**3GPP TSG RAN WG1 #108-e R1-2nnnnn**

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

**Agenda Item: 8.16.1**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for further enhancements on NR-MIMO**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion/approval [108-e-R17-UE-features-MIMO-01] during RAN1 #108-e. According to the Chairman’s Notes:

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| [108-e-R17-UE-features-MIMO-01] Email discussion on UE features for further enhancements on NR-MIMO – Ralf (AT&T)   * 1st check point: February 25 * Final check point: March 3 |

The following was discussed and/or agreed during RAN1 #108-e within the scope of [108-e-R17-UE-features-MIMO-01]. All proposals are based on the latest RAN1 UE features list for Rel-17 NR in [1].

# Summary of Contributions Submitted to RAN1 #108-e

The following is the moderator’s summary of contributions submitted to RAN1 #108-e in this agenda item.

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| 23. NR\_FeMIMO | 23-1-1 | Unified TCI [with joint DL/UL TCI update] for intra- [and inter-cell] beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   FFS: whether to include the following components 2-14 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs  FFS: basic FGs for UEs supporting CA  FFS: separate FGs for inter/intra/joint/separate   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination] 4. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination] 5. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] 6. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 7. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 8. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs) 9. Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling 10. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 11. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] FFS: Whether to make component 9 a prerequisite or merge with 9 12. [Alt. 1: ~~[~~The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list]   [14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied] |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] | It was agreed in RAN#106-e that the maximum number of configured TCI state pools across BWPs and CCs in a band is reported as UE capability.  **Agreement (RAN1#106-e)**  On Rel.17 unified TCI framework, confirm the following working assumption as an agreement with a minor refinement highlighted in red  For common TCI state ID update and activation to provide common QCL information at least for UE-dedicated PDCCH/PDSCH and/or common UL TX spatial filter(s) at least for UE-dedicated PUSCH/PUCCH across a set of [configured] CCs/BWPs:   * RRC-configured TCI state pool(s) can be configured in the PDSCH configuration (*PDSCH-Config*) for each BWP/CC as in Rel-15/16   + Note: Such RRC-configured TCI state pool(s) configuration doesn’t imply that separate DL/UL TCI state pool is excluded or supported * RRC-configured TCI state pool(s) can be absent in the PDSCH configuration (*PDSCH-Config*) for each BWP/CC, and replaced with a reference to RRC-configured TCI state pool(s) in a reference BWP/CC   + In the PDSCH configuration (*PDSCH-Config*) of the reference BWP/CC, RRC-configured TCI state pool(s) shall be configured   + For a BWP/CC where the PDSCH configuration contains a reference to the RRC-configured TCI state pool(s) in a reference BWP/CC, the UE applies the RRC-configured TCI state pool(s) in the reference BWP/CC * When the BWP/CC ID (i.e. *bwp-Id* or *cell*) for QCL-Type A/D source RS in a *QCL-Info* of the TCI state is absent, the UE assumes that QCL-Type A/D source RS is in the BWP/CC to which the TCI state applies * Introduce a UE capability to report maximum number of TCI state pools it can support across BWPs and CCs in a band, and the candidate value at least includes 1 * FFS: Introduce a UE capability to report maximum number of configured TCI states that it can support across BWPs and CCs in a band * FFS: How to define reference BWP/CC   In addition, to reduce memory consumption at UE, similar to legacy UE feature 2-4/2-59 in Rel-15/16, it should be supported to report maximum number of configured unified TCI states across BWPs/CCs in a band in a band combination and per CC in a band in a band combination.  With above analysis, we propose the following:  ***Proposal 2-1: Include the component 4/12 and add a component 4a into FG 23-1-1 as follows and remove all the corresponding brackets***   * + ***4. The maximum number of configured joint TCI states per BWP per CC in a band in a band combination.***   + ***4a. The maximum number of configured joint TCI states across all BWPs and all CCs in a band in a band combination***   + ***12. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band in a band combination.***   It was agreed in RAN#105-e that the maximum number of activated UL TCI states or joint TCI state is reported as UE capability.  **Agreement (RAN1#105-e)**  On path-loss measurement for Rel.17 unified TCI framework, a PL-RS (configured for path-loss calculation) is either included in UL TCI state or (if applicable) joint TCI state or associated with UL TCI state or (if applicable) joint TCI state.   * Whether a UE supports “beam misalignment or not” (detailed definition FFS) between the DL source RS in the UL or (if applicable) joint TCI state to provide spatial relation indication and the PL-RS is a UE capability   + Note: The term “beam misalignment” is for discussion purpose only * Whether it is ‘included in’ or ‘associated with’ (including the manner it is performed and the signaling) is up to RAN2 * The UE maintains the PL-RS of the activated UL TCI state or (if applicable) joint TCI state * The maximum number of activated UL TCI states or (if applicable) joint TCI states per band per cell is a UE capability * FFS: detailed aspects of PL-RS, e.g. CSI-RS type(s), restriction on configuration * FFS: For the definition of “beam misalignment or not”, at least consider the case where the periodic DL source RS in the UL or (if applicable) joint TCI state to provide spatial relation indication is configured/associated as the PL-RS * Note: PL-RS is assumed to be periodic   With above analysis, we propose the following:  ***Proposal 2-2: Include component 5/5a into FG 23-1-1 as follows and remove the corresponding brackets***   * + ***5. The maximum number of MAC-CE activated joint TCI states across all CCs in a band in a band combination.***   + ***5a. The maximum number of MAC-CE activated joint TCI states per CC in a band in a band combination.***   To reflect UE processing capability on number of CCs with beam failure recovery running, there needs be to a UE feature on maximum number of CCs configured with BFR under Rel-17 unified TCI framework. We then propose the following:  ***Proposal 2-3: Include component 10 into FG 23-1-1 as follows***   * + ***10. Maximum number of CCs configured with BFR, with candidate values {1, 2, 3, 4, …, FFS}***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-1 | Unified TCI [with joint DL/UL TCI update] for intra- [and inter-cell] beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   FFS: whether to include the following components 2-14 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs  FFS: basic FGs for UEs supporting CA  FFS: separate FGs for inter/intra/joint/separate   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states ~~[~~per BWP per CC~~] [~~in a band~~]~~ ~~[~~in a band combination~~]~~   4a. The maximum number of configured joint TCI states across all BWPs all CCs in a band in a band combination   1. The maximum number of MAC-CE activated joint TCI states across all CCs ~~[~~in a band~~]~~ ~~[~~in a band combination~~]~~ a) The maximum number of MAC-CE activated joint TCI states per CC ~~[~~in a band~~]~~ ~~[~~in a band combination~~]~~ 2. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] 3. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 4. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 5. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs) 6. Maximum number of CCs configured with BFR ~~FFS whether this is a component or just a note in the FG to reuse R16 signaling~~ 7. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 8. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band ~~[~~in a band combination~~]~~ ~~FFS: Whether to make component 9 a prerequisite or merge with 9~~ 9. [Alt. 1: ~~[~~The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list]   [14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied] |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| vivo [3] | The following FFS on how to group components 2-14 should be discussed.   * FFS: whether to include the following components 2-14 into this FG or one or more separate FGs   The following UE capability can be included into the basic component since all UEs should report the supported numbers for TCI states.   |  | | --- | | Component 4: The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination]  Component 5: The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]  Component 12: The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band; |   The following UE capability for reference BWP configuration should be merged with wording refined as following:   |  | | --- | | Component 9: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list |   All other components should be separate UE feature groups:   |  | | --- | | Component 2: Common multi-CC TCI update and activation | | Component 3: For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS | | Component 6: [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] | | Component 7: Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS | | Component 8: TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) | | Component 10: Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling | | Component 11: Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication |   **Proposal 1-1: Update the components other than component 1 in FG23-1-1 as follows:**   * **The following UE capability can be included into the basic component.**  |  | | --- | | Component 4: The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination]  Component 5: The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]  Component 12: The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band; |   **Proposal 1-2: Component 9 and component 13 are merged as following:**   |  | | --- | | Component 9: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list |   **Proposal 1-3: The following components are split into separate UE feature groups:**   |  | | --- | | Component 2: Common multi-CC TCI update and activation | | Component 3: For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS | | Component 6: [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] | | Component 7: Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS | | Component 8: TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) | | Component 10: Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling | | Component 11: Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication |   **Proposal 1-4: Support additional UE feature group indicating support of association of TCI states with PCI different from the serving cell PCI.** |
| ZTE [4] | Firstly, in the main feature, we need to explicit that the following components should be supported as part of the basic features in 23-1-1:   * Component-1: Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals) * Component-3: For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS * Component-4: The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination] * Component-5-a: The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]   + Note: For facilitating unified TCI framework (as an enhancement over legacy Rel-15/16 unified TCI), the UE should support at least 2 activated TCI states per CC mandatorily. * Component-6: The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS * Component-8: TCI state indication [mode]: update and activation [in case of updates] a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) * Component-11: Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s)   Then, the following functionalities should be supported as part of the basic feature for UE supporting CA in 23-1-1:   * Component-2 Common multi-CC TCI update and activation * Component-9 Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC   After that, we have the following comments for other potential UE feature components captured by the moderator.   * Regarding Component-6&14(BAT time), in our views, the Component-6 is sufficient and also aligned with already agreement, but we fail to identify the necessity of Componet-14 and legacy UE feature for PDSCH beam switching can be reused herein. * Regarding Component 10, we fail to understand the necessity of this component, and it can be well represented by Rel-16 existing UE feature signaling. * Regarding Component-9, 12, 13 (common TCI state pool), there are several candidate descriptions for Component-13, but in our views, the current description in component-9 and 12 is sufficient and also aligned with already agreement. The further wording-polish for above two components may not be needed. Then, Component 9 can be can made as a prerequisite feature for Component 12.   ***Proposal 1:*** *For unified TCI for intra- and inter-cell beam management, the following modification in red is proposed.*   * *Components-{1, 3, 4, 5a, 6, 8, 11} should be supported as a basic feature.* * *Components-{2, 9} should be further supported as a basic feature for UE supporting CA.*  |  |  |  | | --- | --- | --- | | 23-1-1 | Unified TCI ~~[~~with joint DL/UL TCI update~~]~~ for intra- ~~[~~and inter-cell~~]~~ beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals) 2. Common multi-CC TCI update and activation 3. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 4. The maximum number of configured joint TCI states ~~[~~per BWP per CC~~]~~ ~~[~~in a band~~]~~ ~~[in a band combination]~~ 5. The maximum number of MAC-CE activated joint TCI states across all CCs ~~[~~in a band~~]~~ ~~[in a band combination]~~ a) The maximum number of MAC-CE activated joint TCI states per CC ~~[~~in a band~~]~~ ~~[in a band combination]~~ 6. ~~[~~The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS~~]~~ 7. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 8. TCI state indication ~~[~~mode~~]~~: update and activation ~~[in case of updates]~~ a) MAC CE based TCI state indication ~~[~~for one active TCI state~~]~~ b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 9. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs) 10. ~~Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling~~ 11. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 12. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band ~~[in a band combination]~~ ~~FFS: Whether to~~ Note: To make component 9 a prerequisite ~~or merge with 9~~ 13. ~~[Alt. 1: [The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list]~~   ~~[14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied]~~ | |
| OPPO [5] | Regarding each component:   * On component 14, it shall be kept since there was a RAN1 agreement. Some companies seem to think that the rel-15 signaling *timeDurationForQCL* can be re-used here. In our understanding, it can be re-used here but we need to specify it very clearly here for rel-17. Because the rel-15 signalling *timeDurationForQCL* is only for DCI-based dynamic PDSCH scheduling, not for unified TCI state framework. At least some note is needed here to clarify that.  |  | | --- | | **Agreement**  On Rel-17 DCI-based beam indication, regarding application time of the beam indication, the first slot that is at least X ms or Y symbols after the last symbol of the acknowledgment of the joint or separate DL/UL beam indication.   * Note: The gap between the last symbol of the beam indication DCI and that first slot shall satisfy the UE capability |  * On component 13: it is not needed. The function of component 13 can be covered by component 9and 12. Thus, we suggest to remove it. * On component 10: a note in FG to reuse the rel16 signaling is sufficient.   Regarding the partition on FGs:   * The basic FG includes components 1, 4 and 5. * Components 6, 8 and 14 should be in a separate FG * Components 2, 9 and 12 should be in a separate FG for multi-CC TCI state indication * Components 3 and 7 are in a separate FG for power control in unified TCI state framework * Component 11 shall be in a separate FG for those channels/RS that do not follow the rel-17 indicated TCI state.   ***Proposal 1: On UE features for unified TCI framework：***   * ***Keep component 14: a note in the FG to reuse rel15 signalling “timeDurationForQCL” is also ok.*** * ***Remove component 13*** * ***On component 10: a note in FG to reuse the rel16 signalling.***   ***Proposal 2: On FGs for unified TCI framework:***   * ***The basic FG includes components 1, 4 and 5.*** * ***Components 6, 8 and 14 should be in a separate FG*** * ***Components 2, 9 and 12 should be in a separate FG for multi-CC TCI state indication*** * ***Components 3 and 7 are in a separate FG for power control in unified TCI state framework*** * ***Component 11 shall be in a separate FG for those channels/RS that do not follow the rel-17 indicated TCI state.*** |
| CATT [6] | In Rel-17, MAC-CE-based beam indication is supported for all the UEs. Whether to support the DCI-based beam indication (i.e. using DCI format 1\_1/1\_2) depends on UE capability. In addition, for a UE supporting beam indication by DCI format 1\_1/1\_2, it must support beam indication by using DCI 1\_1/1\_2 with DL assignment. But the supportive of beam indication by DCI format 1\_1/1\_2 without DL assignment is UE optional. Therefore two separate UE features regarding the DCI-based beam indication (i.e. use of DCI formats 1\_1/1\_2 with DL assignment and use of DCI formats 1\_1/1\_2 with and without DL assignment) are required and should be reported to gNB. If DCI-based beam indication is supported, the beam application time, i.e. the first slot that is at least Y symbols after the last symbol of the acknowledgment of the joint or separate DL/UL beam indication, should be reported. Therefore, component 6 should be combined with component 8b) or with component 8c), and be defined in a separate FG instead of the basic FG.  ***Proposal-1: For DCI-based beam indication, component 6 should be combined with component 8b) or with component 8c) in a separate FG.***  Considering the basic feature, we prefer to remove component 14 ([The minimum time gap between the beam indication PDCCH and first slot where beam is applied]). Because the corresponding UE capability (timeDurationForQCL) has already been defined in Rel-15. It is not necessary to define a new UE capability in Rel-17.  ***Proposal-2: Component14, i.e. [The minimum time gap between the beam indication PDCCH and first slot where beam is applied], should be removed.***  In Rel-17, although the same beam is used across CCs in the CC list, the interference may be different on each CC. BFR of one CC would not be applied to the other CCs. The restriction on the number of CCs configured with BFR would impact the UE performance. Therefore, it seems no need to introduce a new component for BFR. Component10 in FG should reuse Rel-16 signaling.  ***Proposal-3: Component10, i.e. [Maximum number of CCs configured with BFR], should reuse Rel-16 signaling.***  In RAN1#106-e, the following agreement was achieved on the configuration of TCI state pools:  **Agreement**  On Rel.17 unified TCI framework, confirm the following working assumption as an agreement with a minor refinement highlighted in red  For common TCI state ID update and activation to provide common QCL information at least for UE-dedicated PDCCH/PDSCH and/or common UL TX spatial filter(s) at least for UE-dedicated PUSCH/PUCCH across a set of [configured] CCs/BWPs:   * RRC-configured TCI state pool(s) can be configured in the PDSCH configuration (*PDSCH-Config*) for each BWP/CC as in Rel-15/16   + Note: Such RRC-configured TCI state pool(s) configuration doesn’t imply that separate DL/UL TCI state pool is excluded or supported * RRC-configured TCI state pool(s) can be absent in the PDSCH configuration (*PDSCH-Config*) for each BWP/CC, and replaced with a reference to RRC-configured TCI state pool(s) in a reference BWP/CC   + In the PDSCH configuration (*PDSCH-Config*) of the reference BWP/CC, RRC-configured TCI state pool(s) shall be configured   + For a BWP/CC where the PDSCH configuration contains a reference to the RRC-configured TCI state pool(s) in a reference BWP/CC, the UE applies the RRC-configured TCI state pool(s) in the reference BWP/CC * When the BWP/CC ID (i.e. *bwp-Id* or *cell*) for QCL-Type A/D source RS in a *QCL-Info* of the TCI state is absent, the UE assumes that QCL-Type A/D source RS is in the BWP/CC to which the TCI state applies * Introduce a UE capability to report maximum number of TCI state pools it can support across BWPs and CCs in a band, and the candidate value at least includes 1 * FFS: Introduce a UE capability to report maximum number of configured TCI states that it can support across BWPs and CCs in a band * FFS: How to define reference BWP/CC   According to the above agreement, a UE capability to report maximum number of TCI state pools it can support across BWPs and CCs in a band should be introduced. This has been included by component 12 (The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination]). In our opinon, Alt-1 of component 13 (The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states) is similar as component 12, which is not necessary. Alt-2 of component 13 describes the Rel-17 feature of reference CC, which has been included in component 9. Consequently, Component 13 should be removed.  ***Proposal-4: Component13, i.e. Alt. 1: The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states and Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list, should be removed.***  ***Proposal-5: The UE feaure 23-1-1******is revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-1-1 | Unified TCI [with joint DL/UL TCI update] for intra- [and inter-cell] beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   FFS: whether to include the following components 2-14 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs  FFS: basic FGs for UEs supporting CA  FFS: separate FGs for inter/intra/joint/separate   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states [per BWP per CC] [in a band] ~~[in a band combination]~~ 4. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] ~~[in a band combination]~~ a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] ~~[in a band combination]~~ 5. ~~[The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS]~~ 6. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 7. TCI state indication ~~[mode]~~: update and activation [in case of updates] ~~a)~~ MAC CE based TCI state indication [for one active TCI state] ~~b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)~~ 8. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs) 9. Maximum number of CCs configured with BFR ~~FFS whether this is a component or~~ just a note in the FG to reuse R16 signaling 10. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 11. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] FFS: Whether to make component 9 a prerequisite or merge with 9 12. ~~[Alt. 1: [The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list]~~   ~~[14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied]~~ |  |  |  |  |  | Optional with capability signalling |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-1-1a | DCI-based beam indication for intra- and inter-cell beam management | 1. TCI state indication ~~[mode]~~: update and activation [in case of updates] MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) 2. ~~[~~The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS~~]~~ | 23-1-1 |  |  |  |  | Optional | | 23-1-1b | DCI-based beam indication for intra- and inter-cell beam management | 1. TCI state indication ~~[mode]~~: update and activation [in case of updates]   MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) | 23-1-1a |  |  |  |  | Optional | |
