSs via associating non-serving cell info with TCIs, along with the necessary measurement and reporting scheme(s)     - FFS: Detailed/exact method(s)     - FFS: Metric for the measurement and reporting, e.g. L1-RSRP or L3-RSRP     - FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s)   {FL comment: Reporting/Resource Setting may still be needed} |
| Samsung | **Proposal 2.A:**  In general, we support proposal 2.A with the following comments:   * For the first working assumption, we propose adding: “No RRC reconfiguration signaling is needed, immediately after handover, when a TCI associated with non-serving cell RS is indicated”. There can be RRC reconfiguration later on.   For the second working assumption, there could be an issue with not updating C-RNTI across cells. The C-RNTI pool will now be per cell group rather than per cell reducing the available C-RNTIs in a cell. We agree to send LS to RAN2 for feedback. |
| OPPO | Suggest to make the whole content under second bullet as working assumption since the assumption of no RRC reconfiguration is the ground for all the enhancement scope to be considered.   * Working assumption: The following enhancement scope is assumed:   + Working assumption: No RRC reconfiguration signaling is needed when a TCI associated with non-serving cell RS is indicated     - A non-serving cell RS is an RS that is an SSB of a non-serving cell or has an SSB of a non-serving cell as direct or indirect QCL source     - Working assumption: This implies no C-RNTI update during inter-cell mobility     - To be verified by RAN2   + Facilitating measurement and reporting of non-serving RSs via incorporating non-serving cell info in TCI and/or Reporting/Resource Settings, along with the necessary measurement and reporting scheme(s)     - FFS: Detailed/exact method(s)     - FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s)   + Facilitate serving cell to provide configurations for non-serving cell SSBs via RRC     - FFS: details for the configurations, e.g. time/frequency location, transmission power, etc. |
| NTT Docomo | Support |
| ZTE | Since we consider that “frequency location” may need to be provided, why we need to preclude inter-frequency case.   * + Facilitate serving cell to provide configurations for non-serving cell SSBs via RRC     - FFS: details for the configurations, e.g. time/frequency location, transmission power, etc.   Consequently, we prefer to postpone the discussion for intra-/inter-frequency in this section which is also relevant to Item 2b discussion. From our perspective, intra-/inter-frequency should be treated equally. For instance, there is also no measurement gap for measuring non-serving SSB that is in the active BWP of serving cell, and this case can be well handled in L1 mobility.   * + FFS: Intra-/inter-frequency scenario:   Meanwhile, a small editorial update is to highlight this L1/L2 measurement and reporting.   * + Facilitating L1/L2 measurement and reporting of non-serving RSs via incorporating non-serving cell info in TCI and/or Reporting/Resource Settings, along with the necessary measurement and reporting scheme(s)     - FFS: Detailed/exact method(s)   FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s) |
| vivo | We would like to update as following and support to send LS to RAN2 on the following   * The following enhancement scope is assumed:   + Working assumption: No RRC reconfiguration signaling is needed when a TCI associated with non-serving cell RS is indicated     - A non-serving cell RS is an RS that has an SSB of a non-serving cell as direct or indirect QCL source     - Working assumption: This implies no C-RNTI update during inter-cell mobility     - The reception of signals/channels associated with non-serving cell RS follows Rel-15/16 synchronization assumption between different cells     - To be verified by RAN2   + Facilitating measurement and reporting of non-serving RSs via incorporating non-serving cell info in TCI and/or Reporting/Resource Settings, along with the necessary measurement and reporting scheme(s)     - FFS: Detailed/exact method(s)     - FFS: whether L1 measurement behavior or L3 measurement behavior is assumed.     - FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s)   + Facilitate serving cell to provide configurations for non-serving cell SSBs via RRC     - Send LS to RAN2 to ask whether other RRC parameters are necessary.     - FFS: details for the configurations, e.g. time/frequency location, transmission power, etc.   {FL comment: the comments are incorporated. At this point we do not send LS to RAN2. The FL will keep a list of items for an LS at a later item and this is one of them.} |
| Sony | **Proposal 2.A.** We are supportive in general.  For the last bullet, serving cell could provide not only configuration of non-serving cell SSB to UE, but also other DL RS, e.g. CSI-RS for mobility to UE to measure and report as well. So the expected change would be   * + Facilitate serving cell to provide configurations for non-serving cell SSBs and other DL RS, e.g. CSI-RS for mobility via RRC     - FFS: details for the configurations, e.g. time/frequency location, transmission power, etc. |
| Xiaomi | Support the proposal in principle.  But we have one point to clarify. ‘Support scenarios where all CORESETs are configured without CORESETPoolIndex’, is it to limit the scenario that UE need to monitor PDCCH from only one TRP in serving cell?  {FL comment: Intended to minimize higher-layer impact} |
| Ericsson | Support, with following comments:   * We think it is too early to send an LS to RAN2 * We propose to add the following note at the end:   + Note: In RAN1's understanding, non-serving cell SSB and non-serving cell RS can be part of the serving cell configuration. * The whole enhancement scope cannot be a working assumption. The working assumption is made so that RAN1 can progress the work on the enhancements. Also, the WID says that we should specify enhancements.   Question to Qualcomm: The proposed definition of a non-serving cell RS includes RSs other than SSBs. So if we agree the definition, the FFS on which RSs can be non-serving is resolved. Note that any non-serving RS would still have an SSB as anchor.  Comment to Apple: If the NW is provided with a sequenceL1-RSRP, it is possible to perform the L3 filtering in the NW. This filtering can be tailored to the UE, so there is definitely a potential to improve performance. We agree that the NW should not have to provide non-serving PCIs in all TCI states, and we think that the FL formulation is clear on this.  We disagree with Oppo to make the whole enhancement scope a working assumption. The working assumption is made so that RAN1 can progress the work on the enhancements. |
| Nokia/NSB | We do not see a need to limit the discussion to intra-DU operation and prefer to delete this mention! If there are significant differences between these scenarios (w.r.t. the DU deployment), these should be understood now, otherwise we risk at developing the enhancement for some particular deployment, something which is not in the spirit of the specification. Proposed modification is:   * Intra-/inter-DU operation   {FL comment” There are concerns on including inter-DU since it may have RAN2 or even RAN3 impacts, e.g. Ericsson, Samsung |
| Lenovo/MoM | For the use case, we think it is necessary to include intra-cell multi-TRP, or at least the solution developed for single TRP can be expanded for multi-TRP in the future. Therefore we suggest to add intra-cell multi-TRP as FFS (explicitly add it to “FFS: other scenarios”).    Under the working assumption that “No RRC reconfiguration signaling is needed immediately after handoever when a TCI associated with non-serving cell RS is indicated”, we think it is appropriate to make the following change   * + - This implies no C-RNTI update during inter-cell mobility immediately after handover. |
| FUTUREWEI | We would like to have a clarification on “No RRC reconfiguration signaling is needed immediately after handover”. It is unclear what “immediately” here mean, e.g., is there a time duration value related to this? In addition, limiting to “intra-DU operation” seems not necessary and RAN1 is not the place to decide that.  {FL comment: “immediately” is removed} |
| Intel | On the measurements, it is not clear if L1-RSRP is a sufficient metric based on extensive evaluation results in our paper (R1-2008977). It was shown that L1 filtering is needed. While some companies argue that given sequenced L1-RSRP, the network can perform L3-like filtering, we note that based on our results, especially with impairments like UE rotation, we see that averaging across beams as well as time is important for preventing ping pong effect of L1-HO. In this case, simply relying on network for filtering will mean very high overhead for reporting since all beam combinations for a large number of TCI states will need to be available at gNB. available at gNB. Additionally for the blue highlighted FFS, we talk about details of time frequency location but for SSBs, under the first bullet, we already state “The SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell”. This would imply that FFS is applicable only for the other DL RSs and this should be captured.   * + Facilitating L1/L2 measurement and reporting of non-serving RSs via associating non-serving cell info with some TCI(s) and/or Reporting/Resource Setting(s), along with the necessary measurement and reporting scheme(s)     - FFS: Detailed/exact method(s)     - FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s)     - FFS: Metric for the measurement and reporting, e.g. L1-RSRP or L3-RSRP or time or spatial domain filtered L1-RSRP.     - FFS: whether non-serving cell RS(s) include SSB only, CSI-RS only, or both   + Facilitate serving cell to provide configurations for non-serving cell SSBs or other DL RS (e.g. CSI-RS for mobility) via RRC     - FFS: details for the configurations of other DL RSs, e.g. time/frequency location, transmission power, etc. |