| Nokia, Nokia Shanghai Bell [7] | One major controversial point on FeMIMO UE features is the arrangement of FGs related to unified TCI framework. While RAN1#107bis-e managed to mature a basic set of components for unified TCI framework, we still need to consider how to map those components to one or more FGs. Moreover, one needs to consider what this implies for intra/inter-cell and separate/joint TCI updates.  Before getting into the details of the components mentioned above, it is useful to have a short review on what are the main elements of unified TCI framework, so that one can ensure that the FGs are meaningful and correspond to implementable features in the end, both in UE and network sides.  Basic unified TCI state operation is described below, and illustrated in Figure 1:   * RRC configures set of joint and/or separate TCI states   + Different needs, e.g. to address MPE issue, beam resource allocation flexibility at gNB * MAC activation of up to 8 joint or separate TCI states * DCI indicates one of the activated TCI states/codepoints to be the indicated TCI state ( = common TCI state)   + Before first indication, the first activated TCI state is the current indicated TCI state   + DCI format 1\_1/1\_2 with and without DL assignment   + Indication confirmed by HARQ-ACK by UE   + Application time of the beam indication   + One beam application time (BAT) for a given SCS     Figure 1: Basic operation of unified TCI states  Another essential functionality of unified TCI states is the support for common cross-CC TCI update, described briefly below and exemplified in Figure 2:   * Two cases   1. **RRC-configured TCI state pool(s) can be configured in the PDSCH configuration (PDSCH-Config) for each BWP/CC** as in Rel-15/16      + Source RS in each CC to provide a reference signal for the quasi-colocation for DM-RS of PDSCH, DM-RS of PDCCH and CSI-RS in the CC, and a reference, if applicable, for determining UL TX spatial filter for dynamic-grant and configured-grant based PUSCH and SRS in the CC is associated to source RS of the *indicated* TCI-State   2. RRC-configured TCI state pool(s) can be absent in the PDSCH configuration (PDSCH-Config) for each BWP/CC, and replaced with a reference to **RRC-configured TCI state pool(s) in a reference BWP/CC**      + Source RS of the *indicated* TCI-State provides a reference signal for the quasi-colocation for DM-RS of PDSCH, DM-RS of PDCCH and CSI-RS in the set of configured CCs, and a reference, if applicable, for determining UL TX spatial filter for dynamic-grant and configured-grant based PUSCH and SRS in the set of configured CCs  |  | | --- | |  | | (a) | |  | | (b) |   Figure 2: Cross-CC TCI state update: (a) RRC-configured TCI state pool(s) for each BWP/CC and (b) RRC-configured TCI state pool(s) in a reference BWP/CC.  Finally, UL power control is another key aspect of unified TCI state operation, briefly described below:   * A PL-RS (configured for path-loss calculation) is either included in UL TCI state or (if applicable) joint TCI state or associated with UL TCI state of (if applicable) joint TCI state * For each of PUSCH and PUCCH and SRS, the UL control parameters can be associated with UL TCI state or (if applicable) joint TCI state per BWP   In addition, while it is true that joint TCI state update provides optimized signaling and room for exta TCI states, all use cases for joint TCI state updates can be provided by separate TCI state updates directly. Hence, separate TCI states should be considered as a baseline.  **Proposal: Consider separate TCI state updates as baseline to be supported by UEs supporting Rel-17 unified TCI framework.**  Based on the discussion above, the following mapping can be considered for the essential unified TCI state FGs for joint DL/UL TCI update (component numbers match those in [2] for convenience, updates in red font):   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Index | Feature group | Components | Pre-requisites | Notes | | 23-1-1 | Unified TCI for intra-cell beam management with joint DL/UL TCI update | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)  3. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS  11. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s)  Note: This has no impact on detail signaling design for SRS TCI indication  4. The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination]  6. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS]  7. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS  8. TCI state indication [mode]: update and activation [in case of updates]  a) MAC CE based TCI state indication [for one active TCI state]  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  ~~5. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination]~~  a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination] | 23-1-1c (Separate TCI state update, see below) | Note: Components 3, 11, 6, 7, 8 are common with 23-1-1c (for separate TCI states), and they do not need to be repeated here if 23-1-1c is confirmed as a pre-requisite to 23-1-1. | | 23-1-1a | Multi-CC unified TCI state operation with joint DL/UL TCI update and separate TCI state for each BWP/CC | 2. Common multi-CC TCI update and activation  5. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination]  ~~a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]~~  12. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination]  FFS: Whether to make component 9 a prerequisite or merge with 9 | 23-1-1 | Note: Must be supported if UE supports 23-1-1 and more than 1 CC/BWP | | 23-1-1b | Multi-CC unified TCI state operation with joint DL/UL TCI update and reference BWP/CC | 9. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC  Note: agree component, final wording may change (e.g., when this is merged with other components/FGs)  5. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination]  ~~a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]~~  12. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination]  FFS: Whether to make component 9 a prerequisite or merge with 9 | 23-1-1a |  |   **Proposal: For separate UL/DL TCI state update, the following principles should be followed:**   * **Maximise utilization of FGs defined for joint TCI update case as pre-requisites whenever applicable** * **Support at least one DL and one UL TCI state needs to be ensured if UE supports separate TCI state updates**      |  |  |  |  |  | | --- | --- | --- | --- | --- | | Index | Feature group | Components | Pre-requisites | Notes | | 23-1-1c | Unified TCI for intra-cell beam management with separate DL/UL TCI update | 1. Support of separate DL/UL TCI update (configuration mechanism, applicable source and target signals, including non-serving SSB as direct/indirect QCL source)  3. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS  11. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s)  Note: This has no impact on detail signaling design for SRS TCI indication  4. The maximum number of configured separate TCI states [per BWP per CC] [in a band] [in a band combination]  6. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS]  7. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS  8. TCI state indication [mode]: update and activation [in case of updates]  a) MAC CE based TCI state indication [for one active TCI state]  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  ~~5. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination]~~  a) The maximum number of MAC-CE activated separate TCI states per CC [in a band] [in a band combination], where at least 1 DL and 1 UL TCI activated states need to be supported |  | Separate TCI state update needs to be supported by a UE supporting FG 23-1-1. | | 23-1-1d | Multi-CC unified TCI state operation with separate DL/UL TCI update and separate TCI state for each BWP/CC | 2. Common multi-CC TCI update and activation  5. The maximum number of MAC-CE activated separate TCI states across all CCs [in a band] [in a band combination]  ~~a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]~~  12. The maximum number of configured separate TCI state pools across all BWPs and all CCs in a band [in a band combination]  FFS: Whether to make component 9 a prerequisite or merge with 9 | 23-1-1c | Note: Must be supported if UE supports 23-1-1c and more than 1 CC/BWP | | 23-1-1e | Multi-CC unified TCI state operation with separate DL/UL TCI update and reference BWP/CC | 2. Common multi-CC TCI update and activation  5. The maximum number of MAC-CE activated separate TCI states across all CCs [in a band] [in a band combination]  ~~a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]~~  12. The maximum number of configured separate TCI state pools across all BWPs and all CCs in a band [in a band combination]  FFS: Whether to make component 9 a prerequisite or merge with 9 | 23-1-1d |  | |
| NTT DOCOMO, INC. [7] | We believe FG23-1-1 and FG23-1-2 should be reported per band.  For FG23-1-1, we have the following suggestion:   * Component 4: In Rel.15, the number of configured TCI state for PDSCH per CC is reported, however, the number of configured TCI states across all BWPs/CCs is not reported. Since TCI state is configured per BWP, component 4 should be reported per BWP per CC.   + For the candidate values of component 4, in Rel.15, UE is mandated to report the number of RRC configured TCI states as “64” in FR2 and “the maximum number of allowed SSBs” in FR1. Since Rel.17 unified TCI framework replaces all of Rel.15/16 beam indication mechanism, the mandatory value of Rel.15/16 TCI state should be supported in Rel.17 TCI state. That is, UE is mandated to report the number of RRC configured TCI states per BWP in a CC as “64” in FR2 and “the maximum number of allowed SSBs” in FR1. * Component 5/5a: In Rel.15, the number of activated TCI state for PDSCH per BWP in a CC is reported, however, the number of activated TCI states across all BWPs/CCs is not reported. Hence, component 5/5a should be reported per BWP in a CC. * Component 6/14: Component 6 should be confirmed because RAN1 agreed to introduce the FG. Component 14 is not necessary, because it is redundant. * Component 10: We think this component 10 is not needed. We can reuse Rel.15/16 UE capabilities. * Component 11: For CHs/RSs which cannot share the indicated Rel.17 TCI state, it is inevitable to be indicated Rel.17 TCI state by reusing the Rel-15/16 signaling/configuration design(s), because Rel. 15/16 TCI state and Rel.17 TCI state cannot be configured in the same band. Hence, this should be basic FG. On the other hand, for CHs/RSs which can share the indicated Rel.17 TCI state, whether to support Rel.17 TCI state by reusing the Rel-15/16 signaling/configuration design(s) can be optional FG. To clarify this, we suggest to add “for CHs/RSs which can share the indicated Rel.17 TCI state”. * The basic FGs:   + The basic FGs should be component 3/4/5a/6/8.   + The basic FGs for UEs supporting CA: We believe either CC-common TCI pool configuration or CC-specific TCI pool configuration should be a basic FG for CA. During the RAN1#107bis-e meeting, more number of companies suggest CC-common TCI pool configuration as basic FG, and we are fine with it. Hence, we suggest to make component 2/9 are basic FGs for CA. In this case, we need new component to indicate CC-specific TCI pool configuration. Hence, we suggest to update component 13 to indicate “support of CC-specific TCI pool configuration”. In case UE supports CC-specific TCI pool configuration, UE should support it on all CCs, otherwise it does not work when the number of CCs supported for CA is larger than the number of CCs supported for CC-specific TCI pool configuration.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-1 | Unified TCI with joint DL/UL TCI update for intra- and inter-cell beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   Basic FGs are component 3/4/5a/6/8.  Basic FGs for UEs supporting CA are component 2/9.  FFS: separate FGs for inter/intra/joint/separate   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states per BWP per CC in a band 4. a) The maximum number of MAC-CE activated joint TCI states per BWP per CC in a band 5. The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS 6. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 7. TCI state indication update and activationa) MAC CE based TCI state indication for one active TCI state b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) for more than one active TCI states c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) for more than one active TCI states 8. Support of CC-common TCI pool configuration and reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC 9. Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling 10. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s), for CHs/RSs which can share the indicated Rel.17 TCI state Note: This has no impact on detail signaling design for SRS TCI indication 11. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band  FFS: Whether to make component 9 a prerequisite or merge with 9 12. Support of CC-specific TCI pool configuration. |  |  |  |  | Per band |  |  |  | For component 4, UE supports FG23-1-1 shall report at least “64” in FR2 and “the maximum number of allowed SSBs” in FR1. | Optional with capability signalling | |
| Spreadtrum Communications [9] | In our views, a basic feature is needed for intra-cell beam management. Basic FG includes components 1/4/5/6/8. Besides, components 2/9/12/13 should be in a separate FG which is for CA. While components 3/7/10/11 are additional capabilities which can be grouped into different FGs.  Regarding component 14, noted that this component is not about beam application time, and the capability has been defined in Rel-15 (timeDurationForQCL). It is not necessary to define another UE capability in Rel-17.  ***Proposal 1: For FG 23-1-1, suggest to group the following components as follows,***   * ***Components 1/4/5/6/8 should be in the basic FG*** * ***Components 2/9/12/13 should be in a new FG*** * ***Components 3/7/10/11 should be grouped into multiple FGs different from the above two FGs***   ***Proposal 2: For FG 23-1-1, suggest to remove component 14.*** |
| LG Electronics [10] | **23-1-1**   * FG description: This FG is for ‘joint DL/UL TCI update’ and there should be another FG for ‘separate DL/UL TCI update’. It can also be considered to define separate FGs for inter-cell BM. * Component 3, 4, 5(a), 6, 8(a), 11: These should be included in the basic FG 23-1-1 if basic FG is defined. * Component 8(b), 8(c): These were agreed as optional in RAN1 so these should be in a separate FG. In addition, it was also agreed that UEs supporting TCI state indication by DCI without DL assignment must support TCI state indication by DCI with DL assignment. * Component 2, 9, 12, 13: These belong to separate FG(s) for multi-CC BM. Reference BWP/CC based beam management can be a sub-FG for a general FG for multi-CC BM. In addition, component 12 and 13 can be deleted and merged with component 9 for simplicity. * Component 7: It should be in a separate FG per previous RAN1 agreement * Component 10, 14: We see no need to define these components.   **Proposal 1: Adopt the following table for Rel-17 multi-beam 23-1-1.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-1 | Unified TCI with joint DL/UL TCI updatefor ~~[~~intra- [and inter-cell] beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals) 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination] 4. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination] 5. The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS 6. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] 7. ~~[R17 mechanism reusing R15/16 signalling to indicate~~ Support of indication/configuration of R17 TCI ~~for individual DL channel/RS that cannot share the same unified TCI as UE-dedicated~~ states for aperiodic CSI-RS, PDCCH, ~~/~~PDSCH~~]~~ , and SRS reusing the Rel-15/16 signaling/configuration design(s)  Note: This has no impact on detail signaling design for SRS TCI indication |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-1-1a | TCI state indication by DCI | 1. Support of TCI state indication by DCI in addition to MAC CE based TCI state indication  2. Supported indication method  a) MAC CE+DCI based TCI state indication using DCI formats 1\_1/1\_2 with DL assignment  b) MAC CE+DCI based TCI state indication using DCI formats 1\_1/1\_2 without DL assignment  Note: UEs supporting b) must also support a) |  |  |  |  |  |  |  |  |  |  | | 23. NR\_FeMIMO | 23-1-1b | Multi-CC simultaneous TCI state ID update | 2. Common multi-CC TCI state ID update and activation |  |  |  |  |  |  |  |  |  |  | | 23. NR\_FeMIMO | 23-1-1c | Multi-CC simultaneous TCI state ID update based on single TCI state pool in reference BWP/CC | 9. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC Note: agree component, final wording may change (e.g., when this is merged with other components/FGs) | 23-1-1b |  |  |  |  |  |  |  |  |  | | 23. NR\_FeMIMO | 23-1-1d | Beam misalignment for PL RS | 7. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS |  |  |  |  |  |  |  |  |  |  | |