* 1. Issue 3 (beam indication signaling medium)

The following agreement was made during the first GTW.

|  |
| --- |
| **Agreement**  On beam indication signaling medium to support joint or separate DL/UL beam indication in Rel.17 unified TCI framework:   * Support L1-based beam indication using at least UE-specific (unicast) DCI to indicate joint or separate DL/UL beam indication from the active TCI states   + The existing DCI formats 1\_1 and 1\_2 are reused for joint beam indication     - FFS: If additional DCI format(s) are supported, e.g. existing DCI formats 0\_0, 0\_1, 0\_2, 1\_0 as well as new DCI format(s) dedicated for beam indication   + Support a mechanism for UE to acknowledge successful decoding of beam indication     - The ACK/NAK of the PDSCH scheduled by the DCI carrying the beam indication can be used as an ACK also for the DCI     - FFS: Whether any additional specification support is needed   + FFS beam indication for the TCI state assumption/update for the following cases:     - The beam indication UE-specific DCI (i.e. the CORESETs with the DCI received by UE), the scheduled PDSCH by the DCI and the associated PUCCH for the acknowledgment of the beam indication DCI     - Non-UE-specific CORESETs and PUSCH/PDSCH scheduled/activated and PUCCH transmission triggered by non-UE-specific CORESETs * Support activation of one or more TCI states via MAC CE analogous to Rel.15/16:   + At least for the single activated TCI state, the activated TCI state is applied   + The content for the MAC CE is determined based on the outcome of issue 1   + FFS: If supported, default TCI state when more than one TCI states are activated by MAC CE   + Note: There is no implications on the support of single TRP or multi-TRP * Support a UE capability for the minimum beam indication delay   + FFS: Whether to measure beam indication delay from DCI reception or from acknowledgment of DCI   + FFS: The exact supported values e.g. {0.5ms, 2ms, 3ms} * FFS: Additional enhancement such as L1-based beam indication with group-common DCI * FFS: Whether the Rel.17 beam indication can also apply to beam indication for single channel (e.g. PDSCH only, single CORESET) or a subset of channels * FFS: Additional details on extending the support of L1-based beam indication when separate UL (from DL) common beam indication is configured   **Continue email discussion on the yellow part.** |

Interested companies are encouraged to provide their inputs on the following matters:

* Yellow 3.1: “for joint beam indication” text. The only concern raised about this is the applicability for separate UL beam indication. This can be addressed as follows:
  + The existing DCI formats 1\_1 and 1\_2 are reused for joint DL/UL beam indication
    - FFS: support new DCI format(s) dedicated for beam indication for joint or separate DL/UL beam indication
    - FFS: support for reusing the existing UL-related DCI format(s) (e.g. 0\_0, 0\_1, 0\_2) for joint or separate DL/UL beam indication
    - FFS: support for reusing DCI format 1\_0, 1\_1, and 1\_2 for separate UL beam indication
* Yellow 3.2: vivo FFS
  + Companies’ views:
    - Support (keep): Apple, Intel, NTT Docomo, vivo, ZTE (with addition)
    - Not support (remove): APT, Ericsson, Fraunhofer IIS/HHI, Futurewei, MediaTek, Nokia/NSB, OPPO, Samsung, Sony, Xiaomi
  + **Conclusion**: There is no consensus in including the two FFS points proposed by vivo in the agreement made in the 1st GTW session
* Yellow 3.3: UE capability text, revised as follows (per inputs from interested companies, based on where we left off during the GTW discussion):
  + Application time of the beam indication: down-select from the following:
    - Alt1: the first slot that is at least X ms after the DCI with the beam indication
    - Alt2: the first slot that is at least X ms after the acknowledgment of the beam indication
  + Support a UE capability for the minimum value of X
    - The beam application time X is configured by the gNB via higher-layer (RRC) signaling based the UE capability

FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) supported by UE

Table 6 Additional inputs for round-2 discussion: issue 3 yellow 3.1, 3.2, and 3.3

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | Suggest to remove the UL in main bullet and add the FFS in blue to address the concern.   * + The existing DCI formats 1\_1 and 1\_2 are reused for joint or separate DL~~/UL~~ beam indication     - ...     - FFS: support for reusing the existing UL-related DCI format(s) for separate UL beam indication     - FFS: support for reusing DCI format 1\_1 and 1\_2 for separate UL beam indication |
| LG | Regarding to a UE capability for the beam indication delay, it seems already covered in the legacy UE capability such as Beam Switching Timing. Hence, it requires to clarify the motivation of introducing a new UE capability. |
| Apple | Support all yellow points.  Some clarification for the UE capability, currently the TCI would be applied for both UL and DL signals, we do not have such UE capability. The UL beam indication is often based on MAC CE, whose delay is 3ms. Another aspect is related to UL power control update delay. |
| Samsung | **Proposal 3-A:**  **Yellow 3.1**: In general support. Propose to update as follows:  FFS: support for reusing the existing UL-related DCI format(s) for joint or separate DL/UL beam indication  The rationale for this change is that in case of UL heavy traffic, there might not be downlink related DCIs to update the DL beam (e.g. for the UL grant carried in DL DCI)  **Yellow 3.2**: Do not support. This FFS has more to do with issue 1 than issue 3. Furthermore:   * For first sub-bullet, there is an agreement in issue 1 in the last meeting that a common QCL is used for UE-dedicated PDSCH and CORESETs. We don’t want to revert this agreement. * For the second sub-bullet, this is covered by issue 1 (e.g. proposal 1-D)   **Yellow 3.3:** Support |
| MediaTek | **On Yellow 3.1:** We agree with FL proposal with Qualcomm’s suggestion. According to the main bullet, L1-based beam indication using at least UE-specific (unicast) DCI to indicate separate DL/UL beam indication from the active TCI states is supported. The sub-bullet further points that at least existing DCI formats 1\_1 and 1\_2 shall be reused. For separate TCI, using DCI formats 1\_1 and 1\_2 for beam indication is needed, at least it is natural for DL. Whether DL and/or UL DCI is used for separate TCI indication can be FFS.    **On Yellow 3.2**: We think this FFS is NOT needed. How to indicate beam for those channels not included in the R17 unified TCI framework is discussed in Issue 1. This agreement only made for those channels included in the R17 unified TCI framework, as RAN1 already agreed in the previous meeting.  **On Yellow 3.3:** We suggest to modify it as follows:   * Application time of the beam indication: down-select from the following in RAN1#104-e:   + Alt1: the first slot that is at least P symbols after the DCI with the beam indication   + Alt2: the first slot that is at least P symbols after the acknowledgment of the beam indication   + Support a UE capability for the minimum value of P   + FFS: the exact minimum values of P supported by a UE   Even we don't have to decide the application time in this meeting, but we still prefer to capture it more clearly before we agree to introduce a UE capability for it. According to the proposals from companies, we see the alternatives above have been mentioned. |
| InterDigital | In our view, as the joint indication is different indication method, we think that different application of the minimum beam indication delay should be considered.  We suggest following updates:  • Support a UE capability for the minimum beam indication delay  o FFS: When and how to apply the minimum beam indication delay  o FFS: Whether to measure beam indication delay from DCI reception or from acknowledgment of DCI  o FFS: The exact supported values e.g. {0.5ms, 2ms, 3ms}  {FL comment: please check the latest version based on some suggestion from MediaTek, which should address the issue} |
| OPPO | * 1. Suggest the following change:   + The existing DCI formats 1\_1 and 1\_2 are reused for ~~joint or separate~~ DL and UL beam indication     - ...     - ~~FFS: support for reusing the existing UL-related DCI format(s) for separate UL beam indication~~   3.2: the FFS part is not needed.  3.3: Suggest the following changes:   * + If a fixed beam indication latency is not specified in spec, support a UE capability to ~~accommodate at least two candidate values of~~ report one beam indication latency     - FFS: ~~Whether~~ How to measure beam indication latency, e.g., from DCI reception, e.g., from acknowledgment of DCI decoding     - ~~FFS: Depending on the outcome of above FFS, the exact supported candidate values e.g. X ms (examples: 0.5ms, 2ms, 3ms) or Y symbols~~   {FL comment: please check the latest version based on some suggestion from MediaTek, which should address the issue} |
| NTT Docomo | Yellow 3.1: For separate TCI indication, the existing DCI formats 1\_1 and 1\_2 can be used for DL beam indication. For UL beam indication of the separate TCI indication, there are some options: reuse the existing UL DCI formats, creating new DCI format, or adding new field in DL DCI. For us, it is important that UE sends HARQ-ACK for the reception of the DCI indication, to make sure both of gNB and UE have the same understanding of the current TCI state.  Yellow 3.2: support to discuss the beam assumption of the beam indication DCI/PDSCH/HARQ-ACK.  Yellow 3.3: Support. We prefer to count the beam indication latency from the acknowledgment. In this case, we think the smaller value, including 0ms, is possible depending on UE capability. |
| ZTE | **On Yellow 3.1:** We agree with FL proposal with Qualcomm’s suggestion.  **On Yellow 3.2**: We are fine to FFS points proposed by vivo. Meanwhile, we prefer to add another related FFS part for configured grant PUSCH (we are fine to discuss this issue in item-1 or item-3):   * FFS: Details for updating TCI state for configured-grant based PUSCH (note: Tx beam for Type 1 CG-PUSCH is configured by RRC and Tx beams for Type 2 CG-PUSCH cannot changed during the active time in R15/16).   {FL comment: This part is related to an agreement in the previous meeting for issue 1 which seems to suggest that CG based PUSCH shares the same TCI (hence update) as dynamic PUSCH– it can be proposed there}  **On Yellow 3.3**: We think that the key issue is to study the applicable timing for unified TCI indication. The UE capability part can be assumed as subbullet. How about the following:   * + FFS: applicable timing for beam indication, e.g., starting from beam indication latency from DCI reception or from acknowledgment of DCI decoding     - If a fixed beam indication latency is not specified in spec, support a UE capability to accommodate at least two candidate values of beam indication latency     - FFS: Depending on the outcome of above FFS, the exact supported candidate values e.g. X ms (examples: 0.5ms, 2ms, 3ms) or Y symbols   {FL comment: please check the latest version based on some suggestion from MediaTek, which should address the issue} |
| vivo | Yellow 3.2 related issues needs further study not only related to applicable channels but also how to apply the beams indicated in the DCI for the channels (if supported) listed.  {FL comment: The second part needs to be addressed first – proposal 1.D}  We are fine with yellow 3.1 and yellow 3.3. |
| Sony | **Yellow 3.1.**  In our view, the DL scheduling DCI, i.e. 1\_1 or 1\_2 can be reused for joint beam indication, but not separate UL beam indication which somehow should be facilitated in UL assignment DCI, such as 0\_1 or 0\_2. As for separated DL beam indication, it is already supported in spec for PDSCH beam indication, but not for PDCCH yet. So we suggest to slightly modify the yellow part as below   * + The existing DCI formats 1\_1 and 1\_2 are reused for joint or separate DL~~/UL~~ beam indication     - ...     - FFS: support for reusing the existing UL-related DCI format(s) for separate UL beam indication   {FL comment: Correct, this is addressed in the latest version}  **Yellow 3.2.**  We think this FFS is not necessary. For the 1st bullet, it seems redundant as for repeating the HARQ mechanism (DCI-> scheduled PDSCH-> associated PUCCH) for the beam indication DCI which appears above the Yellow 3.2.  **Yellow 3.3.** We support.  Different from the delay of MAC CE based beam activation (3ms in RAN1 spec) and the delay of Ap-CSI-RS triggering, the UE may need time to prepare UL Tx spatial filter. So we believe such UE capability is needed. |
| Xiaomi | **Yellow 3.1:**  We suggest to remove UL in main bullet and add the FFS as below   * + The existing DCI formats 1\_1 and 1\_2 are reused for joint or separate DL beam indication     - ...     - FFS: support for reusing the existing UL-related DCI format(s) for separate UL beam indication     - FFS: support for reusing the existing UL-related DCI format(s) for joint beam indication   {FL comment: Correct, this is addressed in the latest version}  **Yellow 3.2:** not needed |
| APT | Yellow 3.1: we are supportive of FL’s updated proposal  Yellow 3.2: No clear need for us  Yellow 3.3: for the first bullet, we support Alt. 2. |
| Ericsson | Yellow 3.1: we do not understand the “separate DL beam indication”. Either we have joint (for UL+DL) or separate for UL and DL. It does not make sense to have separate DL, how would the UL beam be controlled?  Yellow 3.2: we do not understand the purpose of the FFS. The joint/common DCI provides the beam indications for the relevant channels/signals  Yellow 3.3: We support having a UE capability. We want to clarify that the beam indication application timing is controlled by the gNB   * + Definition of application time of the beam indication: down-select from the following:     - Alt1: the first slot that is at least X ms after the DCI with the beam indication     - Alt2: the first slot that is at least X ms after the acknowledgment of the beam indication   + Support a UE capability for the minimum value of X   + The beam application time is configured by the gNB based the UE capability   FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) supported by UE |
| MediaTek2 | Yellow 3.1: We are supportive of FL’s updated proposal.  Yellow 3.3: Echo Ericsson’s comment. We share the same understanding that exact application time has to be controlled by NW to better align the scheduling if UEs with different capabilities. We suggest the following modification. However, Ericsson’s proposal is also okay to us.   * + Definition of application time of the beam indication: down-select from the following:     - Alt1: the first slot that is at least X ms after the DCI with the beam indication     - Alt2: the first slot that is at least X ms after the acknowledgment of the beam indication   + Support an RRC parameter to configure the value of X based the UE capability   + Support a UE capability for the minimum value of X   FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) supported by UE |
| Nokia/NSB | **On Yellow 3.1:** we are not seeing a use case for both joint and separate, we think that joint is in fact a particular case of separate and in consequence we propose to use only the term separate, with the clarification that joint can be achieved when all states (in separate) are updated! We propose   * + The existing DCI formats 1\_1 and 1\_2 are reused for ~~joint or~~ separate DL/UL beam indication, where joint indication can be achieve when updating all states.     - ... * FFS: support for reusing the existing UL-related DCI format(s) for separate UL beam indication   {FL comment:} Separate is removed in the most recent version, so this issue is resolved by itself  **On Yellow 3.2:** w.r.t the use of UL DCI for separate beasm indication, as there is need to be able to switch TCI state for UL only, UL-related DCI format(s) should be supported as well for the TCI state switch. Thus, we are fine to remove FFS from  **On Yellow 3.3:** the delays introduced by the DCI operation would put the whole introduction of the DCI operation in question. As observed by several companies, system performance does not really speak in favour of DCI w.r.t. MAC CE. For the DCI to make sense the specification effort, the latency should be significantly improved w.r.t MAC CE. If the introduction of the DCI implies same or larger latency as MAC CE, unconvincing system performance, large specification effort involving the modification or introduction of new DCI formats, we prefer to focus more on MAC CE operation. We could accept a bullet on the UE capability related to the DCI only tied with performance metrics   * + The latency of the DCI design (w/wo specification impact), should be significantly improved with respect to the utilization of MAC CE, otherwise DCI use should not be supported. If a fixed beam indication latency is not specified in spec, support a UE capability to accommodate at least two candidate values of beam indication latency     - FFS: Whether to measure beam indication latency from DCI reception or from acknowledgment of DCI decoding     - FFS: Depending on the outcome of above FFS, the exact supported candidate values e.g. X ms (examples: 0.5ms, 2ms, 3ms) or Y symbols   {FL comment: The latest version proposes UE capability only and down selection of latency definition } |
| Samsung2 | For the updated proposals; for yellow 3-1, we would like to update with text in blue   * + The existing DCI formats 1\_1 and 1\_2 are reused for joint or separate DL beam indication     - ...     - FFS: support for reusing the existing UL-related DCI format(s) for joint or separate DL/UL beam indication     - FFS: support new DCI format(s) dedicated for beam indication for joint or separate DL/UL beam indication     - FFS: support for reusing DCI format 1\_1 and 1\_2 for separate UL beam indication |
| Fraunhofer | Yellow 3.1: Support FL’s proposal  Yellow 3.2: The purpose of the FFS and the framing is unclear to us. |
| Lenovo/MoM | Yellow 3.3: Regarding the capability for the minimum beam indication delay, we prefer to define it from the time of DCI reception (Alt 1). This is because the delay between DCI reception and DCI acknowledgement depends on the PUCCH resource, which may vary based on the resource configuration. The beam switching delay itself depends on UE hardware capability, so defining the delay from DCI reception leaves no room of ambiguity for UE hardware implementation. |
| FUTUREWEI | **Yellow 3.1:** we support FL’s updated proposal.  **Yellow 3.2:** It is unclear to us the need for this FFS. |
| Intel | **Yellow 3.1:** We prefer to keep UL in the main bullet since it defines the scope of applicability of the sub-bullets. We are ok to have the FFS   * + The existing DCI formats 1\_1 and 1\_2 are reused for joint or separate DL/UL beam indication     - ...     - FFS: support for reusing the existing UL-related DCI format(s) for joint or separate DL/UL beam indication     - FFS: support for reusing DCI format 1\_1 and 1\_2 for separate UL beam indication   If other companies insist on removing UL from main bullet, the bullet level of the last FFS point should be moved to the same as the main bullet above.  {FL comment: It is modified and now addressed this comment}  **Yellow 3.2:** Since the entire part is FFS we are ok with this  **Yellow 3.3:** Current formulation is OK. One general comment is that the delay can be measured in slots rather than ms.  For Alt.1, if UE applies the TCI indication after receiving the DCI, what is the importance of the ACK/NACK in this case?  {FL comment: This will be discussed} |
| InterDigital | In our view, MTK’s update does not reflect our concerns. As we are introducing new joint DCI as a common beam indication, we think that we may not need to apply the minimum beam indication delay in some cases. For example, if a newly indicated TCI in DCI is same as previously indicated TCI, we may not need to apply the minimum beam indication in contrast to Rel-15 operation.   * + Application time of the beam indication: down-select from the following:     - Alt1: the first slot that is at least X ms after the DCI with the beam indication     - Alt2: the first slot that is at least X ms after the acknowledgment of the beam indication   + FFS: When and how to apply the minimum beam indication delay   + Support a UE capability for the minimum value of X     - The beam application time X is configured by the gNB via higher-layer (RRC) signaling based the UE capability   FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) supported by UE |