| Intel Corporation [11] | On unified TCI framework we have the following comments:   * FG 23-1-1 should be applicable to both intra-cell and inter-cell unified TCI framework without differentiation * Define basic FG 23-1-1 as collection of components 1, 4, 5 (minimum candidate value of 2 should be supported for 5a), 6, 8 (w/o candidate values), 11 * Component 6 should be supported as it is essential UE capability that was already agreed and would be used to determine RRC configuration for BAT * For component 5a, the minimum candidate value should be at least 2 to take advantage of unified TCI framework for latency reduction and inter-cell beam management * It should be clarified that component 8a is only applicable to one active TCI state * Components 9 and 12 should be captured in separate FGs, where no indication of component 12 would mean support of PDSCH-Configs containing TCI state list for all CCs. * Component 14 is not required.   The proposed modifications are provided below.   |  |  |  | | --- | --- | --- | | 23-1-1 | Unified TCI ~~[with joint DL/UL TCI update]~~ for ~~[~~intra- ~~[~~and inter-cell~~]~~ beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   ~~FFS: whether to include the following components 2-14 into this FG or one or more separate FGs~~  ~~FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs~~  ~~FFS: basic FGs for UEs supporting CA~~  ~~FFS: separate FGs for inter/intra/joint/separate~~   1. ~~Common multi-CC TCI update and activation~~ 2. ~~For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS~~ 3. The maximum number of configured joint TCI states ~~[~~per BWP per CC~~]~~ ~~[in a band]~~ ~~[in a band combination]~~ 4. The maximum number of MAC-CE activated joint TCI states across all CCs ~~[~~in a band~~]~~ ~~[in a band combination]~~ a) The maximum number of MAC-CE activated joint TCI states per CC ~~[~~in a band~~]~~ ~~[in a band combination]~~ 5. ~~[~~The minimum beam application time between PUCCH of ACK to beam indication DCI and the first slot in Y symbols per SCS~~]~~ 6. ~~Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS~~ 7. TCI state indication ~~[mode]~~: update and activation ~~[in case of updates]~~ a) MAC CE based TCI state indication ~~[~~for one active TCI state~~]~~ b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 8. ~~Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC Note: agree component, final wording may change (e.g., when this is merged with other components/FGs)~~ 9. ~~Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling~~ 10. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 11. ~~The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] FFS: Whether to make component 69 a prerequisite or merge with 69~~ 12. ~~[Alt. 1: [The maximum number of PDSCH-Configs containing configured joint TCI states across all BWPs and all CCs in a band] [in a band combination] that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list]~~ 13. ~~[The minimum time gap between the beam indication PDCCH and first slot where beam is applied]~~ 14. Support of separate DL/UL TCI state | | 23-1-1a | Common multi-CC TCI update and activation | 1. Support of common multi-CC TCI update and activation | | 23-1-1b | Association between TCI state and UL PC settings | 1. Support of association between TCI state and UL PC settings for PUCCH, PUSCH, and SRS, except for PL RS | | 23-1-1c | Common TCI state list across CCs/BWPs | 1. Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list 2. The maximum number of PDSCH-Configs containing TCI state list across all BWPs and all CCs in a band | |
| Apple [12] | For the remaining issues on elements for joint TCI for intra-cell operation, our view is provided as follows:   1. void 2. void 3. void 4. Support to use “in a band” to be aligned with element 12 5. Support to use “in a band”, since CCs in a band should share the same antenna, and this FG is related to beam tracking capability 6. Support this element, which has already been agreed 7. void 8. Support to include the word “mode” as it is related to the different beam indication schemes, for other words, we failed to see necessity 9. void 10. Support to have a separate element with regard to the band with PCell + SCell 11. void 12. Support to define it per band to be aligned with agreements, and component 9 can be considered as a candidate value for this element 13. We think this is redundant compared to element 12 14. We are open to this element   **Proposal 1.1-1: Support the following change for the remaining issues for “joint TCI for intra-cell operation”**   1. **Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)** 2. **Common multi-CC TCI update and activation** 3. **For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS** 4. **The maximum number of configured joint TCI states in a band** 5. **The maximum number of MAC-CE activated joint TCI states across all CCs in a band a) The maximum number of MAC-CE activated joint TCI states per CC in a band** 6. **The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS** 7. **Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS** 8. **TCI state indication mode: update and activation a) MAC CE based TCI state indication  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)** 9. **Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs)** 10. **Maximum number of CCs configured with BFR** 11. **Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication** 12. **The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band**   **[14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied]**  For FG splitting, the following is proposed with regard to reporting granularity and functionality.  **Proposal 1.1-2: The FG for joint TCI for intra-cell operation should be organized as follows:**   * **FG 23-1-1: Element 1, which is reported per UE with FR1/FR2 differential** * **FG 23-1-1a (TCI configuration/activation in CA): Element 2, 4, 5, 9, and 12, which is reported per band** * **FG 23-1-1b (Power control): Element 3 and 7, which is reported per UE with FR1/FR2 differential** * **FG 23-1-1c (Beam indication): Element 6, 8, and 11, which is reported per band** * **FG 23-1-1d (BFR): Element 10, which is reported per band**   For separate TCI for intra-cell operation, similar to joint TCI, the TCI counting should consider UL/DL TCI states, and the following is proposed:  **Proposal 1.1-3: Support the following feature list for separate TCI for intra-cell operation**  **1. Separate DL/UL TCI update with their components**  **2-7. Reuse component 2, 3, 6, 7, 8, 9, and 10 from feature list for joint TCI for intra-cell operation**  **8. The maximum number of configured DL TCI state pools across all BWPs and all CCs in a band**  **9. The maximum number of configured UL TCI state pools across all BWPs and all CCs in a band**  **10. The maximum number of configured DL TCI states across all BWPs and all CCs in a band**  **11. The maximum number of configured UL TCI states across all BWPs and all CCs in a band**  **12. The maximum number of configured DL+UL TCI states across all BWPs and all CCs in a band**  **13. The maximum number of configured DL TCI states per BWP**  **14. The maximum number of configured UL TCI states per BWP**  **15. The maximum number of configured DL+UL TCI states per BWP**  **16. The maximum number of MAC CE activated DL TCI states across all CCs in a band**  **17. The maximum number of MAC CE activated UL TCI states across all CCs in a band**  **18. The maximum number of MAC CE activated DL+UL TCI states across all CCs in a band, and a DL and UL TCI is counted as 1 if they share the same QCL source (reuse the same rule for FG 2-62)**  For join TCI for inter-cell operation, the default beam to receive signals from different cells and CORESET C should be features to be considered, and the following is proposed  **Proposal 1.1-4: Support the following feature list for joint TCI for inter-cell operation**  **1-12. Reuse 1-12 from joint TCI for intra-cell operation**  **13. Support of a CORESET associated with at least a Type3 CSS/USS and at least a Type 0/0a/1/2 CSS**  **14. Support of a PDSCH scheduled by PDCCH in Type3 CSS or USS with scheduling offset smaller than threshold reported in FG 2-2**  **15. Support of aperiodic CSI-RS with scheduling offset smaller than threshold reported in FG 2-28**  For separate TCI for inter-cell operation, similar to separate TCI for intra-cell operation, the TCI counting should consider UL/DL TCI and the default beam and CORESET C issue for inter-cell operation should be considered, and the following is proposed.  **Proposal 1.1-5: Support the following feature list for separate TCI for inter-cell operation**  **1-18. Reuse 1-18 for separate TCI for intra-cell operation in proposal 2**  **19-21. Reuse 13-15 for joint TCI for inter-cell operation in proposal 3**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-1 | Unified TCI [with joint DL/UL TCI update] for intra- [and inter-cell] beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   FFS: whether to include the following components 2-14 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs  FFS: basic FGs for UEs supporting CA  FFS: separate FGs for inter/intra/joint/separate   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states in a band 4. The maximum number of MAC-CE activated joint TCI states across all CCs in a band a) The maximum number of MAC-CE activated joint TCI states per CC in a band 5. The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS 6. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 7. TCI state indication mode: update and activation a) MAC CE based TCI state indication  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 8. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs) 9. Maximum number of CCs configured with BFR 10. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 11. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band   [14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied]  ***FG splitting:***   * **FG 23-1-1: Element 1, which is reported per UE with FR1/FR2 differential** * **FG 23-1-1a (TCI configuration/activation in CA): Element 2, 4, 5, 9, and 12, which is reported per band** * **FG 23-1-1b (Power control): Element 3 and 7, which is reported per UE with FR1/FR2 differential** * **FG 23-1-1c (Beam indication): Element 6, 8, and 11, which is reported per band** * **FG 23-1-1d (BFR): Element 10, which is reported per band**   **Additional FGs for joint TCI for inter-cell BM, joint/separate TCI for intra-cell/inter-cell BM are required.** |  |  |  |  |  |  |  |  | 1. Candidate value: {Support, not support}  2. Candidate value: {Support, not support}  3. Candidate value: {Support, not support}  4. Candidate value: {4, 8, 16, 24, 32, 64, 128}  5. Candidate value: {1, 2, 4, 8}  5a. Candidate value: {1, 2, 4, 8}  6. Candidate value: {14, 28, 42}  7. Candidate value: {Support, not support}  8. Candidate value: {MAC CE, MAC CE + DCI 1\_1/1\_2 with data, MAC CE + DCI 1\_1/1\_2}  9. Candidate value: {Support, not support}  10. Candidate value: {1, 2, 4, 8}  11. Candidate value: bitmap where the bits indicate support of {aperiodic CSI-RS for BM, aperiodic CSI-RS for CSI, non-UE dedicated PDCCH/PDSCH, SRS for CB, SRS for NCB, SRS for antenna switching, SRS for BM}  12. Candidate value: {1, 2, 3, 4} | Optional with capability signalling | |
| CMCC [13] | For component 6 and 8, we suggest to remove the bracket.  For component 10, we suggest to remove it. Reuse R16 signaling is sufficient.  We think component 2, 9 ,12 ,13 are related with common TCI state update for multi-CC, and these components can be a separate FG. For the TCI state pool for CA, two options have been agreed. Option 1 is to share a single TCI state pool for the set of configured CCs, and option 2 is to configure RRC TCI state pool per individual CC. We propose to do not merge component 2 and component 9, and do not make component 9 as a prerequisite for component 12. Regarding component 13, we suggest to adopt Alt2. The description of Alt1 is overlapped with component 12.  Besides, we think if a UE support unified TCI, it should support both joint TCI and separate TCI. The FG of Unified TCI with separate DL/UL TCI update should be discussed.  ***Proposal 1: For FG 23-1-1, suggest to adopt the following changes.***   * ***For component 6 and 8, remove the bracket*** * ***Remove component 10*** * ***Put component 2, 9 ,12 ,13 for a separate FG for common TCI state update*** * ***For component 13, remove Alt1*** |
| Xiaomi [14] | First, as for the title of 23-1-1, since there is a separate FG for inter cell, and the component 1 includes only joint DL/UL TCI state, we prefer to revise it to “Unified TCI with joint DL/UL TCI state for intra-cell beam management”.  Second, we prefer separate FGs for joint and separate DL/UL TCI state.  Third, for component 13, we prefer Alt 1.  Last for other components, we prefer to split as below:   * Component 8a can be included in a basic FG * Component 4 and 5a can be included in a separate basic FG with per band report * Component 2, 5, 9, 12, 13 can be included in a separate FG for CA * Component 8b/c, 14 can be included in a separate FG for DCI based unified TCI state indication.   ***Proposal 1: Revise the title of FG23-1-4 to “Unified TCI with joint DL/UL TCI state for intra-cell beam management”.***  ***Proposal 2: Prefer separate FGs for joint and separate DL/UL TCI state.***  ***Proposal 3: Prefer to split other components as below:***   * Component 8a can be included in a basic FG * Component 4 and 5a can be included in a separate basic FG with per band report * Component 2, 5, 9, 12, 13 can be included in a separate FG for CA * Component 8b/c, 14 can be included in a separate FG for DCI based unified TCI state indication. |
| Samsung [15] | Regarding the name of FG 23-1-1 which is a basic feature that enables the unified TCI framework for both intra-cell and inter-cell beam management, we support to remove bracket for “[and inter-cell]” in the name of FG to confirm that this FG can enable basic functionalities for both intra- and inter-cell beam management for Unified TCI. Also, we would like to delete [with joint DL/UL TCI update] in order not to make fragment UE capabilities.  **Proposal 1:** Remove the bracket for “[and inter-cell]” in the name of FG and delete “[with joint DL/UL TCI update]” to support functionalities for both intra- and inter-cell beam management, and also for both joint and separate DL/UL TCI update for Unified TCI based on FG 23-1-1.   |  | | --- | | 1. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS |   Regarding the description of Component 7 for FG 23-1-1 as above, we do not support to include beam alignment related parameters/proposals for PLRS until we have a RAN1 agreement.  **Proposal 2:** Do not support Component 7 without the corresponding RAN1 agreement.   |  | | --- | | 6. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] |   Regarding Component 6 for FG 23-1-1 as above, we support the component for minimum beam activation latency (Y symbols). The candidate values for the minimum Y per SCS can be discussed further. Note that Y is configurable by the NW.  **Proposal 3:** Support Component 6, i.e., “The minimum beam application time in Y symbols”, and the candidate values per SCS can be discussed further.   |  | | --- | | 1. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination] 2. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) |   Regarding the Component 5 and 8 for FG 23-1-1 as above, a UE that supports Rel-17 unified TCI framework should support at least 4 activated TCI states by MAC-CE+DCI-based TCI indication with and without DL assignment for both intra-cell and inter-cell beam management (as a basic feature).  In addition, TCI state indication (8) depends on the maximum number of MAC-CE activated TCI states as described below:   * When the maximum number of MAC-CE activated TCI states is one, MAC-CE based TCI state indication applies * When the maximum number of MAC-CE activated TCI states is more than one, MAC-CE+DCI-based TCI state indication applies   Therefore, 5 and 8 can be combined (for clarity and conciseness) into one item.  **Proposal 4:** On TCI state indication and maximum number of MAC-CE activated joint TCI states:   * As a Rel-17 TCI basic feature, support 4 activated TCI states by MAC-CE+DCI-based TCI indication with and without DL assignment for both intra-cell and inter-cell beam management. * Merge 5 and 8 as follows:  |  | | --- | | 5’. The maximum number of MAC-CE activated joint TCI states per CC and the associated TCI state indication mode (activation and update):   1. When the maximum number of MAC-CE activated TCI states is one, MAC-CE based TCI state indication applies 2. When the maximum number of MAC-CE activated TCI states is more than one, MAC-CE+DCI-based TCI state indication applies (using DCI formats 1\_1/1\_2 with or without DL assignment) |   Regarding the Component 4 and 12 for FG 23-1-1 as below,   |  | | --- | | 1. The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination]   12. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] |   For FG 23-1-1, in order to avoid duplicated functionality for the “counting” features as above components 4 and 12., e.g., if UE supports *N* TCI states for intra-cell, it should support *N* for inter-cell as well.  **Proposal 5:** Supportsame value for “counting” features for both intra-cell and inter-cell beam management.  For both FG 23-1-1 and 23-1-2, which are considered as basic features for Rel-17 TCI framework, we would like to propose the signalling granularity as per band based on two reasons. First reason is that based on working assumption in RAN1#107-e, the UE is not expected to be configured with Rel-15/Rel-16 TCI/*SpatialRelationInfo* if the UE is configured with Rel-17 TCI in any CC in a band. Second reason is that according to RAN2 guidance, the UE features which have “per-band combination” or “per-band per band combination” should be minimized. Hence, “per band” granularity is quite natural starting point to consider for those basic features.  **Proposal 7:** SupportFG 23-1-1 and FG 23-1-2 as basic features and per-band granularity. |
| MediaTek Inc. [16] | Regarding FG 23-1-1, the following component is agreed:   1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   Other than this component, we think the following components should be included in FG 23-1-1 as well:   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination] 4. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] 5. The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination] 6. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] 7. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)   Regarding component 2 in current FG 23-1-1, we don't think a separate FG is needed for UEs supporting CA. Instead, we can clarify in this component that it is supported when UE supports CA operation, e.g.,   * Common multi-CC TCI update and activation if the UE supports CA   Regarding component 4 in current FG 23-1-1, following the principle of Rel-15/16 UE capability, the maximum number of configured joint TCI states is reported per BWP per CC. We suggest the following change:   * The maximum number of configured joint TCI states ~~[~~per BWP per CC~~] [in a band] [in a band combination]~~   Regarding component 5 in current FG 23-1-1, the maximum number of MAC-CE activated joint TCI states across all CCs should be reported per band. Meanwhile, we'd like to clarify the MAC-CE activated joint TCI states should include the activated joint TCI states for ALL PDCCH/ PDSCH/PUSCH/PUCCH receptions. We suggest the following change:   * The maximum number of MAC-CE activated joint TCI states for all PDCCH/PDSCH/PUSCH/PUCCH receptions across all CCs ~~[~~in a band~~]~~ ~~[in a band combination]~~   Regarding component 5a in current FG 23-1-1, since the component is already agreed to be reported per CC, “in band” and “in a band combination” are redundant. Meanwhile, we'd like to clarify the MAC-CE activated joint TCI states should include the activated joint TCI states for ALL PDCCH/ PDSCH/PUSCH/PUCCH receptions. We suggest the following change:   * The maximum number of MAC-CE activated joint TCI states for all PDCCH/PDSCH/PUSCH/PUCCH receptions per CC ~~[in a band] [in a band combination]~~   Regarding component 6 in current FG 23-1-1, the wording is incorrect. The definition of Y symbols is not the offset between PUCCH of ACK and the first slot. In order to avoid confusion, We suggest the following change:   * The minimum beam application time ~~between PUCCH of ACK and the first slot~~ in Y symbols per SCS  |  | | --- | | **Agreement**  On Rel-17 DCI-based beam indication, regarding application time of the beam indication, the first slot to apply the indicated TCI is at least Y symbols after the last symbol of the acknowledgment of the joint or separate DL/UL beam indication.   * Note: The Y symbols are configured by the gNB based on UE capability, which is also reported in units of symbols. |   **Proposal 1: The following components should be included/kept in FG 23-1-1**   1. **Common multi-CC TCI update and activation if the UE supports CA** 2. **For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS** 3. **The maximum number of configured joint TCI states ~~[~~per BWP per CC~~]~~ ~~[in a band] [in a band combination]~~** 4. **The maximum number of MAC-CE activated joint TCI states for all PDCCH/PDSCH/PUSCH/PUCCH receptions across all CCs ~~[~~in a band~~]~~ ~~[in a band combination]~~** 5. **The maximum number of MAC-CE activated joint TCI states for all PDCCH/PDSCH/PUSCH/PUCCH receptions per CC ~~[in a band] [in a band combination]~~** 6. **~~[~~The minimum beam application time ~~between PUCCH of ACK and the first slot~~ in Y symbols per SCS~~]~~** 7. **TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)**  |  |  |  | | --- | --- | --- | | 23-1-1 | Unified TCI ~~[~~with joint DL/UL TCI update~~]~~ for intra-cell~~[and inter-cell]~~ beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals) 2. Common multi-CC TCI update and activation if the UE supports CA 3. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 4. The maximum number of configured joint TCI states ~~[~~per BWP per CC~~]~~ ~~[in a band] [in a band combination]~~ 5. The maximum number of MAC-CE activated joint TCI states for all PDCCH/PDSCH/PUSCH/PUCCH receptions across all CCs ~~[~~in a band~~]~~ ~~[in a band combination]~~ 6. ~~5a.~~ The maximum number of MAC-CE activated joint TCI states for all PDCCH/PDSCH/PUSCH/PUCCH receptions per CC ~~[in a band] [in a band combination]~~ 7. ~~6. [~~The minimum beam application time ~~between PUCCH of ACK and the first slot~~ in Y symbols per SCS~~]~~ 8. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) |   Regarding component 7 in current FG 23-1-1, this should be included in a separate FG.  **Proposal 2: Component 7 in current FG 23-1-1 should be included in a separate FG 23-1-1a**   |  |  |  | | --- | --- | --- | | 23-1-1a | **Beam misalignment** | 1. **~~7.~~ Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS** |   Regarding components 9, 12, and 13 in current FG 23-1-1, they can be included in a separate FG. However, they can be merged and modified.  **Proposal 3: Component 9, 12, and 13 in current FG 23-1-1 should be included and merged in a separate FG 23-1-1b**   |  |  |  | | --- | --- | --- | | 23-1-1b | Common TCI state pool | 1. ~~Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC~~   ~~Note: agree component, final wording may change (e.g., when this is merged with other components/FGs)~~   1. ~~The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] FFS: Whether to make component 69 a prerequisite or merge with 69~~ 2. ~~[Alt. 1: [The maximum number of PDSCH-Configs containing configured joint TCI states across all BWPs and all CCs in a band] [in a band combination] that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list]~~ 3. **Support PDSCH-Config which contains a reference to another CC/BWP in which the PDSCH-Config contains the TCI state list** 4. **The maximum number of PDSCH-Configs containing TCI states across all BWPs and all CCs in a band if any PDSCH-Config contains a reference to another CC/BWP in the band** |   Regarding component 11 in current FG 23-1-1, this should be included in a separate FG. However, something need be clarified in this FG. The following signals need to be should be precluded from this component/FG since RAN1 never agrees they can share the indicated Rel-17 TCI state, i.e., UE should support the Rel-15/16 signaling/configuration to provide Rel-17 TCI states for them anyway.   * AP CSI-RS for tracking * P/SP SRS for BM   **Proposal 4: The following components should be included in FG 23-1-1c**   |  |  |  | | --- | --- | --- | | 23-1-1c | Indication/configuration of R17 TCI states reusing the Rel-15/16 signaling/configuration design(s) | 1. ~~11.~~ Support of indication/configuration of R17 TCI states for aperiodic CSI-RS (expect aperiodic CSI-RS for tracking), PDCCH, PDSCH, and SRS (expect periodic/semi-persistent SRS for BM) reusing the Rel-15/16 signaling/configuration design(s) |   Regarding component 10 in current FG 23-1-1, we don't see the need to have this component in any FG. Rel-15/16 UE capability allows UE to report the maximum number of CCs configured with BFR. Moreover, this is not even discussed in Rel-17 FeMIMO.  Regarding component 14 in current FG 23-1-1, we also don't see the need to have this component in any FG. Component 6 (already agreed by RAN1) should be sufficient.  **Proposal 5: Not support Component 10 and 14 in current FG 23-1-1 in any FG**  Meanwhile, FG 23-1-1 should be the FG only for unified TCI with joint DL/UL TCI update for intra-cell BM. For separate DL/UL TCI update and unified TCI for inter-cell BM, we prefer to have separate FGs for them, and these FGs only capture the additional functionalities that need to be supported on top of FG 23-1-1.  **Proposal 6: FG 23-1-1 should be the FG only for unified TCI with joint DL/UL TCI update for intra-cell beam management**  **Proposal 7: Support a separate FG (e.g., FG 23-1-1d) for separate DL/UL TCI update**   |  |  |  | | --- | --- | --- | | 23-1-1d | Unified TCI with separate DL/UL TCI update for intra-cell beam management | 1. Separate DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals) 2. The maximum number of configured DL TCI states per BWP per CC 3. The maximum number of configured UL TCI states per BWP per CC 4. The maximum number of MAC-CE activated DL TCI states for all PDCCH/PDSCH receptions across all CCs in a band 5. The maximum number of MAC-CE activated UL TCI states for all PUSCH/PUCCH receptions across all CCs in a band 6. The maximum number of MAC-CE activated DL TCI states for all PDCCH/PDSCH receptions per CC 7. The maximum number of MAC-CE activated UL TCI states for all PUSCH/PUCCH receptions per CC |   **Proposal 8: Support a separate FG (e.g., FG 23-1-1e) for unified TCI for inter-cell BM**   |  |  |  | | --- | --- | --- | | 23-1-1e | Unified TCI for inter-cell beam management | 1. Support of SSB associated with PCI different from serving cell PCI is used as an indirect QCL reference for DL TCI (in case of separate DL/UL TCI) or joint TCI, or an indirect/direct QCL reference for UL TCI (in case of separate DL/UL TCI) 2. The maximum number of PCI(s) (including that of the serving cell) that can be associated with activated TCI states for UE-dedicated PDCCH/PDSCH and PUSCH/PUCCH | |
| Lenovo [17] | Component 9 in FG 23-1-1 indicates whether a UE can be configured a reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC, so alt 1 is preferred for component 13.   1. For FG 23-1-1, alt 1 is preferred for component 13, i.e., the maximum number of PDSCH-Configs containing that can be referred to from a PDSCH-Config without TCI states   For component 8 in FG 23-1-1, more clarification is needed on whether more than one TCI state indication mode can be reported by a UE. For example, both 8. b) and 8.c) may be supported by a UE.   1. Clarification of component 8 of FG 23-1-1 is needed, whether more than one TCI state indication mode can be reported by a UE |
| Qualcomm Incorporated [18] | ***Proposal 2-1***: For FG 23-1-1 on the joint TCI for intra-cell operation (R1-2200780), suggest to consider the following changes.   * Different combinations of TCI types and intra/inter-cell BM should have different FGs, because communication can work with only 1 combination, e.g. joint TCI + intra-cell BM   + Separate FG for joint TCI + intra-cell BM   + Separate FG for joint TCI + inter-cell BM   + Separate FG for separate TCI + intra-cell BM   + Separate FG for separate TCI + inter-cell BM * For component 2, 3, 7, 8-b, 8-c, 9, 11, 12, 13, they are not must-have features, and can be in a separate FG * For component 4, 5, 6, 8-a, they can be basic features, and can be merged into FG 23-1-1 * For component 4   + Prefer “per BWP per CC” than “per CC”, which is inaccurate in legacy description to our understanding   + Prefer “in a band”, which is same as legacy definition * For component 5   + Prefer “in a band”, which is same as legacy definition * For component 8   + Prefer to keep “mode”, since the 3 sub-components correspond to 3 modes to our understanding   + Prefer to remove “in case of updates”, which seems redundant   + Sub-component 8-a can be basic feature, while 8-b and 8-c should be optional * For component 9, 12, 13, suggest to merge them into a single component as below   + Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list.     - If support, UE also reports the maximum number of PDSCH-Configs containing TCI states if any PDSCH-Config contains a reference to another CC/BWP |
| Ericsson [19] | The work in the multi-beam agenda targets to develop a more efficient TCI framework. Unnecessary flexible configurations are removed, and the signalling mechanisms for the critical parts are streamlined. However, this work has led to that some Rel-15/16 functionality has been replicated, and based on this replicated functionality, enhancements have been added.  It may be tempting to define a basic level of functionality that contains only the replicated functionality. This would bring the Rel-17 TCI framework on par with the Rel-15/16 functionality and would lead to a functional feature. However, there is no incentive for an operator to deploy only the replicated functionality, and there is no incentive for a NW vendor to implement only the replicated functionality:   1. There is no incentive for a NW vendor to implement only the parts of the Rel-17 TCI framework that replicated the Rel-15/16 functionality.   Based on Observation 1, we conclude that a UE that supports the Rel-17 TCI framework must also support enhancements on top of the replicated functionality:   1. A UE that supports the Rel-17 TCI framework must support enhancements relative the Rel-15/16 TCI framework: it is not sufficient to support only the replicated functionality.   To reiterate: no NW will implement *only* the duplicated functionality. There is no point that a UE only implements and advertises support for the replicated functionality. This would be a useless paper product.  A UE that supports the Rel-17 TCI framework would thus have to also support enhancements. Overall, the Rel-17 TCI framework supports two main performance enhancements:   * DCI-based TCI state update for all channels * Inter-cell beam management   To make the Rel-17 TCI framework attractive for an operator to deploy and attractive for a NW vendor to implement, the basic level of UE support should include both DCI-based TCI state update and inter-cell beam management:   1. A UE that supports the Rel-17 TCI framework should support both DCI-based TCI state update and inter-cell beam management.   The support described in Proposal 1 could be on a minimum level: for example, DCI-based TCI state update requires that the UE supports two active TCI states – but not more than that. Inter-cell beam management would require that the UE can measure on SSBs associated with one PCI different from the serving cell PCI – but not more than one. More advanced UEs could then advertise larger values for these capabilities.  During RAN1#107bis-e, several new agreements were made, and captured into the placeholder FG 23-1-1. This placeholder still contains a few highlighted items, which we will address in this section.  The first proposal addresses the name of the feature group. In line with Proposal 1, we propose to remove the highlighting and brackets in the feature group name, to clarify that the components are applicable to both intra-cell and inter-cell beam operation:   1. Remove the highlighting and brackets in the feature group name for FG 23-1-1.   In the agreed list of features, component 1 includes the basic functionality for the Rel-17 TCI framework. The next highlighted issue is related to which additional components should be included in the basic functionality. Again, referring to Proposal 1, we propose to include the DCI-based TCI state update, i.e., component 8, in the basic functionality. Also, we prefer to include component 2 (Common multi-CC TCI update and activation) in the basic functionality:   1. Include component 2 and 8 as part of the basic functionality in FG 23-1-1.   This means that components 3, 7 and 11 are not included in the basic functionality and will be signalled separately. Of course, “numerical” capabilities must also be signalled separately.  In components 4, 5 and 5a, the text “[in a band][in a band combination]” are highlighted. This would see to refer to the type, and should be removed from the component description:   1. Remove “[in a band][in a band combination]” from the description for component 4, 5 and 5a in FG 23-1-1.   The type is a separate discussion, and here we prefer that to define the UE feature per band, in accordance with the RAN2 guidance.  Component 4 should match how the NW configures TCI states, which is per BWP. Hence, in the description of component 4, “per BWP” should be included.  Component 6 is the UE feature that corresponds to the RRC parameter *beamAppTime-r17*. The description is correct, and hence we propose to remove the brackets and highlighting:   1. Remove the brackets and highlighting in component 6 in FG 23-1-1.   In component 8, some highlighting remains. As we see it, the highlighted text is unnecessary, and we would prefer to remove it: it only makes the component difficult to understand.  The next highlighting refers to components 9, 12 and 13, all of which refers to the functionality where TCI states are only defined in one PDSCH-Config across several CCs and BWPs. In PDSCH-Configs where no TCI states are defined, a pointer to another CC/BWP is included. The UE would then instead use the TCI states configured in the PDSCH-Config in that other CC/BWP. After some offline discussion during RA1#107bis-e, a proposal was formulated which would replace components 9, 12 and 13. Thus we propose   1. Replace components 9, 12 and 13 in FG 23-1-1 with the following component:  **Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list.**  * **If support, UE also reports the maximum number of PDSCH-Configs containing TCI states if any PDSCH-Config contains a reference to another CC/BWP**   Now turning to component 10, which proposes to introduce a limitation on the total number of CCs configured with BFR. For this component, there is no relation to the Rel-17 TCI framework. The motivation that was brought forward was that this component would change the interpretation of a Rel-16 feature. This will not work: the NW will not check Rel-17 UE features to enable Rel-16 features. If necessary, a Rel-16 CR could be considered. In any case, component 10 should be removed:   1. Remove component 10 in FG 23-1-1 since this is not related to the Rel-17 TCI framework.   The final highlighted component is component 14. There is no need for this component since component 6 provides the required information. Component 14 can be removed.  Summing up, we propose the following modification of the components in the 23-1-1 placeholder:   |  |  | | --- | --- | | Unified TCI ~~[~~with joint DL/UL TCI update~~]~~ for intra- ~~[~~and inter-cell~~]~~ beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   ~~FFS: whether to include the following components 2-14 into this FG or one or more separate FGs~~  ~~FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs~~  ~~FFS: basic FGs for UEs supporting CA~~  ~~FFS: separate FGs for inter/intra/joint/separate~~   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states ~~[~~per BWP ~~per CC]~~ ~~[in a band] [in a band combination]~~ 4. The maximum number of MAC-CE activated joint TCI states across all CCs ~~[in a band] [in a band combination]~~ a) The maximum number of MAC-CE activated joint TCI states per CC ~~[in a band] [in a band combination]~~ 5. ~~[~~The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS~~]~~ 6. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 7. TCI state indication ~~[mode]~~: update and activation ~~[in case of updates]~~ a) MAC CE based TCI state indication ~~[for one active TCI state]~~ b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 8. **Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list.**    1. **If support, UE also reports the maximum number of PDSCH-Configs containing TCI states if any PDSCH-Config contains a reference to another CC/BWP**  ~~Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC Note: agree component, final wording may change (e.g., when this is merged with other components/FGs)~~ 9. ~~Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling~~ 10. Support of indication/configuration of R17 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 11. ~~The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] FFS: Whether to make component 9 a prerequisite or merge with 9~~ 12. ~~[Alt. 1: [The maximum number of PDSCH-Configs containing TCI states that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in~~ which the PDSCH-Config contains the TCI state list]   ~~[14. The minimum time gap between the beam indication PDCCH and first slot where beam is applied]~~ |   No components have been agreed for separate UL/DL TCI. The assumption is FG 23-1-1 can be used as a starting point to define such components.  Since it is unlikely that separate UL/DL TCI is implemented early, it would make sense that separate UL/DL TCI is a separate FG, to facilitate IODT:   1. Separate DL/UL TCI is a separate FG, and joint DL/UL TCI is a prerequisite FG.   A straightforward extension of component 1 is to replace “joint” with “separate”. However, one additional modification would make sense. Note that SRS is a valid source RS for UL TCI, and that SRS cannot be used as a PL RS. Defining beam alignment between SRS and a DL RS is non-trivial, since in the most realistic case, the SRS is configured without any relation to a DL RS. Based on this argument, we assume that a UE that supports separate DL/UL TCI would have to also support an arbitrary PL RS:   1. The basic component for ‘separate DL/UL TCI’ would be: “Separate DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals, support for beam misalignment)”   Some of the components discussed in subsection 2.1.1 are related to the number of TCI states, both configured and activated.  Since joint DL/UL TCI is a prerequisite FG for the separate DL/UL TCI, and a joint DL/UL TCI is identical to a DL TCI state from a configuration point of view, we propose   1. A UE that supports separate UL/DL TCI states supports the same number of configured DL TCI states as configured joint TCI states.   Of course, there is no need to introduce a separate component – the number reported under FG 23-1-1 can be reused. However, it is required that the UE reports how many configured UL TCI states it supports:   1. A UE that supports separate UL/DL TCI states reports how many configured UL TCI states it supports in addition to the number of joint/DL TCI states.   Note that the number of configured TCI states that are needed is not reduced with the introduction of separate DL/UL TCI. The same is true for the activated TCI states: the number of activated DL TCI states that are needed is not reduced with the introduction of UL TCI states. Hence, we have the corresponding proposals for the activated TCI states:   1. A UE that supports separate DL/UL TCI states supports the same number of activated DL TCI states as activated joint TCI states. 2. A UE that supports separate DL/UL TCI states reports how many activated UL TCI states it supports in addition to the number of activated joint TCI states.   In [2], the UL TCI states are now defined in the UL BWP. It would thus make sense to define UE features for the maximum number of UL TCI states per BWP and the total maximum number of UL TCI states across all CCs:   1. Introduce components for the maximum number of TCI states per BWP and across all CCs.   We note that there is no agreement on any pool of UL TCI states, nor any agreement on a reference CC for UL TCI states:   1. There is currently no agreement on any UL TCI state pool, and it is premature to define any UE features related to such a pool.   In summary, we propose the following components for separate DL/UL TCI:   |  |  | | --- | --- | | Unified TCI with separate DL/UL TCI update for intra- and inter-cell beam management | 1. Separate DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals, beam misalignment) 2. The maximum number of RRC configured UL TCI states per BWP 3. The maximum number of RRC configured UL TCI states across all CCs 4. The maximum number of activated UL TCI states per BWP 5. The maximum number of activated UL TCI states across all CCs | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  2. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] (FFS: if K is a component candidate value)  3. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement)  [4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]]  [5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]]  [6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]  [7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]  [8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]  [9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]  [10. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]  [11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]  [12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]  [13.[The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)] | [2-24, 2-29] |  |  |  | [per band] |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] | As discussed in RAN1#106bis-e, regarding the number of RRC-configured PCI(s) different from serving cell PCI for beam measurement, it is agreed that two independent X values (X1, X2) are reported as UE capability for two different assumptions on additional SSB time domain position and periodicity with respect to serving cell SSB. In addition, it was agreed that this UE capability has FR1 and FR2 differentiation. Considering UE implementation complexity, the candidate values for X1 and X2 are recommended to be extended to {0, 1, 2, 3, 4, 5, 6, 7}.  ***Proposal 2-4: Include component 7/8 into FG 23-1-2 as follows and remove the corresponding brackets***   * + ***7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs, with candidate values {0, 1, 2, 3, 4, 5, 6, 7};***   + ***8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs, with candidate values {0, 1, 2, 3, 4, 5, 6, 7};***   Regarding the number of SSBs with PCI(s) different from serving cell PCI for L1 beam measurement, to keep the memory consumption and computing complexity at UE under control, and also to put a limit on total number of SSB resources with PCI(s) same as or different from serving cell PCI, we propose the following:  ***Proposal 2-5: Include component 4/5 into FG 23-1-2 as follows and remove the corresponding brackets***   * + ***4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI across all CCs.***   + ***5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI across all CCs.***   In addition, to mitigate UE complexity increase from L1 inter-cell beam measurement on top of L3 mobility measurement, it would be beneficial to allow UE to report not supporting measurement on SSBs with PCIs that are not included in L3 mobility measurement. We propose the following:  ***Proposal 2-6: Include component 6 into FG 23-1-2 and remove the corresponding brackets***   * + ***6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement***   As FG 16-1g was introduced in Rel-16 as a shared capability, it enables a better balance between UE implementation complexity and gNB scheduling flexibility. Similarly, it would also be beneficial to introduce a shared capability between intra-cell and inter-cell measurement in Rel-17. So we propose:  ***Proposal 2-7: Include component 12/13 into FG 23-1-2 and remove the corresponding brackets***   * + ***12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement.***   + ***13. The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  2. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] (FFS: if K is a component candidate value)  3. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement)  ~~[~~4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI ~~[~~across all CC~~]]~~  ~~[~~5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI ~~[~~across all CC~~]]~~  ~~[~~6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement~~]~~  ~~[~~7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs~~]~~  ~~[~~8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs~~]~~  [9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]  [10. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]  [11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]  ~~[~~12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)~~]~~  ~~[~~13.~~[~~The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)~~]~~ | [2-24, 2-29] |  |  |  | [per band] |  |  |  |  | Optional with capability signalling | |