* 1. Issue 4 (MP-UE)

Based on the discussion so far, it seems that trying to agree on features (proposal 4.D) would be impossible without agreeing first on use cases and some other more fundamental questions. To narrow down the options, the questions are now asked differently. After this is decided, we should be able to continue our discussion on the FL proposals made in R1-2008147 (where we left off, every point of the FL proposal 4.2 in R1-2008147 was objected).

Interested companies are encouraged to share their views on the issues below (reformulated 4.1, 4.5, and 4.8):

Table 7 Summary for round-2 discussion: issue 4 some fundamental issues

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 4.1 | Use cases for fast UL panel selection | **Opt1**: **MPE mitigation**   * Yes: vivo, Samsung, Fraunhofer IIS/HHI, Intel, Nokia/NSB, MediaTek, Qualcomm, Xiaomi, NTT Docomo, APT, IDC, ZTE, LG, Apple, Sony, Sharp * No:   **Opt2: UE power saving**   * Yes: Apple, OPPO, Samsung, Qualcomm, ZTE, LG, Sony * No:   **Opt3: UL mTRP**   * Yes: vivo, APT, Intel, LG, IDC * No: Samsung (to be discussed in mTRP)   **Opt4: UL interference management**   * Yes: Qualcomm, NTT Docomo, LG, Sony * No:   **Opt5: Support different configurations across panels**   * Yes: Qualcomm, NTT Docomo, Sony, Sharp, Nokia/NSB, LG, Samsung * No: | Whether **Opt3** should be addressed in MB (item 1) or mTRP (item 2a/c) will need to be discussed.  Use cases would guide the decision on at least #4.6, 4.7, 4.8. For instance, at least Opt1, 2, 4 may suggest that (4.8) there should be an option where the UE decides panel selection/activation. |
| 4.5 | Whether DL RX panel(s) can be different from UL TX panel(s) | **Yes**: LGE, Nokia/NSB (but with overlap), MediaTek, Intel, NTT Docomo (with overlap), Qualcomm, Xiaomi, ZTE, APT (with overlap), Lenovo/MoM, Sony, Samsung, IDC  **No**: Huawei/HiSi | Early observation suggests that “Yes, with overlap” could be a good compromise. |
| 4.8 | Which side decides panel selection/activation [Qualcomm, APT, MediaTek] | **Alt1 NW:**  **Yes**: ZTE, IDC (based on UE recommendation), NTT Docomo, APT  **No**:  **Alt2 UE:**  **Yes**: Qualcomm, ZTE, Apple, Sony, MediaTek, NTT Docomo, APT  **No**: | Note: If NW decides panel activation, UE-to-NW signaling may comprise recommendation whereas NW-to-UE signaling includes assignment |

**Proposal 4.A**: In Rel.17 enhancement for facilitating fast uplink panel selection, the following use cases are assumed:

* MPE mitigation
* UE power saving
* UL interference management
* Support different configurations across panels
* FFS: UL mTRP (whether to handle this issue in mTRP or MB)

**Proposal 4.B**: In Rel.17 enhancement on MP-UE to facilitate fast UL panel selection and MPE mitigation, UL Tx panel(s) is a same set or subset of DL Rx panel(s)

**Proposal 4.C**: In Rel.17 enhancement for facilitating fast uplink panel selection, UE-initiated UL panel selection/activation are supported:

* FFS: Whether NW-initiated panel selection/activation is also supported

Table 8 Additional inputs for round-2 discussion: issue 4 (reformulated 4.1, 4.5, and 4.8)