| vivo [3] | Similar as discussion above, regrouping of UE features should be discussed firstly.  **Proposal 1-5: The following grouping should be supported**   |  |  |  |  | | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI 2. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] (FFS: if K is a component candidate value) 3. The maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement in FR1 (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement) 4. The maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement in FR2(FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement)   [5. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]]  [6. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]] | | 23. NR\_FeMIMO | 23-1-2b | SSBs with different PCIs for L1 measurement | [Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement] | | 23. NR\_FeMIMO | 23-1-2c | L1 measurement over overlapped SSBs with different PCIs | 1. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement | | 23. NR\_FeMIMO | 23-1-2d | L1 measurement outside SMTC | 2. Supported inter-cell measurement inside SMTC or ouside SMTC or both. |   One additional UE capability should also be supported since overlapped measurement on SSB and reception of PDSCH would imply more complicated UE behavior.  **Proposal 1-6: One additional UE capability FG should be indicated:**   * **Support of simultaneous reception of PDSCH and SSB for L1-RSRP measurement on overlapped REs.** |
| ZTE [4] | Firstly, regarding PCI(s) different from serving cell PCI, we prefer to reuse the legacy UE feature of [2-24] SSB/CSI-RS for beam measurement as a starting point.  Then, based on already agreement, the maximum value of supported K is a UE capability, and then the corresponding candidate value should be provided, e.g., {1, 2, 4} as legacy beam reporting.  After that, we have the following comments for other potential UE features captured by the moderator.   * Regarding the basic feature, in our views, component 1~5 can be considered. To be more specific, the component-3 should be considered as the maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement per CC in a band, and thus this feature can report individual values for FR1 and FR2. Then, this parameter is just relevant to RRC CSI-SSB resource set configuration, and we do not need to consider time domain behavior for measurement/report. * Regarding component 6 (relationship between L1 and L3 measurement), we think that, based on the gNB configuration for this L1 inter-cell measurement (as intra-cell beam measurement), we do not identify the relationship. * Regarding component 7 and 8 (configured PCI for transmission), we think that these two parameters should be discussed in FG 23-4. * Regarding component 9, 10, and 11, we need to wait for the RAN4 reply LS, or if needed, RAN4 can request some related UE feature to RAN2 directly. * Regarding component 12 and 13, we have the similar requirement for FG 23-5 group based reporting, and in our views, due to the same requirement, the Rel-16 UE FG 16-1g/1g-1 can be refined rather than introducing new one(s).   ***Proposal 2:*** *For inter-cell measurement and reporting (for inter-cell BM and mTRP), the following modification is proposed in red*   * *Components-{1, 2, 3, 4, 5} should be supported as a basic feature.*  |  |  |  | | --- | --- | --- | | 23-1-2 | Inter-cell beam measurement and reporting ~~[~~(for inter-cell BM [and mTRP])~~]~~ | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  2. Support of up to K~~[=4]~~ SSBRI-RSRP ~~[~~pairs~~/beams]~~ in one report ~~[~~where at least one ~~[~~pair~~/beam]~~ associated with a PCI different from serving cell PCI can be reported~~]~~  🡪 Candidate value comprises {1,2,4}  3. The maximum number of ~~[~~RRC-configured~~]~~ PCI(s) different from serving cell PCI for L1-RSRP measurement] per CC in a band ~~(FFS: whether to split this for FR1 and FR2) (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement)~~  ~~[~~4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]~~]~~  ~~[~~5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]~~]~~  ~~[6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]~~  ~~[7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]~~  ~~[8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]~~  ~~[9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]~~  ~~[10. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]~~  ~~[11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]~~  ~~[12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~  ~~[13.[The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~ | |
| OPPO [5] |  |
| CATT [6] | For inter-cell beam management and inter-cell mTRP, K is defined as the number of beams associated at least with non-serving cell(s) reported in a single CSI reporting instance. For component 2, the candidate values of K should be listed in the Note column. In our view, UE would decide whether to report the beam of non-serving cell. It is not necessary to introduce the restriction in the bracket. In addition, since there is no definition of beam in the spec, we prefer to remove the corresponding description. For component 3, there is no agreement that the maximum number of PCI(s) could be different for FR1 and FR2. In our opinion, the same value should be used. In this way, it is not needed to split this component for FR1 and FR2. In our opinion, it seems not necessary to introduce new UE capability to report the number of SSBs for inter-cell beam reporting. The normal L1-RSRP measurement will not result in additional complexity for UE implementation. Therefore, component 4-6 should be removed. Similarly, component 9-13 should also be removed. Component 7-8 are aligned with the agreement of inter-cell mTRP, which should be included in the FG.  ***Proposal-6: For inter-cell measurement and reporting, the UE feaure 23-1-2******is revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  2. Support of up to K~~[=4]~~ SSBRI-RSRP ~~[~~pairs~~/beams]~~ in one report ~~[where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] (FFS: if K is a component candidate value)~~  3. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] ~~(FFS: whether to split this for FR1 and FR2)~~ (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement)  ~~[4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]]~~  ~~[5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]]~~  ~~[6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]~~  ~~[~~7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs~~]~~  ~~[~~8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs~~]~~  ~~[9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]~~  ~~[10. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]~~  ~~[11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]~~  ~~[12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~  ~~[13.[The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~ | [2-24, 2-29] | [per band] |  |  | 2. Candidate value of {1,2,3,4} | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] | For inter-cell TCI state update, the structures above can be used as baseline one they are stable. In addition the following principles need to be followed for better organization of the FGs and to avoid complexity on network and UEs alike:  **Proposal:**   * **Intra-cell operation be pre-requisite to inter-cell, as it is not sensible to imagine UEs that can support Rel-17 TCI state updates only for inter-cell scenarios.** * **Counting to be done consistently for both intra- and inter-cell cases, e.g. N TCI states type of features**   One specific aspect of inter-cell TCI state updates are the related measurements. Based on discussions in RAN1#107bis-e, the following candidate components can be considered further (component numbers match those in [2] for convenience):   |  |  | | --- | --- | | **Potential components based on RAN1#107bis-e discussions** | **Comments** | | **[7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]**  **[8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]** | Needed, but there is little value in too fine granularity of values. Potential range for X1 and X2 is {1, 3, 7}. | | **1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI** | Should be part of a basic FG. Can be merged with 2. | | **2. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] (FFS: if K is a component candidate value)** | Should be part of a basic FG. Can be merged with 1. | | **3. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement)** | Needed | |
| NTT DOCOMO, INC. [7] | For FG23-1-2, we have the following suggestion:   * FG23-1-2 should cover both L1/L2 inter cell mobility and M-TRP inter cell. * Component 2: We suggest to update as “where at least one [pair/beam] can be associated with a PCI different from serving cell PCI”. The discussion point was that the selected pair/beam is not always associated with a PCI different from serving cell PCI. However, it is true that the selected pair/beam “can be” associated with a PCI different from serving cell PCI. * Component 3: The difference between component 3 and component 7/8 should be clarified, otherwise, either component(s) should be removed. Also, since FG23-1-2 would be reported per band, we don’t need to differentiate the component 3 for FR1 and FR2. * Component 7/8: We are fine to have the component 7/8 per agreement in M-TRP inter cell. We believe the scenario of component 7 is more typical in commercial use-case. * Component 10/11: whether SSB of serving cell PCI and SSB of non-serving cell are overlapped is up to gNB implementation. gNB already transmits SSB for Rel.15/16 UEs, it is difficult to change SSB location for Rel.17 UEs. Since we already have component 7/8, UE can report the number of PCIs for both two modes. Hence, we don’t need component 10/11. * Component 4/5/6/12/13: We don’t think these components are needed.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting (for inter-cell BM and mTRP) | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  2. Support of up to K=4 SSBRI-RSRP pairs/beams in one report where at least one pair/beam can be associated with a PCI different from serving cell PCI can be reported (FFS: if K is a component candidate value)  3. The maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement]  7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs  8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs  [9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}] | [2-24, 2-29] |  |  |  | per band |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] | The components 2-17 can be divided into 3 FGs. Components 2/3/4/5/7/8/9/10/11 can be grouped into the basic FG. Components 6 is an additional capability which should be in a separate FG. Similar as FG 16-1g, components 12/13 should be in a separate FG.  ***Proposal 3: For FG 23-1-2, suggest to group the following components as follows,***   * ***Components 2/3/4/5/7/8/9/10/11 should be in the basic FG*** * ***Component 6 should be in a separate FG*** * ***Components 12/13 should be in a separate FG*** |
| LG Electronics [10] | **23-1-2**   * FG description: ‘for inter-cell BM [and mTRP]’ seems redundant, so suggest to delete it. * Component 1, 2, 3: It should be included in the basic FG 23-1-2. For component 3, the number of additional PCIs for beam measurement can be typically common for FR1 and FR2. Moreover, suggest to remove the bracket on ‘RRC configured’ as agreed in RAN1#106bis-e * Component 4-13: We see no strong need for these components. Some components such as component 4/5 may be addressed by existing 16-1g or a new component for Rel-17 analogous to 16-1g, e.g. 23-5-1a.   **Proposal 2: Adopt the following table for Rel-17 multi-beam 23-1-2.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI   * 1. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] FFS: if K is a component candidate value   2. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement | [2-24, 2-29] |  |  |  | [per band] |  |  |  | ~~[2. Candidate value of {1,2,3,4}]~~  ~~[3. candidate values {1, 2, 4, 6}]~~  ~~[4. candidate values {1, 2, 4}]~~  ~~[5. candidate values: {2, 4, 8, FFS}]~~  ~~[6. candidate values: {4, 8, 16, 32, 64, FFS}]~~  ~~[7. candidate values {not support}]~~ | Optional with capability signalling | |
| Intel Corporation [11] | For inter-cell measurement and reporting we have the following comments:   * Define basic FG the includes components 2, 7, 8, [11], [12], [13] * Component 2 should support at least 4 SSBRI-RSRPs as candidate values * Component 4 is not needed since the inter-cell measurement would be difficult to define within single slot duration due to propagation delays. * Component 5 is not needed and can be covered by legacy capability for the number of RS for L1-RSPR measurements * Component 6 is not needed, since motivation of such capability is not needed * Component 9 is not needed. Additional inputs on necessity of this component may be needed. * Component 10 is not needed considering support of components 7 and 8 * Component 11 may be needed, but RAN4 input on necessity of corresponding FG would be useful. * Component 12 and 13 may not be needed and covered by legacy capability  |  |  |  | | --- | --- | --- | | 23-1-2 | Inter-cell beam measurement and reporting ~~[(~~for inter-cell BM ~~[~~and mTRP~~])]~~ | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  ~~FFS: whether to include the following components 2-13 into this FG or one or more separate FGs~~  ~~FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs~~   * 1. Support of up to K~~[~~=4~~]~~ SSBRI-RSRP ~~[~~pairs/beams~~]~~ in one report ~~[~~where at least one ~~[~~pair/beam~~]~~ associated with a PCI different from serving cell PCI can be reported~~]~~ FFS: if K is a component candidate value   2. ~~The maximum number of [RRC configured] PCI(s) different from serving cell PCI for L1-RSRP measurement FFS: whether to split this for FR1 and FR2~~ ~~FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement~~   3. ~~[The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]]~~   4. ~~[The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]]~~   5. ~~[Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]~~   6. ~~[~~The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs~~]~~   7. ~~[~~The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs~~]~~   8. ~~[Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]~~   9. ~~[Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]~~   10. [Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement~~]~~   11. ~~[The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~   12. ~~[The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~ | |
| Apple [12] | Based on previous agreement on inter-cell beam measurement for mTRP operation, UE can report the maximum number of additional PCIs X1 for the case when SSBs for all the cells are fully overlapped and X2 for the other case.  In addition, since inter-cell L1-RSRP measurement is introduced in Rel-17, an extension for FG 16-1g/16-1g-1 in Rel-16 could be necessary. Thus, the following change is proposed.  **Proposal 1.2-1: Support the following change for the remaining issues on FG 23-1-2 for inter-cell beam measurement and report**  **1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI**  **2. Support of up to K SSBRI-RSRP in one report where K is a component candidate value**  **3. The maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement]**  **4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI across all CC**  **5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI across all CC**  **6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement**  **7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs**  **8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs**  **11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement**  **12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)**  **13.The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)**  **Proposal 1.2-1: Support the following FG splitting inter-cell beam measurement and report**   * **FG 23-1-2: Element 1, which is reported per UE with FR1/FR2 differential** * **FG 23-1-2a: Element 2, 3, 4, 5, 6, 7, 8, 11, which are reported per band** * **FG 23-1-2b: Element 12 and 13, which is reported per UE with FR1/FR2 differential (Same as R16)** * **FG 23-1-2c: Element 12 and 13, which is reported per UE (Same as R16)**  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  2. Support of up to K SSBRI-RSRP in one report where K is a component candidate value  3. The maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement  4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI across all CC  5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI across all CC  6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement  7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs  8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs  11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement  12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)  13.The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)  ***FG splitting:***   * **FG 23-1-2: Element 1, which is reported per UE with FR1/FR2 differential** * **FG 23-1-2a: Element 2, 3, 4, 5, 6, 7, 8, 11, which are reported per band** * **FG 23-1-2b: Element 12 and 13, which is reported per UE with FR1/FR2 differential (Same as R16)** * **FG 23-1-2c: Element 12 and 13, which is reported per UE (Same as R16)** | [2-24, 2-29] |  |  |  | [per band] |  |  |  | 1. Candidate value: {Support, not support}  2. Candidate value: {1, 2, 3, 4}  3. Candidate value: {1, 2, 3, 7}  4. Candidate value: {1, 2, 4, 8}  5. Candidate value: {1, 2, 4, 8}  6. Candidate value: {Support, not support}  7. Candidate value: {0, 1, 2, 3, 7}  8. Candidate value: {0, 1, 2, 3, 7}  11. Candidate value: {1, 2, 4, 8}  12. Candidate value: {1, 2, 4, 8}  13. Candidate value: {1, 2, 4, 8} | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | There is an agreement about supporting a UE feature on how many physical cell IDs can be associated with the activated TCI states as following [6]:  **Agreement**  On Rel.17 beam indication enhancements for inter-cell beam management, for the supported Rel-17 MAC-CE-based and/or DCI-based beam indication (at least using DCI formats 1\_1/1\_2 with and without DL assignment including the associated MAC-CE-based TCI state activation):   * Support a UE feature on how many physical cell IDs (including that of the serving cell) can be associated with the activated TCI states   + FFS: If UE is configured for only one physical cell ID, decide between the following two options:     - Opt1: the NW can activate TCI states associated with either the same physical cell ID as that of the serving cell or a different physical cell ID from that of the serving cell     - Opt2: the NW can only activate TCI states associated with the same physical cell ID as that of the serving cell   Note: The above does not necessarily mean that more than 1 physical cell ID that is not serving cell in RRC  Until now, we just discussed the maximum number of RRC-configured PCI(s) different from serving cell PCI for L1-RSRP measurement. For inter-cell beam management, we still need to decide how many physical cell IDs (including that of the serving cell) can be associated with the activated TCI states. Accordingly, it is better to add a new feature group to deal with it.  ***Proposal 4: Add new FG23-1-3 about the beam indication for inter-cell beam management to discuss the supported number of MAC-CE activated PCI(s) different from serving cell PCI.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  … |  |  |  |  | per band |  |  |  |  | Optional with capability signalling | | 23.  NR\_FeMIMO | 23-1-3 | inter-cell beam indication for inter-cell BM | 1. The number of MAC-CE activated PCI(s) different from serving cell PCI for beam indication. |  |  |  |  |  |  |  |  |  |  | |