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | We strongly prefer to keep panel activation flexibility to UE, same as today. Many UE algorithms are built on this flexibility. Otherwise, gNB may ask too many panels to activate, and UE may have to request every time to activate a panel. There is huge impact on the power/performance/latency. |
| LG | Regarding the moderator note ‘Whether **Opt3** should be addressed in MB (item 1) or mTRP (item 2a/c) will need to be discussed’ on issue 4.1, UL mTRP scenario should be addressed in MB for fast UL panel selection. mTRP item 2a is for URLLC scenario so it’s focus is to transmit PUSCH/PUCCH with multiple beams, e.g. beam cycling, so it is not directly related to dynamic panel selection. In mTRP item 2c, the main focus is the beam reporting enhancement and BFR enhancement, so currently there is no related work for fast panel selection.  On issue4, in general, we are worried on the progress by noting that this item belongs to ‘**Identify and specify** …’ rather than ‘Evaluate and, if needed, specify …’. Note that we already discussed use cases during Rel-16 eMIMO last year. Considering that PUCCH resource grouping is introduced in Rel-16, where each PUCCH resource group can be mapped to a UE panel, would the following proposal be acceptable as a first step?  **Proposal: Support RRC to configure an association of each PUCCH resource group to other UL resource(s), including at least SRS.**  **- Note: associated resources can be mapped to a same panel**  **- FFS on details of association (e.g. via attaching an ID to resources or resource groups)** |
| Apple | In 4.1, we do not see any company raising concern for the use cases. Maybe we can try to agree that first?  **Proposal**  **The following use cases for fast uplink panel selection are assumed:**   * **MPE mitigation** * **UE power saving** * **UL mTRP** * **UL interference management** * **Support different configuration across panels** |
| Samsung | Re Opt4, we need some clarification from the proponents. Since UL interference management is NW controlled, does this imply that some NW to UE signaling is needed? |
| MediaTek | If time permitted, we can give Issue 4.5 a try, hope Huawei can accept the following proposal.  **Proposal: On MP-UE assumption to facilitate fast UL panel selection and MPE mitigation, UL Tx panel(s) is a same set or subset of DL Rx panel(s).** |
| InterDigital | In our view, UE can recommend panels to be activated based on its implementation flexibility. We think that UE implementation is not only the factor to be used for panel activation. In that sense, we prefer to have gNB indication based on UE recommendation. |
| OPPO | We prefer to first settle down the use case for UL panel selection before we discuss any other aspects |
| NTT Docomo | Please find added views in the above table.  For issue 4.1, besides MPE, we think UL interference control is also an important use case. With more information of UL condition, gNB can make better panel selection for UL Tx.  For issue 4.8, we suggest adding more details of the alternatives for further discussion. In our understanding, following alternatives can be further considered:   * Alt.1-1. NW decides panel activation/deactivation and indicates to UE * Alt.1-2. NW decides panel activation/deactivation. UE can request/recommend panel activation/deactivation, a panel can be activated/deactivated after gNB’s confirmation. * Alt.2-1. UE decides panel activation/deactivation and indicates to gNB * Alt.2-2. UE decides panel activation/deactivation. NW can request/recommend panel activation/deactivation, a panel is activated/deactivated after UE’s confirmation. |
| ZTE | We share the same views with Apple and OPPO that we need to complete issue 4.1 firstly. We can support Apple’s proposal.  **Regarding issue 4.5**, “with overlap” seems to be a good solution. We are fine with MediaTek’s proposal.  **Regarding issue 4.8**, one compromise solution is that UE can report its active UL panel(s), and gNB can indicate one out of them for UL transmission.  **Proposal:** A list of active panel(s) can be reported by UE, and gNB can indicate one out of active panels for UL transmission by unified TCI indication. |
| vivo | Regarding issue 4.5, we are also supportive of same active panel for DL reception and UL transmission. |
| Xiaomi | We share same views to complete issue 4.1 firstly. |
| APT | For issue 4.5, we favor MTK’s proposal than Proposal 4.B. Proposal 4.B seems also imply a case that DL RX panels are a subset of UL TX panels, which we think may not be typical.  For issue 4.8, we agree with Interdigital’s view and add our preferences into above table. Hence, we can support Proposal 4.C. |
| Ericsson | 4.A: Support  4.B: Support  4.C. Support only UE-initiated panel activation. The gNB should not control the UE hardware – we have strong concerns on this. |
| MediaTek | 4.A: Support  4.B: Still prefer our original proposal ☺  4.C: Support only UE-initiated panel activation. We have concerns on NW controlling UE panel activation/deactivation. |
| Nokia, NSB | We are fine with Mediatek’s proposal for issue 4.5. In general, we consider that fast UL panel/beam selection could be provided in UE panel transparent manner. In other words, we think that there may not be a need for an explicit panel ID but both MP-UE and MPE mitigation (Opt1 of 4.1. as well as Opt4 and Opt5 of 4.1) could be supported with simple enhanced beam reporting that would contain SSBRIs/CRIs feasible for UL beam selection and a metric that reflects UL transmission capability and/or quality (e.g. taking MPE into account). The following use cases we consider the most important ones for fast uplink panel/beam selection:   * MPE mitigation   Support different configuration across panels |
| Fraunhofer | 4.A: Support  The need of the restriction in issue 4.B “When different, it is assumed that at least one panel is common for DL reception and UL transmission” is unclear to us. For MPE mitigation, when UL panel switch is required, it may not be possible to have a common panel for DL reception and UL transmission. For e.g., if a 2-panel UE transmitting and receiving using a single panel is required to switch to the second panel for UL transmission because of an MPE event, this proposal would not allow such a panel switching. While proposal 4.A says that panel selection may be performed considering MPE mitigation, the inclusion of this restriction may affect MPE mitigation in certain cases. |
| Lenovo/MoM | **Proposal 4.A**: Support in principle. Regarding UL mTRP, we do not see a difference between mTRP or MB. We can just handle it here.  **Proposal 4.B**: Support in principle. Regarding the bullet “When different, it is assumed that at least one panel is common for DL reception and UL transmission”, is it correct to understand this common DL & UL panel is about the UE capability, not DL/UL operation at a particular time?  **Proposal 4.C**: support |
| AT&T | Proposal 4A: mTRP use case can be handled here  Proposal 4B: ok with proposal  Proposal 4C: more clarification needed on NW-initiated Panel activation |
| Intel | **Proposal 4.B:** We would like to have the sub-bullet as FFS. For some use cases, it may be beneficial to have different DL Rx and UL Tx panels e.g., HetNet. |

* 1. Issue 5 (MPE mitigation)