| Samsung [15] | Regarding FG 23-1-2, this feature should cover both inter-cell beam measurement and reporting. Since the components which are relevant to inter-cell beam management are already included in FG 23-1-1, we would like to rename this feature to support of inter-cell beam measurement and reporting.  **Proposal 6:** Rename FG 23-1-2 as “Inter-cell beam measurement and reporting”.  For both FG 23-1-1 and 23-1-2, which are considered as basic features for Rel-17 TCI framework, we would like to propose the signalling granularity as per band based on two reasons. First reason is that based on working assumption in RAN1#107-e, the UE is not expected to be configured with Rel-15/Rel-16 TCI/*SpatialRelationInfo* if the UE is configured with Rel-17 TCI in any CC in a band. Second reason is that according to RAN2 guidance, the UE features which have “per-band combination” or “per-band per band combination” should be minimized. Hence, “per band” granularity is quite natural starting point to consider for those basic features.  **Proposal 7:** SupportFG 23-1-1 and FG 23-1-2 as basic features and per-band granularity. |
| MediaTek Inc. [16] | First, we see FG 23-1-2 should be used for both inter-cell BM and inter-cell mTRP. However, it may not need to mention this in the FG since this FG should be the prerequisite FG for inter-cell BM and inter-cell MTRP.  **Proposal 9: FG 23-1-2 should be the prerequisite FG of the following FGs:**   * **FG for “Unified TCI for inter-cell beam management”** * **FG for “IntCell-mTRP”**   Regarding component 2 in current FG 23-1-2, according to the following agreement, K is defined as the number of beams associated at least with non-serving cell(s) reported in a single CSI reporting instance, which is configured by NW based on the UE capability. Thus, UE should be able to report the maximum supported K by capability signaling. Meanwhile, we think “where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported” is redundant, which is clearly captured in specification.   |  | | --- | | **Agreement from RAN1#105**  On Rel.17 L1-RSRP multi-beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP,   * Support at least K=4, where K is defined as the number of beams associated at least with non-serving cell(s) reported in a single CSI reporting instance   + The maximum value of supported K is a UE capability   + K is configured by NW based on the UE capability   + FFS: The support of K=8 and 16     - For K>4, the maximum number of beams associated with one cell is 4 * FFS: Support L1-based event-driven reporting based on Rel-16 SCell BFR framework or analogous to L3-based event-driven reporting, including the definition of L1-based event, if needed   Note: If another beam metric other than L1-RSRP is supported (e.g. L3-RSRP is still FFS), the above also applies |   **Proposal 10: Update component 2 in current FG 23-1-2 with the following changes:**   1. **~~Support of up to~~ The maximum value of supported K~~[=4]~~ SSBRI-RSRP ~~[~~pairs~~/beams]~~ in one report ~~[where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported]~~**   Regarding component 3 in current FG 23-1-2, we prefer to have different reported numbers of RRC configured PCI(s) for L1-RSRP measurement associated with periodic, aperiodic, and semi-persistent reporting, respectively. For example:   1. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement associated with periodic L1-RSRP reporting 2. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement associated with semi-persistent L1-RSRP reporting 3. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement associated with aperiodic L1-RSRP reporting   On whether to split them for FR1 and FR2, this can be further discussed.  **Proposal 11: Separate component 3 in current FG 23-1-2 for L1-RSRP measurement associated with periodic, aperiodic, and semi-persistent reporting into the following components, respectively:**   1. **3a. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement associated with periodic L1-RSRP reporting** 2. **3b. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement associated with semi-persistent L1-RSRP reporting** 3. **3c. The maximum number of RRC configured PCI(s) different from serving cell PCI for L1-RSRP measurement associated with aperiodic L1-RSRP reporting** 4. **FFS: whether to split them for FR1 and FR2**   On components 4~13 in current FG 23-1-2, we are fine in principle. We can further discuss the details.  **Proposal 12: Support components 4~13 in current FG 23-1-2 in principle, further discuss the details.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs   1. ~~Support of up to~~ The maximum value of supported K~~[=4]~~ SSBRI-RSRP ~~[~~pairs~~/beams]~~ in one report ~~[where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported]~~   3a. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) for periodic L1-RSRP measurement  3b. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) for aperiodic L1-RSRP measurement  3c. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) for semi-persistent L1-RSRP measurement  [4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]]  [5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]]  [6. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]  [7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]  [8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]  [9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]  [10. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]  [11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]  [12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]  [13.[The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)] | [2-24, 2-29]  23-1-1,23-5-1 |  |  |  | [per band] |  |  |  |  | **Optional with capability signalling** | |
| Lenovo [17] | For FG 23-1-2, component 7 and 8 has been reported in FG 23-4, it’s unnecessary to report a same feature in different FG since they are applied to both inter-cell BM and inter-cell mTRP.   1. Remove component 7 and component 8 from FG 23-124 or remove component 2 and component 3 from FG 23-4   There is an editorial issue of component 9 of FG 23-1-2, and it should be revised as “[Supported ~~mode~~ inter-cell measurement mode: {inside SMTC, both inside and outside SMTC}]”   1. Revise component 9 of FG 23-1-2 as “[Supported ~~mode~~ inter-cell measurement mode: {inside SMTC, both inside and outside SMTC}] |
| Qualcomm Incorporated [18] | ***Proposal 2-2***: For FG 23-1-2 on the inter-cell beam measurement/report (R1-2200780), suggest to consider the following changes.   * Suggest to remove the bracket on “for both inter-cell BM and mTRP”, since the measurement should be applicable to both as in the updated WID * For component 10, 11, they are not must-have features, and can be in a separate FG * For component 2, 3, 7, 8, they can be basic features, and can be merged into FG 23-1-2 * For component 2   + Prefer to keep current wording, can clarify K can have different candidate values, which is aligned with agreement with Kmax as UE capability * For component 3   + Prefer to keep “RRC configured” for clearer definition, or no change is also fine * For component 4, 5   + They may not be needed if we have component 12 , 13 * For component 6   + It may not be needed, since today the serving cell SSB can be simultanouesly configured for L3 and L1 measurement * For component 9   + It may not be needed. SSB for L1 measurement can be within or outside SMTC without complexity impact * For component 10, 11   + They are needed, since UE cannot measure overlapped SSBs if not supporting two Rx beams simultaneously   + In addition, 10 can be removed if we have 11 with canaidate value of 0. * For component 12, 13   + Suggest to include them to the FG 23-5-1a, or add a note to clarify the resources in FG 23-1-2 are counted in FG 16-1g |
| Ericsson [19] | In FG 23-1-2, the inter-cell beam measurements are discussed, and several components are highlighted.  The first highlighting is related to the name of the FG: should it be for inter-cell beam management only, or should inter-cell mTRP be included in the same FG? Here we propose to include both use cases in the same FG:   1. FG 23-1-2 includes both inter-cell BM and inter-cell mTRP.   The next highlighted item is related to if any additional FG is needed. We do not see any need for that, since all the components are numerical:   1. There is no need to split FG 23-1-2 into multiple FGs.   The next highlighted item is related to if any basic FG should be defined, and since we proposed not to split FG 23-1-2, there is no such need.  The benefit of component 2 is that it could indicate the maximum number of beams that can be included in the RSRP report. However, the actual reporting of an inter-cell beam measurement is not more complicated than an intra-cell beam measurement, which is described by the intra-cell reporting beam reporting feature ***maxNumberNonGroupBeamReporting.*** Hence, component 2 is not needed:   1. Component 2 can be removed in FG 23-1-2, since *maxNumberNonGroupBeamReporting is applicable*.   Components 3, 5, 7 and 8 are all related to the maximum number of RRCs configured parameters. Such components are usually introduced to limit the memory consumption in the UE, whereas other parameters are introduced to limit complexity, e.g., the number of measured RSs per slot. For component 3, the additional PCIs are configured using a list of *SSB-MTCAdditionalPCI-r17* [2]:  SSB-MTCAdditionalPCI-r17 ::= SEQUENCE {  additionalPCIIndex-r17 AdditionalPCIIndex,  additionalPCI-r17 PhysCellId,  ssb-periodicity ENUMERATED { ms5, ms10, ms20, ms40, ms80, ms160, spare2, spare1 }  ssb-ToMeasure-r16 SetupRelease { SSB-ToMeasure }  }    The number of bits needed to store one element (for one PCI) is around 80 bits. Although there is no formal agreement for the maximum number of additional PCIs supported by the specification, it is reasonable to assume that it is at most 7. Introducing an additional UE feature to report could be considered, but the amount of memory that can be saved is quite small. Therefore, we propose   1. Component 3 in FG 23-1-2 is removed since the additional memory required is marginal.   Note that RRC configuring a PCI different from serving cell PCI does not necessarily mean that the UE must perform measurements on that other PCI.  Component 5 proposes to limit the number of SSB resources that can be configured for inter-cell beam measurements. Again, the target is to limit memory consumption of the UE.  The current assumption is that an *additionalPCIIndex-r17* is configured in the *CSI-SSB-ResourceSet.* Hence, the UE would at most be configured with 3 additional bits for every *CSI-SSB-ResourceSet.* The additional memory that the UE needs for this purpose would thus be insignificant. Hence, we propose   1. Component 5 in FG 23-1-2 is removed, since the additional memory required is marginal.   Note that there are already features specified in 38.306 that limit the memory requirements of the UE. For example, the UE feature *beamManagementSSB-CSI-RS* was designed for this purpose. Clearly, that UE feature is also applicable to inter-cell beam measurements.  Components 7 and 8 are introduced to ensure that the UE would automatically rate match around SSBs corresponding to PCIs other than the serving cell PCI. This was introduced for inter-cell mTRP but would be equally applicable to inter-cell beam management. However, this is not related to the inter-cell beam measurements, and we propose to remove them from this FG:   1. Remove components 7 and 8 in FG 23-1-2 since they are not related to measurements.   The components may still be applicable to inter-cell beam management. Note that for this purpose, we may reuse FG 23-1-4.  In component 4, we introduce a limitation on how many SSB resources can be measured in one slot, when the PCI may be different from the PCI of the serving cell. It would seem reasonable that performing measurements on such SSBs are more complex than only intra-cell beam measurements. It would seem reasonable to keep that component. Hence, we propose   1. Remove the brackets and highlighting for component 4 in FG 23-1-2.   It can be further discussed if there is a need to split component 4 into a ‘per CC’ limitation.  The idea with component 6 is to define a baseline mode of operation where only the PCIs that are configured for L3 mobility measurements can be reported in an inter-cell beam report. In this baseline mode of operation, the UE could reuse the measurements it anyway performs for L3 mobility and report only those over L1. However, the default operation in NR (and LTE) is that the UE is not configured with specific PCIs for L3 mobility. Instead, the measurement object contains only an ARFCN, and the UE finds all the relevant PCIs. For this normal configuration, the proposed component is not operational. However, the idea is sound: as part of the L3 mobility, the UE detects the SSBs that are important, and it is sufficient that those SSB measurements are reported. In contrast, for the legacy intra-cell L1-RSRP measurements, the UE is required to measure on all configured candidates.  To cover the case where no explicit PCIs are configured for L3 measurements, we propose the following modification of component 6:   1. Introduce a component “Report all configured SSBs with PCI different from serving cell PCI” in FG 23-1-2   A UE that does not support this component would only report the SSBs the UE anyway detects during L3 mobility.  In component 9, the SMTC window is discussed. Here we do not see any reason to request the UE to perform measurements outside the SMTC window. Hence, component 9 can be removed:   1. Remove component 9 in FG 23-1-2 since measurements outside the SMTC window are anyway not supported.   All NR deployments rely on overlapping SSB transmissions: essentially it is assumed that all cells can transmit all SSBs. A UE that cannot perform measurements on overlapping SSBs would in practice not support inter-cell beam measurements. Hence, components 10 and 11 can be removed:   1. Component 10 and 11 in FG 23-1-2 can be removed since measurements on overlapping SSBs are required.   Components 12 and 13 are meant to extend FG 16-1g (*maxTotalResourcesForAcrossFreqRanges-r16* and *maxTotalResourcesForOneFreqRange-r16*). As we see it, maxTotalResourcesForAcrossFreqRanges*-r16* and *maxTotalResourcesForOneFreqRange-r16* are applicable also for inter-cell beam measurements – it is a natural interpretation, since an inter-cell L1-RSRP measurement is still an L1-RSRP measurement. Therefore, we propose   1. Components 12 and 13 in FG 23-1-2 can be removed, since the Rel-16 capabilities are applicable.   If needed, we can make a conclusion to clarify that inter-cell beam measurements are included in *maxTotalResourcesForAcrossFreqRanges-r16* and *maxTotalResourcesForOneFreqRange-r16.*  In summary, we propose the following modifications of FG 23-1-2:   |  |  | | --- | --- | | Inter-cell beam measurement and reporting ~~[~~(for inter-cell BM ~~[~~and mTRP~~]~~)~~]~~ | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  ~~FFS: whether to include the following components 2-13 into this FG or one or more separate FGs~~  ~~FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs~~  ~~2. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] (FFS: if K is a component candidate value)~~  ~~3. The maximum number of [RRC-configured] PCI(s) different from serving cell PCI for L1-RSRP measurement] (FFS: whether to split this for FR1 and FR2) (FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement~~  ~~[~~4. The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]~~]~~  ~~[5. The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]]~~  ~~[~~6. Support that all configured inter-cell SSBs are measured. ~~Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]~~  ~~[7. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]~~  ~~[8. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]~~  ~~[9. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]~~  ~~[10. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]~~  ~~[11. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]~~  ~~[12. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~   1. ~~[13.[The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]~~ | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-1-3 | MPE mitigation | 1. Support of enhanced [PHR] reporting which includes pairs of (P-MPR, SSBRI/CRI)  2. Maximum number of reported P-MPR and SSBRI/CRI pairs  3. Maximum number of candidate RS(s) configured in a RRC pool for MPE mitigation |  |  |  |  |  |  |  |  | 2. Candidate value of {1,2,3, 4}  3. Candidate valueFFS | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | Based on the following agreement, the N P-MPR values and corresponding SSBRI(s)/CRI(s) can be reported. In our views, M should be fixed to 1, and if sharing the same MPE impacts, the UE can provide same P-MPR values for different SSBRI(s)/CRI(s), respectively, in a report instance. Therefore, a new sub-feature of maximum number of P-MPR and SSBRI/CRI pairs can be introduced, and reusing legacy candidate values for normal beam report can be considered as a starting point, i.e., {1, 2, 4}.  Then, based on the following highlighted part, we need to further consider another new UE feature of maximum number of candidate RS(s) configured in a RRC pool for MPE mitigation. As a candidate value, we think that at least the value of ‘64’ should be supported.  **Agreement**  On Rel.17 enhancements to facilitate MPE mitigation, confirm the following working assumption (in the midst of the previous agreement) as an agreement with the following refinement (highlighted in red):   |  | | --- | | On Rel.17 enhancements to facilitate MPE mitigation, support the following enhancement on the Rel-16 event-triggered P-MPR-based reporting (included in the PHR report when a threshold is reached, reported via MAC-CE):   * In addition to the existing field in the PHR MAC-CE, N≥1 P-MPR values can be reported   + The N P-MPR values are reported together with the following:     - ~~(Working Assumption)~~ For each P-MPR value, up to M SSBRI(s)/CRI(s), where the SSBRI(s)/CRI(s) is selected by the UE from a candidate SSB/CSI-RS resource pool (FFS: how to perform the selection)       * Support M=1       * ~~FFS: The supported value(s) of M~~ * ~~FFS: Additional reporting quantities, e.g. SSBRI/CRI, MPR+DL RSRP, or modified virtual PHR~~ * ~~FFS: additional signaling (e.g. CSI triggering) from the NW~~ |   ***Proposal 3:*** *For MPE mitigation, the following modification is proposed in red*   |  |  |  | | --- | --- | --- | | 23-1-3 | MPE mitigation | 1. Support of enhanced ~~[~~PHR~~]~~ reporting which includes pairs of (P-MPR, SSBRI/CRI)  2. Maximum number of reported P-MPR and SSBRI/CRI pairs  3. Maximum number of candidate RS(s) configured in a RRC pool for MPE mitigation  🡪 Candidate value comprises at least 64. | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] | * + **23-1-3:**     - Component 3 candidate values: In order to enable the UE to find an new candidate beam, the pool of configured RS should be as large as possible to enable UE to find new candidate beams, i.e. 64 RS. |
| NTT DOCOMO, INC. [7] | For FG23-1-3, we have the following suggestion   * Component 1: Regarding the text in bracket, we think it can be kept. From our perspective, it is fine to clarity that the report is in PHR report. * Component 2: Considering multiple entry PHR, PHRs and PMPRs of multiple CCs are included in one MAC CE, it is better to clarify the maximum number of reported P-MPR and SSBRI/CRI pairs is per CC or across all CCs. From companies’ input in email discussion during RAN1#107bis-e, it can be observed that companies have different understanding on this. Some company mentioned that it is max number per CC, while some company mentioned that it is max number in a single report which include multiple CCs in case of multi-entry PHR. In our view, the maximum number of reported P-MPR and SSBRI/CRI pairs should be per CC. * Component 3: Regarding candidate value, {4,8,16,32,64} can be considered.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-3 | MPE mitigation | 1. Support of enhanced PHR reporting which includes pairs of (P-MPR, SSBRI/CRI)  2. Maximum number of reported P-MPR and SSBRI/CRI pairs per CC  3. Maximum number of candidate RS(s) configured in a RRC pool for MPE mitigation |  |  |  |  |  |  |  |  | 2. Candidate value of {1,2,3, 4}  3. Candidate value {4,8,16,32,64} | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-3 | MPE mitigation | 1. Support of enhanced PHR reporting which includes pairs of (P-MPR, SSBRI/CRI)  2. Maximum number of reported P-MPR and SSBRI/CRI pairs  3. Maximum number of candidate RS(s) configured in a RRC pool for MPE mitigation |  |  |  |  |  |  |  |  | 2. Candidate value of {1,2,3, 4}  3. Candidate value {1, 2, 4, 8} | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 2-3***: For FG 23-1-3 on the MPE mitigation (R1-2200780), prefer to use “P-MPR” instead of “PHR” for the name in yellow |
| Ericsson [19] | This FG describes enhancements to the P-MPR reporting. The basic capability would include support for a N (P-MPR,SSBRI/CRI) pairs in a new PHR MAC CE.  We propose the following changes:  1. Support of enhanced ~~[~~PHR~~]~~ reporting which includes pairs of (P-MPR, SSBRI/CRI)  2. Maximum number of reported P-MPR and SSBRI/CRI pairs  3. Maximum number of candidate RS(s) configured in ~~a RRC pool~~ mpe-ResourcePool-r17. ~~for MPE mitigation~~  We note that “in a RRC pool” is somewhat unclear. We propose to be precise, and use the RRC field name, which is mpe-ResourcePool-r17.  In addition, there is a need to decide on the candidate values for the number of candidate RSs. This feature resembles beam failure recovery, and the corresponding beam failure recovery feature is  maxNumberCSI-RS-SSB-CBD INTEGER (1..256)  However, the corresponding BFR feature is defined across all CCs, which motivates the large value range. We note that for the feature to be of any use, if must be possible to include all the SSBs configured in the cell in the candidate list. Since the number of SSBs per cell can be between 1 and 64, one option could be to have the same value range for this capability. However, in current FR2 deployments many SSBs is used, and for the feature to be useful, that number must be matched. For example, if the UE reports that it only supports four candidate RSs, the NW will not enable the feature: a larger number is required. Therefore, we propose   1. The candidate values for the maximum number of candidate RSs are (8,16,32,64)   In accordance with the RAN2 guidance to minimize the number of features that are reported per band combination, we propose   1. FG 23-1-3 is defined per band.   We note that the corresponding BFR feature is also defined per band. |

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| 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | 1. Supported UE capability value [sets] and corresponding max number of SRS ports for each UE capability value [set] |  |  |  |  | per band |  |  |  | Candidate values: [Up to [4] value [sets] each with one value of {[0,]1,2,4}]  Note: the reported list contains only unique value [sets]  This FG is a working assumption | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | ***MP-UE***  We support component 1 and suggest considering maximum 4 UE capability sets, each with up to 4-port SRS resource for Rel-17.  ***Proposal 2-8: Support component 1 in FG 23-1-4 and remove the corresponding brackets***   * + ***1. Supported UE capability value sets and corresponding max number of SRS ports for each UE capability value set***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | 1. Supported UE capability value ~~[~~sets~~]~~ and corresponding max number of SRS ports for each UE capability value ~~[~~set~~]~~ |  |  |  |  | per band |  |  |  | Candidate values: ~~[~~Up to ~~[~~4~~]~~ value ~~[~~sets~~]~~ each with one value of {[0,]1,2,4}~~]~~  Note: the reported list contains only unique value [sets]  This FG is a working assumption | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | In RAN1#107bis-e, the following FG has been introduce for MPUE report for UL.   * Based on RAN1 agreement, we have already agreed the terminology of ‘UE capability value set’, so we prefer to use the same terminology to aligned with already agreement and RAN1 spec * Then, we think that up to 3 value is sufficient, and meanwhile the identical values in the different set should be allowable for facilitating the typical UE design of symmetric panel(s). * After that, for semi-persistent or periodic reporting, in order to accommodate UE panel switching, UE can further indicate recommended periodicities, as a new component, then gNB configures a periodicity based on the reported periodicities. * Finally, we do not identify the necessity of introduce ‘0’ in the candidate value set, and if we would like to consider DL-only reporting, we prefer to have a new sub-component rather than a wired signaling   ***Proposal 4:*** *For MPUE support for UL, the following modification is proposed in red*   |  |  |  | | --- | --- | --- | | 23-1-4 | MPUE support for UL | 1. Supported UE capability value ~~[~~sets~~]~~ and corresponding max number of SRS ports for each UE capability value ~~[~~set~~]~~  🡪 Candidate values: ~~[~~Up to ~~[4]~~ 3 value ~~[~~sets~~]~~ each with one value of {~~[0,]~~1,2,4}~~]~~  ~~🡪 Note: the reported list contains only unique value [sets]~~  2. Supported maximum periodicity for periodic/semi-persistent report  🡪 Candidate values: {40, 80, 160, 320} slots | | 23-1-4a | DL-only report | * + - 1. Support of indicating ‘DL-only’ for a reported RS in a beam report instance | |
| OPPO [5] |  |
| CATT [6] | For uplink panel selection of MP UE, it was agreed that UE reporting a list of UE capability value sets, and the UE capability value set refers to the max supported number of SRS ports. In the last meeting, it was proposed that the candidate values for the max number of SRS ports is {[0], 1, 2, 4} where 0 is used to indicate DL-only panel and needs to be confirmed. In our view, the UE capability value set reporting indicates NW both the capability of each panel as well as the number of panels for uplink transmission. If the panel is a DL-only panel, this panel information should be reported to NW such that the later beam reporting from this panel can’t be used for uplink panel selection.  ***Proposal-7: For MP UE support for UL, candidate value ”0” is supported for the maximum number of SRS ports to indicate DL-only panel.***  In RAN1 #107 e-meeting, there is the following agreement:   |  | | --- | | **Conclusion**  *On Rel.17 enhancements to facilitate UE -initiated panel activation and selection via UE reporting a list of UE capability value sets, other than the max supported number of SRS ports (note: currently pending endorsement in proposal 4.A), there is no consensus on supporting another UE capability type* |   From the agreement, the UE capability type reported by UE refers to maximum number of SRS ports, no other UE capability type will be reported. So the “sets” in the UE capability value [sets] can be deleted.  ***Proposal-8: For MP UE support for UL, support UE capability value report instead of capability value sets report.***  ***So UE feature 23-1-4 is revised as follows:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | 1. Supported UE capability value ~~[sets]~~ and corresponding max number of SRS ports for each UE capability value ~~[set]~~ | per band | Candidate values: [Up to [4] value [sets] each with one value of {~~[~~0,~~]~~1,2,4}]  Note: the reported list contains only unique value [sets]  This FG is a working assumption | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] | * + **23-1-4:**      - RAN1 already agreed that UE reports a list of UE capability value sets, the correspondence between each reported CSI-RS and/or SSB resource index and one of the UE capability value sets in the reported list is determined by the UE (analogous to Rel-15/16) and is informed to NW in a beam reporting instance. |
| NTT DOCOMO, INC. [7] | For FG23-1-4, we support to keep the text “sets”, which is aligned with RAN1 agreement. We support the candidate value of up to 4 value sets. We support to have one value of 0, which represent “DL only” panel, since we have agreed that UL panels can be a subset of DL panels.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | 1. Supported UE capability value sets and corresponding max number of SRS ports for each UE capability value set |  |  |  |  | per band |  |  |  | Candidate values: Up to 4 value sets each with one value of {0,1,2,4}  Note: the reported list contains only unique value sets  This FG is a working assumption | Optional with capability signalling | |
| Spreadtrum Communications [9] | Regarding the UE capability value set, since there’s no consensus on supporting another UE capability type, the UE capability value set will only contain the max supported number of SRS ports. Therefore, UE capability value set should be revised to UE capability value.  ***Proposal 4: For FG 23-1-4, UE capability value set should be revised to UE capability value.*** |
| LG Electronics [10] | **23-1-4**   * Component 1: Regarding the candidate value, we support to include ‘0’ for max number of SRS ports per each value set to indicate that the UE has DL only panel(s).   **Proposal 3: Adopt the following table for Rel-17 multi-beam 23-1-4.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | ~~[depending on agreement]~~ 1. Supported UE capability value [sets] and corresponding max number of SRS ports for each UE capability value [set] |  |  |  |  | ~~FSPC~~ per band |  |  |  | Candidate values: [Up to [4] value [sets] each with one value of {0, 1,2,4}]  Note: the reported list contains only unique value [sets]  This FG is a working assumption | Optional with capability signalling | |
| Intel Corporation [11] | For MPUE support for UL we have the following comments:   * The candidate value with “0” ports should not be supported. In Rel-15/Rel-16 it was assumed that all UE’s panels can be used for both DL and UL transmissions. Support of the panel for DL only capability contradicts to this assumption and is not essential for this feature for fast multi-panel selection for UL transmission.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-1-4 | MPUE support for UL | 1. Supported UE capability value ~~[~~sets~~]~~ and corresponding max number of SRS ports for each UE capability value ~~[~~set~~]~~ | per band | Candidate values: ~~[~~Up to [4] value ~~[~~sets~~]~~ each with one value of {~~[0,]~~1,2,4}~~]~~  Note: the reported list contains only unique value ~~[~~sets~~]~~  This FG is a working assumption | |
| Apple [12] | Based on the working assumption agreed in RAN1 #107, the following is proposed.  **Proposal 1.3-1: Support the change for FG 23-1-4 (MPUE support for UL)**  **1. Supported UE capability value sets and corresponding max number of SRS ports for each UE capability value set**  **2. Capability set index report in a periodic beam report instance**  **3. Capability set index report in a semi-persistent beam report instance**  **4. Capability set index report in an aperiodic beam report instance**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | 1. Supported UE capability value sets and corresponding max number of SRS ports for each UE capability value set |  |  |  |  | per band |  |  |  | Candidate values: {1, 2}  Note: the reported list contains only unique value [sets]  This FG is a working assumption | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | Regarding Component in FG 23-1-4 as below,   |  | | --- | | 1. Supported UE capability value [sets] and corresponding max number of SRS ports for each UE capability value [set] |   Since RAN1 can only agree on one UE capability for this feature (i.e. max # SRS ports, and concluded no consensus on the support of other types), it is still not clear why “value set” is needed. It should be eplaced with “value” in the above description, so we would like to remove [sets] in the above description.  **Proposal 8:** Remove [sets] in the Component description in FG 23-1-4. |
| MediaTek Inc. [16] |  |
| Lenovo [17] | For FG 23-1-4, it’s better to align with RAN1 agreement to use the term of “UE capability values set”   1. For FG 23-1-4, the term of “UE capability values set” should be used to align with RAN1 agreement and RAN1 specification |
| Qualcomm Incorporated [18] | ***Proposal 2-4***: For FG 23-1-4 on the MPUE support on UL (R1-2200780), suggest to consider the following changes.   * For component 1, prefer to keep “set”, which is the wording for agreement as well as current spec * For the note, it can be revised as the report list only contains a unique candidate value per set * For the candidate value, support the value of 0 to indicate a panel is DL only. Otherwise, UE cannot report the best DL panel if it is DL only, and that will degrade DL performance |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs [with [non-SFN scheme] TDM and FDM (except FR2)] [including PDCCH repetition for Type 3 CSS]  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | Component 2 candidate values: details 2 or 3  Component 4 candidate values: [{0,1,2,3}]  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the multi-TRP PDCCH repetition enhancement, three schemes have been agreed SFN, TDM and FDM in Rel-17. Therefore, the combinations of supported schemes should be a UE capability. For capability on SFN PDCCH, this has been captured as UE capability in HST-SFN feature.  ***Proposal 3-1: Remove the brackets around the component 1 in FG 23-2-1,***   * + ***1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs with non-SFN scheme TDM and FDM (except FR2) including PDCCH repetition for Type 3 CSS.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs ~~[~~with ~~[~~non-SFN scheme~~]~~ TDM and FDM (except FR2)~~]~~ ~~[~~including PDCCH repetition for Type 3 CSS~~]~~  1a. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs with non-SFN scheme FDM including PDCCH repetition for Type 3 CSS  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | Component 2 candidate values: details 2 or 3  Component 4 candidate values: [{0,1,2,3}]  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | On MTRP PDCCH repetition enhancement, four FGs (23-2-1, 23-2-1a, 23-2-2 and 23-2-3) are listed in [1]. We have some comments on these FGs as below.  For FG 23-2-1, we are agreeable to it in principle. Regarding the limitation “except FR2” of FDM scheme in component 1, it is NOT in line with any agreement in the previous RAN1 meetings so far, hence we think it should be removed.   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-2-1 | ~~[Multi-TRP]~~ PDCCH repetition | 1. Support of intra-slot PDCCH repetition ~~(~~based on two linked SS sets associated with corresponding CORESETs~~)~~ with non-SFN scheme TDM and FDM including PDCCH repetition for Type 3 CSS  2. Support of reporting one ~~[or more]~~ number~~(s)~~ as required number of BDs for the two PDCCH candidates  ~~3. [If 3 or {2, 3} is reported in component 2,] support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET [for the case that the linked PDCCH candidates is 3 BDs] [If 2 or {2,3} is reported in component 2, the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs.]~~  FFS: ~~4~~3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | ~~Component 1 details FFS~~  Component 2 candidate values: ~~details FFS~~ 2 or 3  ~~Component 3 candidate values: details FFS {monitored, not monitored}~~  Component 4 candidate values: [{0,1,2,3}] ~~details FFS~~  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  Note: for component4, if N PDCCH candidates are overlapped, the number of overlaps is counted as one. | |
| OPPO [5] |  |
| CATT [6] | For Component 1, according to the following agreement and conclusion, both SFN scheme and non-SFN scheme TDM and FDM are supported for PDCCH repetition. Since SFN based PDCCH repetition is captured as UE capability in HST-SFN feature (23-6-1), only non-SFN scheme is considered in FG 23-2-1. Then square brackets related to non-SFN scheme shall be removed.   |  | | --- | | **Agreement**  For PDCCH reliability enhancements, support SFN scheme + Alt 1-1.   * FFS: TCI state activation for CORESET, impact on default beam, BFD resource for BFR   **Conclusion**  The agreed PDCCH repetition framework (Option 2 + Case 1 + Alt3) supports both TDM and FDM multiplexing schemes. |   When UE performs PDCCH repetition with FDM scheme in FR2, two CORESETs may have either same or different QCL-TypeD parameters. It doesn’t mean that FDM in FR2 implies higher UE capability. Therefore, ‘(except FR2)’ can be removed. Correspondingly, ‘TDM and FDM’ can also be removed for duplication.  It was agreed that PDCCH repettion can be performed for both USS and Type 3 CSS. In our view, compared with PDCCH repetition for USS, PDCCH repetition for Type 3 CSS will not require additional complexity. Therefore, there is no need to introduce additional capability for Type 3 CSS PDCCH repetition. One option is to remove the related brackets for Type 3 CSS PDCCH repetition. In another option, both brackets and description related to Type 3 CSS PDCCH repetition can be deleted. Both options are acceptable to us.  For Component 3, it was agreed in RAN1#106-e that UE capability for max number of overlaps of linked PDCCH candidates and individual candidates is introduced. Since this capability affects gNB configuration in PDCCH repetition directly, we propose to list it as basic UE capability, and ‘FFS:’ can be removed.  Based on the above analysis, we have the following proposal:  ***Proposal-9: For PDCCH repetition, UE feature 23-2-1*** ***is revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs ~~[~~with ~~[~~non-SFN scheme~~]~~ ~~TDM and FDM (except FR2)]~~ ~~[~~including PDCCH repetition for Type 3 CSS~~]~~  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  ~~FFS:~~ 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  | Component 2 candidate values: details 2 or 3  Component 4 candidate values: [{0,1,2,3}]  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-2-1, we have following suggestion.   * Component 1: regarding the text in bracket, we think the text except “(except FR2)” should be kept. In our view, if a UE supports PDCCH repetition, it supports both TDM and FDM repetition and also supports repetition for Type3 CSS. We don’t see the intention to add “(except FR2)”. * Component 3: since it was agreed that UE capability for such overlap is introduced, we support to have component 3. Meanwhile, we think it is better to keep the Note for component 3 to clarify how the number of overlaps is counted when N PDCCH candidates are overlapped, i.e., counted as one overlap or counted as N overlaps. Thus, we suggest to keep the Note for component 3.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs with non-SFN scheme TDM and FDM including PDCCH repetition for Type 3 CSS  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | Component 2 candidate values: 2 or 3  Component 3 candidate values: [{0,1,2,3}]  Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot  Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one. | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | **23-2-1**   * Component 1: Remove [non-SFN scheme] and [including PDCCH repetition for Type 3 CSS]. SFN PDCCH has already defined as separate feature from PDCCH repetition and Type 3 CSS repetition is separately captured as FG 23-2-3.   **Proposal 4: Adopt the following table for Rel-17 M-TRP PDCCH.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs [with TDM and FDM (except FR2)]  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | Component 2 candidate values: details 2 or 3  Component 4 candidate values: [{0,1,2,3}]  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] | Optional with capability signalling | |
| Intel Corporation [11] | Regarding UE capabilities for multi-TRP PDCCH repetitions, we have the following comments:   * for FG 23-2-1 component-1, FDM multiplexing in FR2 would need reception of 2 QCL Type-D beams * for FG 23-2-1 component-1, no need to consider SFN as a reference scheme (editorial) * for FG 23-2-1 component-1, support of Type 3 CSS could be part of basic FG but no need in component description * for FG 23-2-1 components2, re-phrase (editorial) * for FG 23-2-1 component-3, this is okay to have * FG 23-2-X, for corresponding inter-span PDCCH monitoring add support of PDCCH repetition and restriction on the total number of linked candidates  |  |  |  |  | | --- | --- | --- | --- | | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition (based on two linked SS sets associated with corresponding CORESETs) with ~~non-SFN scheme~~ TDM and FDM (except FR2)~~]~~ ~~[including PDCCH repetition for Type 3 CSS]~~  2. ~~Support of reporting one number as required~~ The required number of BDs for the two PDCCH candidates  ~~FFS:~~ 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  | | 23-2-X | PDCCH inter-span repetition | 1. Support of PDCCH repetition  2. The total number of linked candidates of which the first candidate is received and the second one has not been received at any given span (X1 per CC, X2 across CCs) | 23-2-1 | |