Table 9 Summary: issue 5

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 5.1 | When MPE event occurs, is UL spatial filter switching performed at beam-level or panel-level? | **Beam-level (including other UL TX beam candidates on the problematic panel)**: Xiaomi, Ericsson, Qualcomm, NTT Docomo, Intel, IDC, ZTE, Apple, Sony, Sharp, Nokia/NSB, Convida  **Panel-level (excluding all UL TX beam candidates on the problematic panel)**: OPPO, Sony, Samsung, Xiaomi, NTT Docomo, Lenovo/MoM, Intel, LG | This issue determines: 1) report content (CAT1), 2) candidates for alternative UL TX beam |
| 5.2 | CAT0 (MPE detection) | **No need for spec support**: MediaTek, Huawei/HiSi, Samsung, OPPO, Spreadtrum, APT, Sony, Sharp, Convida  **Wait until Rel.16 functionality is clear**: Ericsson  **Spec support (?)**: | A number of CAT0 proposals are re-categorized into CAT1 aspects since they either represent reporting content or triggering condition.  For condition-based triggering, the metric and threshold mechanisms can be decided later (e.g. BFR/partial BFR-like threshold, L1-RSRP/SINR threshold, Rel.16 PHR).  Early observation suggests that CAT0 is not needed and can be a part of CAT1 if UE-initiated condition-based approach is agreed.  Issue #5.3 on content (especially reporting alternate UL beam/panel) will have to be considered jointly with issue #4.7. This also depends on the conclusion on issue #4.1 and #5.1.  CAT1: Can UE-initiated co-exist with NW-triggered (input from NTT Docomo)? |
| 5.3 | CAT1 (UE reporting): triggering | **No need for spec support:** Spreadtrum, OPPO  **Wait until Rel.16 functionality is clear**: Ericsson,  **UE-initiated condition-based**: Huawei/HiSi, Samsung, CATT, Nokia/NSB, Sony, LGE, Qualcomm, NTT Docomo, ZTE, [Intel], Xiaomi, MediaTek, Apple, Convida, IDC  **UE-initiated without condition**:  **NW-triggered**: NTT Docomo, Nokia/NSB (configuration and activation/triggering of reporting) |
| CAT1 (UE reporting): content | **No need for spec support:** Spreadtrum  **Wait until Rel.16 functionality is clear**: Ericsson  **MPE event indication**: Nokia/NSB, Samsung, LG  **CRI/SSBRI associated alternate UL panel and/or TX beam**: CATT, CMCC, Samsung, MediaTek, Intel, NTT Docomo, Qualcomm, Fraunhofer IIS/HHI, ZTE, Nokia/NSB, Apple, Sony, Ericsson, APT, Xiaomi, LG, Sharp, IDC  **L1-RSRP (companion of CRI/SSBRI)**: Apple, Samsung, [Ericsson], Nokia/NSB, IDC  **P-MPR**: Apple, Huawei/HiSi, IDC, vivo, Sony, Xiaomi, NTT Docomo (beam/panel specific), Nokia/NSB, CMCC, ZTE (beam/panel specific), Qualcomm, OPPO, Lenovo/MoM  **Pcmax**: Apple  **Virtual PHR**: Apple, ZTE, Nokia/NSB, Convida |
| 5.4 | CAT2 (NW signaling in response to UE reporting) | **No need for spec support (beyond separate UL beam indication):** Spreadtrum, OPPO, MediaTek, APT, Convida  **gNB confirmation (ACK)**: IDC, NTT Docomo, Samsung  **Spec support for UE behavior during/after MPE event reporting**: Nokia/NSB | Note: The support of separate UL beam indication from DL has been agreed in RAN1#102-e (issue 1b). The scheme is to be decided (Alt1 vs 2-1 vs 2-2) |
|  |  |  |  |

Based on the previous inputs, it seems that one possible way to proceed is to address the UE reporting first (which not only involves MPE mitigation, but also MP-UE aspects) – following the suggestion from some companies (cf. R1-2008147).

**Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17, investigate the following:

* Reporting of panel level P-MPR report based on Rel.16 framework.
* Reporting SSBRI(s)/CRI(s) 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
* Any additional reporting: down-select from the following in RAN1#104-e
  + Alt0: no additional reporting content
  + Alt1: P-MPR + L1-RSRP
  + Alt2: virtual PHR + L1-RSRP
  + Alt3: L1-RSRP/SINR with and without MPE effect
  + Alt4: virtual PHR
    - Note that PHR including PH and Pcmax is calculated based on P-MPR and the L1-RSRP

Table 10 Additional inputs for round-2 discussion: issue 5 proposal 5.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | We are fine for proposal 5A as starting point. |
| Apple | We support proposal 5.A. Just some refinement below to add options from different companies.  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17:   * Support SSBRI/CRI indicating an alternative UE panel or TX beam for UL transmission * Any additional reporting: down-select from the following in RAN1#104-e   + Alt0: no additional reporting   + Alt1: P-MPR + L1-RSRP   + Alt2: virtual PHR + L1-RSRP     - virtual PHR includes PH and Pcmax, which is calculated based on P-MPR and the L1-RSRP. |
| Samsung | **Proposal 5.A:**  In general, supportive of direction of proposal. For Alt1, we propose adding more options:   * L1-RSRP with and without MPE effect. * L1-SINR with and without MPE effect. |
| MediaTek | Support FL proposal with some minor changes as follows:  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17:   * Support reporting of SSBRI(s)/CRI(s) to indicate an alternative UE panel(s) or TX beam(s) for UL transmission * Any additional reporting: down-select from the following in RAN1#104-e   + Alt0: no additional reporting content   + Alt1: additional reporting content(s)     - e.g. L1-RSRP, P-MPR, PHR, Pcmax, etc.   FFS: separate reporting from L1-RSRP reporting for DL or joint reporting with L1-RSRP reporting for DL  Details of additional reporting content(s) can be further discussed in the next meeting. |
| InterDigital | We are fine with the origianl proposal 5.A and prefer to further discuss the additional reporting. |
| OPPO | gNB indicating SSBRI/CRI for UE UL transmission is already supported in the spec. Thus we do not need to restate here. We support to discuss additional reporting, for example P-MPR.  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17:   * ~~Support SSBRI/CRI indicating an alternative UE panel or TX beam for UL transmission~~ * Any additional reporting: down-select from the following in RAN1#104-e   + Alt0: no additional reporting   + Alt1: additional reporting     - e.g. L1-RSRP, P-MPR, PHR, Pcmax, etc. |
| NTT Docomo | We suggest more clarification on the UE report content and triggering. In our understanding, there are following alternatives to be further studied.  Thus, we suggest medication as below.  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17, further study the following alternatives   * Alt.1. SSBRI/CRI indicating an alternative UE panel or Tx beam for UL transmission   + the report is UE initiated with condition-based triggering   + FFS: additional reporting e.g. L1-RSRP, per panel/beam P-MPR/PHR/PCMAX * Alt.2. SSBRI/CRI indicating feasible UE panels or Tx beams for UL transmission taking MPE into account   + the report is NW configured e.g. P/SP/AP reporting   + FFS: additional reporting e.g. L1-RSRP, per panel/beam P-MPR/PHR/PCMAX |
| ZTE | From our perspective Alt-1 is incomplete, and we may need to provide more details through a new alternative like Apple mentioned or extend the examples. Please check our update based on Apple’s and NTT DOCOMO’s version with one more alternative.  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17 that is UE initiated with condition based triggering:   * Support reporting of SSBRI(s)/CRI(s) to indicate an alternative UE panel or TX beam for UL transmission * Any additional reporting contents: down-select from the following in RAN1#104-e   + Alt0: no additional reporting content   + Alt1: P-MPR + L1-RSRP   + Alt2: virtual PHR + L1-RSRP   + Alt3: virtual PHR   + Note that PHR including PH and Pcmax is calculated based on P-MPR and the L1-RSRP |
| vivo | In Rel-17 NR FeMIMO scope, the MPE issue mainly refers to mitigating the UL coverage loss due to meeting the MPE regulation by panel-specific UL beam selection. Furthermore, according to our simulation results we don’t observe performance difference of switching to a different beam in the same panel. We don’t think it is necessary to consider P-MPR report at beam level.  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17:   * Support ~~SSBRI/CRI indicating an alternative UE panel or TX beam for UL transmission~~ panel level P-MPR report based on Rel.16 framework. * Any additional reporting: down-select from the following in RAN1#104-e   + Alt0: no additional reporting   + Alt1: additional reporting     - e.g. L1-RSRP, P-MPR, PHR, Pcmax, etc. |
| Sony | **Proposal 5.A**. Support the principle.  As for the wording, we somehow share the same understanding with OPPO that SSBRI/CRI reporting has been supported. Here we think the intention is to let UE report SSBRI/CRI when considering the MPE impact. So we would like to suggest a modification as below  **Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17:   * Support SSBRI/CRI indicating an ~~alternative~~ UE panel or TX beam for UL transmission when considering MPE impact * Any additional reporting: down-select from the following in RAN1#104-e   + Alt0: no additional reporting   + Alt1: additional reporting     - e.g. L1-RSRP, P-MPR, PHR, Pcmax, etc. |
| Xiaomi | Support the proposal |
| Ericsson | We are generally supportive of the proposal. For the additional reporting part, we propose to have only two alternatives:   * + Alt0: no additional reporting content   Alt1: New reporting associated with the reported SSBRI/CRIThe reason to just have two options is to avoid that everyone need to get their preferred method into the list. Since the topic is new, we do not see any reason to exclude anything. |
| Convida Wireless | Support the proposal. |
| MediaTek | Share similar view with Ericsson including the wording for the additional reporting part.  On the first sub-bullet, whether Rel.16 framework means Rel.16 P-MRP report in PHR MAC CE. If so, prefer to describe it more clearly.   * Reporting of panel level P-MPR report by enhancing Rel.16 P-MRP report in PHR MAC CE |
| Nokia/NSB | In general, we are supportive of the proposal. We are not fine with ZTE’s proposal to make reporting conditioned with UE based triggering (it could be additionally defined). We think that network controlled beam reporting (CRI/SSBRI**)** to reveal feasible DL RSs for UL from MPE point of view is seen as a basis from beam management functionality point of view to be supported. That would also mean network controlled configuration and activation/triggering of the reporting. We are also supportive for additional reporting to provide UL related metric (e.g. L1-RSRP + P-MPR, L1-RSRP+virtual PHR, etc.)  We are also supportive for Mediatek’s proposal:  FFS: separate reporting from L1-RSRP reporting for DL or joint reporting with L1-RSRP reporting for DL  Regarding issue 5.4, we consider that it could be further studied that whether there is need for prioritization of UL transmissions carrying MPE related info to gNB. |
| Lenovo/MoM | Support in principle.  Regarding indication of UE panel, it is should be based on how a UE panel is represented (implicit or explicit panel ID). We prefer to postpone this part after UE panel identification is finalized. |
| Intel | Support in principle. Agree with Ericsson’s comment on the additional reporting part. There is no need to list all applicable solutions in the agreement at this early stage. Also, it is unclear if the additional report targets current (impacted) beam or new alternative beam – this should be further clarified. |
| InterDigital | We are fine with the updated proposal. |

* 1. Issue 6 (beam refinement/tracking)

Table 11 Summary: issue 6

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies** |
| 6.1 | Beam measurement and reporting enhancement via RACH for initial access (e.g. RO for measurement and MSG3 for reporting) | AT&T, Qualcomm, Samsung, CMCC, Xiaomi, Sony |
| 6.2 | Improving efficiency (latency, overhead) of beam refinement:   * Enabling joint DL TX and RX beam refinement/tracking (P2+P3) * Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity) | Apple (CSI-RS based), Samsung (CSI-RS based), Intel (using SRS/CRI), Qualcomm (e.g. reporting rate of beam direction change) |
| 6.3 | Beam management with reduced DL signaling:   * Dynamic beam update based on beam report (without beam indication) * Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering) * Configuring/indicating to UE multiple SSBs for beam tracking * Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment) * Reducing activation delay of TCI states (via storing QCL properties of a subset of source RSs for a time period) | Futurewei, Nokia/NSB, Samsung, Apple, Intel , NTT Docomo , Qualcomm, Xiaomi, Ericsson, Sharp |
|  |  |  |

From moderator perspective, proposal 6.A has been stable and is (almost) ready for endorsement.

* Regarding some comments on priority, as this is a study effort for now, the progress is based on the level of interest from companies. It is clearly understood that the other five issues take higher precedence than issue 6 since the associated work has been quite well defined.
* Regarding some comments on initial access, there is a parallel discussion in CovEnh WI (and agreement to work on this). Some discussion in the December RAN is expected to resolve whether this enhancement is to be worked on in FeMIMO or CovEnh. For now, it is included here since it is assumed that the expertise resides within the MIMO collective ☺

**Proposal 6.A**: Investigate and, if needed, specify *at least* the following enhancements for beam refinement/tracking in Rel.17:

* Beam measurement and reporting enhancement via RACH during initial access (e.g. RO for measurement and MSG3 for reporting)
* Improving efficiency (latency and/or overhead) of beam refinement assuming the unified TCI framework (issue 1):
  + Enabling joint DL TX and RX beam refinement/tracking (P2+P3)
  + Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity)
* Beam management with reduced DL signaling assuming the unified TCI framework (issue 1):
  + Dynamic beam update based on beam report (without beam indication)
  + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)
  + Configuring/indicating to UE multiple SSBs for beam tracking
  + Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)
  + Reducing activation delay of TCI states (e.g. via storing QCL properties of a subset of source RSs for a time period)

Interested companies are encouraged to provide additional inputs (if any) on proposal 6.A.

Table 12 Additional inputs for round-2 discussion: issue 6 proposal 6.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | Suggest to add “if applicable” because some cases may not cannot use the unified TCI framework, e.g. the beam reporting during IA  **Proposal 6.A**: Investigate and, if needed, specify *at least* the following enhancements for beam refinement/tracking in Rel.17 assuming the unified TCI framework if applicable (issue 1): |
| Apple | Support the proposal |
| Samsung | Support the proposal |
| MediaTek | Support the proposal |
| OPPO | The main bullet says “assuming the unified TCI framework”. TCI framework is UE in RRC connected status. So the beam enhancement during initial access shall not be included.  **Proposal 6.A**: Investigate and, if needed, specify *at least* the following enhancements for beam refinement/tracking in Rel.17 assuming the unified TCI framework (issue 1):   * ~~Beam measurement and reporting enhancement via RACH during initial access (e.g. RO for measurement and MSG3 for reporting)~~ * Improving efficiency (latency and/or overhead) of beam refinement:   + Enabling joint DL TX and RX beam refinement/tracking (P2+P3)   + Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity) * Beam management with reduced DL signaling:   + Dynamic beam update based on beam report (without beam indication)   + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)   + Configuring/indicating to UE multiple SSBs for beam tracking   + Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)   + Reducing activation delay of TCI states (via storing QCL properties of a subset of source RSs for a time period)   {FL comment: “unified TCI framework” is used only for the 2nd and 3rd bullets} |
| NTT Docomo | Support, and we prefer to discuss “Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)” |
| ZTE | Firstly, we think this issue should be postponed after above five issues are stable considering the limited GTW and non-F2F meeting.  Could any proponent nicely clarify the candidate solution or examples for each of candidate in the Proposal 6.A, especially for the following cases?   * + Dynamic beam update based on beam report (without beam indication)   + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)   + Configuring/indicating to UE multiple SSBs for beam tracking   + Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)   {FL comment: The questions should be answered as a part of the investigation. The current proposal is still a high-level description for “study”} |
| vivo | We share similar understanding as ZTE. |
| Sony | Support the FL proposal. |
| Xiaomi | Support the proposal |
| Ericsson | Support |
| Convida Wireless | Same view as ZTE and vivo. The previous issues already fill up the GTW/email bandwidth. |
| Lenovo/MoM | Support |
| AT&T | Support the proposal |
| FUTUREWEI | Support the proposal. |
| Intel | Support the proposal.  On the last bullet on reducing activation delay of TCI, the scheme can be an example such that other schemes are not precluded:   * + Reducing activation delay of TCI states (for example via storing QCL properties of a subset of source RSs for a time period) |

Appendix A: Agreements in RAN1#102-e

Issue 1

* [Issue 1] For Rel.17 NR FeMIMO, on the unified TCI framework
  1. Support joint TCI for DL and UL based on and analogous to Rel.15/16 DL TCI framework
     + The term “TCI” at least comprises a TCI state that includes at least one source RS to provide a reference (UE assumption) for determining QCL and/or spatial filter
     + The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and all or subset of CORESETs in a CC
       - FFS: Optionally this common QCL information can also apply to CSI-RS resource for CSI, CSI-RS resource for BM, and CSI-RS for tracking
       - FFS: Applicability on PDSCH includes PDSCH default beam
       - Working Assumption: Select between M=1 and M>=1
     + 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
       - FFS: applicability of this UL TX spatial filter to SRS configured for beam management (BM)
       - FFS: PUSCH port determination based on the TCI, e.g., to be mapped with SRS ports analogous to Rel.15/16
       - Working Assumption: Select between N=1 and N>=1
     + FFS: extension to common QCL information applied to only some of the CORESETs or PUCCH resources in a CC, e.g. for mTRP
     + FFS: When used for the purpose of joint beam indication for UL and DL, whether a joint TCI pool for DL and UL dedicated for the purpose is used, or the same TCI pool as that used for the purpose of separate DL/UL beam indication is used
     + Note: The resulting beam indication directly refers to the associated source RS(s)
     + FFS (RAN1#103-e): Details on extension to intra- and inter-band CA
     + FFS (RAN1#103-e): The supported number of active TCI states considering factors such as multi-TRP and issue 6
     + FFS (RAN1#103-e): Applicable QCL types, and co-existence with DL TCI and spatial relation indication in Rel.15/16
  2. In RAN1#103-e, investigate, for the purpose of down selection, the following alternatives for accommodating the case of separate beam indication for UL and DL
     + Alt1. Utilize the joint TCI to include references for both DL and UL beams
     + Alt2. Utilize two separate TCI states, one for DL and one for UL. The TCI state for the DL is the same as agreed in 1a. The TCI state for the UL can be newly introduced.
       - Alt 2-1: The UL TCI state is taken from the same pool of TCI states as the DL TCI state
       - Alt 2-2: The UL TCI state is taken from another pool of TCI states than the DL TCI state
     + Note: The resulting beam indication directly refers to the associated source RS(s)
     + FFS (RAN1#103-e): Details on extension to intra- and inter-band CA
     + Note: This may be related to issue 5 as well as other reasons for different TCIs such as network flexibility/scheduling
  3. Support the use of SSB/CSI-RS for BM and/or SRS for BM as source RS to determine a UL TX spatial filter in the unified TCI framework
     + Whether the UL TX spatial filter corresponds to UL TCI (separate from DL TCI) depends on the outcome of 1b) above
     + FFS: Support the use of non-BM CSI-RS and/or non-BM SRS in addition
  4. In RAN1#103-e, decide if SRS for BM can be configured as a source RS to represent a DL RX spatial filter in the unified TCI framework
  5. In RAN1#103-e, decide/finalize all other parameters included in or concurrent with (but not included in) the TCI, e.g. UL-PC-related parameters (involving P0/alpha, PL RS, and/or closed loop index), UL-timing-related parameters
  6. In RAN1#103-e, identify issues pertaining to alignment between DL and UL default beam assumptions using the unified TCI framework

Issue 2

* [Issue 2] For Rel.17 NR FeMIMO, on L1/L2-centric inter-cell mobility:
  1. In RAN1#103-e, finalize scope and use cases for L1/L2-centric inter-cell mobility, including:
     + Applicability in various non-CA and CA setups such as intra-band and inter-band CA
     + Use cases in comparison to Rel.15 L3-based handover (HO) taking into account potential extension of DAPS-based Rel.16 mobility enhancement to FR2-FR2 HO
     + The extent of RAN2 impact (MAC CE, RRC, user plane protocols)
     + Network architecture, e.g. NSA vs. SA, inter-RAT scenarios
  2. In RAN1#103-e, depending on the outcome of 2a), further identify additional components –along with the associated alternatives –required for supporting inter-cell mobility based on the same unified TCI framework as that for intra-cell mobility (including dynamic TCI state update signaling), including
     + Method(s) for incorporating non-serving cell information associated with TCI
     + Method(s) for DL measurements and UE reporting (e.g. L1-RSRP) associated with non-serving cell(s)
     + UE behavior for reception of signals and non-UE-specific control and data channels associated with non-serving cell(s)
     + UL-related enhancements, e.g. related to RA procedure including TA
     + Beam-level event-driven mechanism for L1/L2-centric inter-cell mobility

Issue 3

* [Issue 3] For Rel.17 NR FeMIMO, on dynamic TCI state update signaling medium:
  1. In RAN1#103-e, investigate, for the purpose of down selection, the following alternatives:
     + Alt1. DCI
     + Alt2. MAC CE
     + Note: Combination between DCI and MAC CE for, e.g. different use cases or control information partitioning can also be considered
     + Note: The study should consider factors such as feasibility for pertinent use cases, performance (based on at least the agreed EVM), overhead (including PDCCH capacity), latency, flexibility, reliability including the support of retransmission
     + Note: This may be related to outcome of issue 1a), 1b), and 6a)
  2. In RAN1#103-e, depending on the outcome of 3a), identify candidates for more detailed design issues for the dynamic TCI state update such as
     + Exact content
     + Signaling format
     + Reliability aspects including the support of retransmission
     + Extensions, including the support of UE-group (in contrast to UE-dedicated) signaling

Issue 4

* [Issue 4] For Rel.17 NR FeMIMO, on MP-UE assumption to facilitate fast UL panel selection:
  1. The following assumptions are used:
     + In terms of RF functionality, a UE panel comprises a collection of TXRUs that is able to generate one analog beam (one beam may correspond to two antenna ports if dual-polarized array is used)
     + UE panels can constitute the same as well as different number of antenna ports, number of beams, and EIRP
     + No beam correspondence across different UE panels
     + FFS: For each UE panel, it can comprise an independent unit of PC, FFT timing window, and/or TA.
     + FFS: Same or different sets of UE panels can be used for DL reception and UL transmission, respectively
  2. In RAN1#103-e, identify candidate use cases including MPE, and consider remaining aspects if use cases are identified
  3. In RAN1#103-e, identify candidate signaling schemes for the following:
     + NW to MP-UE (taking into account potential extension of the unified TCI framework in issue 1)
     + MP-UE to NW

Issue 5

* [Issue 5] For Rel.17 NR FeMIMO, on MPE mitigation (that is, minimizing the UL coverage loss due to the UE having to meet the MPE regulation), in RAN1#103-e:
  1. If needed, identify candidate solutions to be down-selected in future meeting(s). The following sub-categories can be used:
     + CAT0. The need for specification support for MPE event detection and, if needed, candidate solutions
     + CAT1. The need for UE reporting associated with an MPE and/or a potential/anticipated MPE event if the UE selects a certain UL spatial resource, e.g., corresponding to DL or UL RS
     + CAT2. The need for NW signaling in response to the reported MPE event (taking into account issue 1) and UE behavior after receiving the NW signaling
     + Note: RAN4 has agreed to specify P-MPR reporting (cf. CRs for TS 38.101/102/133) which can be used as a baseline scheme for further enhancement
     + Note: This may be related to outcome of issue 4b)
  2. Companies are encouraged to submit evaluation results based on the agreed EVM to justify the benefits of the candidate solutions

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