| Apple [12] | With regard to additional processing delay for soft combining, we suggest we add an element to report additional delay required for mTRP PDCCH decoding as a new element.  **Proposal 1.4-1: Support the following change for FG 23-2-1 (mTRP PDCCH)**  **1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs**  **2. Support of reporting one number as required number of BDs for the two PDCCH candidates**  **3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier**  **4. Additional delay (number of symbols) for mTRP PDCCH processing**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier  **4. Additional delay (number of symbols) for mTRP PDCCH processing** |  |  |  |  |  |  |  |  | Component 2 candidate values: details 2 or 3  Component 3 candidate values: {0,1,2,3}  Component 3 candidate values: {4, 7, 14}  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] | Optional with capability signalling | |
| CMCC [13] | Besides, both FG 23-2-1and FG 23-2-2 are only used for PDCCH repetition, not SFN PDCCH. Therefore, the text of “with non-SFN scheme” in the blanket of FG 23-2-1and FG 23-2-2 should be included.  ***Proposal 3: Keep the text of “with non-SFN scheme” in FG 23-2-1 and FG 23-2-2.***  Based on the above analysis, we suggest to adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:  ***Proposal 5: Adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs ~~[~~with ~~[~~non-SFN scheme~~]~~ TDM and FDM (except FR2)~~]~~ ~~[~~including PDCCH repetition for Type 3 CSS~~]~~  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  | Component 2 candidate values: details 2 or 3  Component 4 candidate values: [{0,1,2,3}]  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] | Optional with capability signalling | |
| Xiaomi [14] | As for component 1 “1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs [with [non-SFN scheme] TDM and FDM] [(except FR2)] [including PDCCH repetition for Type 3 CSS]” in FG23-2-1, we prefer to keep “with non-SFN scheme TDM and/or FDM”, and delete “including PDCCH repetition for Type 3 CSS” because of the note.  ***Proposal 5: Revise component FG23-2-1 as below.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs ~~[~~with ~~[~~non-SFN scheme~~]~~ TDM and FDM~~] [(except FR2)] [including PDCCH repetition for Type 3 CSS]~~  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | Component 2 candidate values: 2 or 3  Component ~~4~~ 3 candidate values: [{0,1,2,3}]  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  Note: for component ~~4~~ 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one. | Optional with capability signalling | |
| Samsung [15] | * We are fine the wording only “with TDM and FDM (except FR2)” since it seems “non-SFN scheme” and “TDM and FDM” are duplication, and since FDM in FR2 is supported only when FG 23-2-2 is supported, the clarification on FR2 is fine for us. * We are fine with deleting the wording “including PDCCH repetition for Type 3 CSS” and maintaining the above Note since the Note describes the applicable search space sets much better. * We prefer to remove FG 23-2-3 which defines support of PDCCH repetition for Type 3 CSS as separate FG since there is no agreement on Type 3 CSS as UE optional feature. It should be a basic feature to support both USS and Type 3 CSS. * Regarding the reporting granularity of FG 23-2-1, it should be per FSPC due to the complex functionality and buffer burden of multi-TRP PDCCH repetition for UE.   **Proposal 9:** Support “with TDM and FDM (except FR2)”, “including PDCCH repetition for Type 3 CSS” in the Component 1 and the above Note in FG 23-2-1.  **Proposal 11:** Support FG 23-2-1 per FSPC.  Regarding the description of Component 3 and the corresponding candidate values and Note for FG 23-2-1 as follows,   |  | | --- | | FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier  Component 4 candidate values: [{0,1,2,3}]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.] |  * Our view is that since it was agreed to support maximum number of overlaps between one of the linked PDCCH candidates and an individual PDCCH candidate by UE capability, Component 3 which is now FFS should be supported. * Regarding candidate values [{0,1,2,3}], it can be discussed further. * We are fine with the corresponding note in order to describe how to count the number of overlaps.   **Proposal 12:** Support Component 3 (which is now FFS) and the corresponding note in FG 23-2-1. |
| MediaTek Inc. [16] | We propose to remove the description inside square brackets in the description of component 1 of FG 23-2-1, i.e., [with non-SFN scheme TDM and FDM] [including PDCCH repetition for Type 3 CSS]. Firstly, the new FG 23-2-3 already captures Type3 CSS repetition supports separately, secondly, PDCCH repetition and SFN capabilities are each captured independently and should not be confused; hence, it needs to be removed from the description.  **Proposal 13: Remove the description inside square brackets from description of FG 23-2-1 component 1. Adopt the following description for FG 23-2-1 component 1:**   * **Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs**   Due to dependency of component 3 in FG 23-2-1 on support of component 23-2-1a, i.e., component is only applicable for UEs which support component 23-2-1a, we propose to have a separate FG capturing this feature.  **Proposal 14: Make a separate FG to capture component 3 of FG 23-2-1, i.e., FG 23-2-1b with following description.**   * **Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier**   We propose to add a note for this FGI to clarify this feature is only applicable for Multi-TRP scenarios. It should be noted that the WID under which this feature was developed specifically notes the objective to be improvements in the Multi-TRP scenarios:  *Enhancement on the support for multi-TRP deployment, targeting both FR1 and FR2:*   * 1. *Identify and specify features to improve reliability and robustness for channels other than PDSCH (that is, PDCCH, PUSCH, and PUCCH) using multi-TRP and/or multi-panel, with Rel.16 reliability features as the baseline*   **Proposal 15: Add a note to clarify FG 23-2-1 is applicable to Multi-TRP scenarios only.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs ~~[with [non-SFN scheme] TDM and FDM (except FR2)] [including PDCCH repetition for Type 3 CSS]~~  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  ~~FFS: 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier~~ |  |  |  |  |  |  |  |  | Component 2 candidate values: details 2 or 3  ~~Component 4 candidate values: [{0,1,2,3}]~~  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  [Note: for component 3, if N PDCCH candidates are overlapped, the number of overlaps is counted as one.]  Note: This feature is applicable to M-TRP use cases | **Optional with capability signalling** | | 23. NR\_FeMIMO | 23-2-1b | PDCCH repetition with overlapped CCEs | Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per ~~scheduling~~ scheduled component carrier | **23-2-1a** |  |  |  |  |  |  |  | Component 4 candidate values: [{0,1,2,3}] | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | In Rel-15, PDCCH monitoring capability is defined for different cases including Case 1-1 for basic capability (FG 3-1), Case 1-2 for single occasion monitoring (FG 3-2), and Case 2 for PDCCH monitoring with span gap (FG 3-5b). Furthermore, Rel-16 introduced additional capabilities (FG 11-2 family). The support of Rel-17 mTRP PDCCH repetition should be separately indicated for each of these PDCCH monitoring capabilities. In other words, the basic FG for Rel-17 mTRP PDCCH repetition should only include the basic PDCCH monitoring capability. This is because PDCCH repetition can significantly increase the UE complexity and some of the advanced PDCCH monitoring features that the UE is able to support in the absence of PDCCH repetition need a separate capability when combined with PDCCH repetition. This enables a UE to support an advance PDCCH monitoring capability in absence of PDCCH repetition while support a more basic PDCCH monitoring capability in the presence of PDCCH repetition.  Furthermore, for the proposed FGs 23-2-1c and 23-2-1d, UE should be able to indicate the supported mode of PDCCH repetition wrt intra-span versus inter-span. In fact, such capability is already agreed:  **Agreement**  When 3 BDs are counted for two linked candidates   * The third BD is counted in the later span for inter-span PDCCH repetition when r16monitoringcapablityis configured. * Note: Inter-span repetition is UE optional   Additionally, in RAN1 #107-e, the following was agreed to handle the UE complexity / memory requirement, which needs to be captured entirely by UE capability spec (since the editor of 38.213 clarified that this agreement can be completely taken care of by UE capability spec instead of by 38.213), and is specific to inter-span PDCCH repetition  **Agreement**  To handle UE complexity / memory requirements for linked PDCCH candidates, address the issue by UE capability, where UE indicates a limit (X) associated with the total number of linked candidates of which the first candidate is received and the second one has not been received at any given span.   * The limit X is indicated as a total count assuming count 1 for AL=1; 2 for AL=2; 4 for AL=4 or 8 or 16. * The limit X is indicated per CC and also across all CCs * Note: “received” and “not been received” is wrt the end of the corresponding span of PDCCH candidate. * Above is applicable at least for the inter-span case (FFS: intra-span case)   Based on the discussions above, and the agreements during the WI mentioned above, we propose the following:  ***Proposal 3-1:***   * ***The basic FG for Rel-17 mTRP PDCCH repetition (FG 23-2-1) should only include the basic PDCCH monitoring capability, i.e., the highlighted note in square bracket is required (square bracket should be removed).*** * ***PDCCH repetition for more advanced PDCCH monitoring capabilities need a separate capability for each of the following***   + ***Add FG 23-2-1b for “PDCCH repetition with PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot”***   + ***Add FG 23-2-1c for “PDCCH repetition for Case 2 PDCCH monitoring with a span gap”***     - ***Add a component for “Supported mode of PDCCH repetition” with candidate values {intra-span, inter-span, both}***     - ***Add a component for “X per CC” and “X across all CCs”, where X is defined in the agreement above applicable to inter-span PDCCH repetition***   + ***Add FG 23-2-1d for “PDCCH repetition for Rel-16 PDCCH monitoring”***     - ***Add a component for “Supported mode of PDCCH repetition” with candidate values {intra-span, inter-span, both}***     - ***Add a component for “X per CC” and “X across all CCs”, where X is defined in the agreement above applicable to inter-span PDCCH repetition***   ***Proposal 3-2:***   * ***Remove the “FFS” from component 3 of FG 23-2-1 and add “per slot” at the end, i.e., “Supported max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier per slot”.***    + ***Also, the note should be revised to “for component 3, ~~if N PDCCH candidates are overlapped, the number of overlaps~~ each unique pair of overlaps is counted as one”*** * ***A similar component (component 5 in the table below) is needed for FG 23-2-1d as “Supported max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier per span”***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1 | PDCCH repetition | 1. Support of intra-slot PDCCH repetition based on two linked SS sets associated with corresponding CORESETs ~~[with [non-SFN scheme] TDM and FDM (except FR2)] [including PDCCH repetition for Type 3 CSS]~~  2. Support of reporting one number as required number of BDs for the two PDCCH candidates  ~~FFS:~~ 3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier per slot |  |  |  |  | Per FS |  |  |  | Component 2 candidate values: ~~details~~ 2 or 3  Component ~~4~~ 3 candidate values: ~~[{0,1,2,3}]~~ {2,4,6,10,20,40}  ~~[~~Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot~~]~~  ~~[~~Note: for component 3, ~~if N PDCCH candidates are overlapped, the number of overlaps~~ each unique pair of overlaps is counted as one.~~]~~ | Optional with capability signalling | | 23. NR\_FeMIMO | 23-2-1b | PDCCH repetition with PDCCH  monitoring on any span of up to 3 consecutive OFDM symbols of a slot | Support of PDCCH repetition for PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot | 3-2  23-2-1 |  |  |  | Per Band |  |  | FR1 only |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-2-1c | PDCCH repetition for Case 2 PDCCH monitoring with a span gap | 1. Support of PDCCH repetition for PDCCH monitoring of any occasions with span gap as defined in FG 3-5b.  2. Supported mode of PDCCH repetition  3. X per CC  4. X across all CCs | 3-5b  23-2-1 |  |  |  | Per FS |  |  |  | This capability is necessary for each SCS.  Component2: {intra-span, inter-span, both}  Component3: FFS candidate values  Component 4: FFS candidate values  Note:   * Components 3 and 4 are reported only if UE supports inter-span PDCCH repetition. * The limit (X) is associated with the total number of linked candidates of which the first candidate is received and the second one has not been received at any given span, where “received” and “not been received” is wrt the end of the corresponding span of PDCCH candidate.   The limit X is indicated as a total count assuming count 1 for AL=1; 2 for AL=2; 4 for AL=4 or 8 or 16. | Optional with capability signalling | | 23. NR\_FeMIMO | 23-2-1d | PDCCH repetition for Rel-16 PDCCH monitoring | 1. Support of PDCCH repetition with Rel-16 PDCCH monitoring capability as defined in FG 11-2 family.  2. Supported mode of PDCCH repetition  3. X per CC  4. X across all CCs  5. Supported max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier per span | 11-2  23-2-1 |  |  |  | Per FS |  |  |  | This capability is signalled for SCS 15 kHz and 30 kHz.  Component2: {intra-span, inter-span, both}  Component3: FFS candidate values  Component 4: FFS candidate values  Note:   * Components 3 and 4 are reported only if UE supports inter-span PDCCH repetition. * The limit X is associated with the total number of linked candidates of which the first candidate is received and the second one has not been received at any given span, where “received” and “not been received” is wrt the end of the corresponding span of PDCCH candidate. * The limit X is indicated as a total count assuming count 1 for AL=1; 2 for AL=2; 4 for AL=4 or 8 or 16.   Component5: {1,2,3,5,10,20} | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | [23-2-1] |  |  |  |  |  |  |  | [Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET] | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | For FG 23-2-1a, we think the description of the note is inaccurate based on the following views. Our suggested wording is shown in the proposal as below.   * For the case of BDs number is equal to 2, whether the individual PDCCH candidates can be monitored or not depends on how the UE implements blind detection. More precisely, the individual PDCCH candidates can be monitored when the UE implement individual detection, rather than soft combining. * For the case of BDs number is equal to 3, the individual PDCCH candidates can always be monitored due to UE has to implement both individual detection and soft combining anyways.  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | [23-2-1] |  |  |  |  |  |  |  | [Note: [If 2 is reported in component 2 of FG 23-2-1,] support of whether the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs.] | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-2-1a, we think the Prerequisite feature groups should be kept. Regarding the note, in our understanding, when 3 is reported in FG23-2-1 component 2, the individual candidate is always monitored in case of overlapping because there is always one individual decoding when the number of BDs is reported as 3. On the other hand, when 2 is reported in FG23-2-1 component 2, whether individual candidate is monitored in case of overlapping needs to be reported, because when 2 BDs is reported, either individual decoding or soft combining may be performed by UE.     |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | 23-2-1 |  |  |  |  |  |  |  | Note: If 2 is reported in component 2 of FG 23-2-1, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET is reported. If 3 is reported in component 2, the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | **23-2-1a**   * We are fine with removing note and making this FG independent with reported value in component 2 in FG 23-2-1.   **Proposal 4: Adopt the following table for Rel-17 M-TRP PDCCH.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | [23-2-1] |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] | In addition, for FG 23-2-1a, we think the number of BDs should not be tied with whether the individual PDCCH candidate is monitored or not for the case of overlapping. Because even if 3 BDs is reported in component 2, it cannot be mandatory that the UE can perform two individual decoding and one soft combing. Some UE may still need 3BDs for one individual decoding and one soft combing, so whether the individual candidate can be monitored or not should be reported even if 3BDs is reported as required number of BDs for the two PDCCH candidates. Therefore, the note in FG 23-2-1a should be deleted.  ***Proposal 4: Delete the note in FG 23-2-1a.***  Based on the above analysis, we suggest to adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:  ***Proposal 5: Adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | [23-2-1] | ~~[Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET]~~ | Optional with capability signalling | |
| Xiaomi [14] |  |
| Samsung [15] | Regarding Component, pre-requisite, and the Note for FG 23-2-1a as follows,   |  | | --- | | Component: Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET  Pre-requisite: [23-2-1]  [Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET] |  * Regarding the pre-requisite, we think that FG 23-2-1 can be a pre-requisite of this FG 23-2-1a since if a UE reports candidate value 0 for Component 3 (max number of overlaps) in FG 23-2-1, then the overlap may not happen to the UE based on gNB’s configuration. * Regarding the Note, the description clarifies the relationship between this FG and the reported number of BD counting which is Component 2 in FG 23-2-1. We think that the Note is not needed since the support of monitoring of individual candidates are not related to the reported number of BD counting.   **Proposal 13:** Support FG 23-2-1 as pre-requisite of the FG 23-2-1a.  **Proposal 14:** Not support (i.e., delete) the Note in FG 23-2-1-a. |
| MediaTek Inc. [16] | We propose to remove the note for this FG, as can lead to unnecessary confusion and furthermore it doesn’t reflect the RAN1 decisions. We believe feature description is already clear and doesn’t require further clarification through this note.  **Proposal 16: Remove the current note from FG 23-2-1a.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET |  |  |  |  |  |  |  |  | ~~[Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET]~~ | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | Regarding FG 23-2-1a, we think there should not be any dependency on component 2 of FG 23-2-1. This is because for whether the UE performs soft-combining or not and the relationship to number of BDs was extensively discussed in RAN1 and no consensus was achieved. Hence, the note from FG 23-2-1a should be deleted. Furthermore, component 3 is already agreed as shown below, and it needs to be included that this max number is per scheduled CC per slot. However, this number (component 3) should be per scheduled CC “per span” for Rel-16 span-based PDCCH monitoring since BDs and CCEs are also defined per span in this case. Hence, a similar component is also needed for FG 23-2-1d (component 5).  **Agreement**  When one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET   * Interpretation of the detected DCI is based on Rel. 17 PDCCH repetition rules (wrt reference PDCCH candidate).   + Whether the individual candidate is monitored or not is determined by a UE capability     - FFS (In UE feature session): The details including reusing the reported number of BDs for this purpose, or relation to reported number of BDs   + In both cases, the individual candidate is not counted toward the BD limit. * UE capability for max number of such overlaps is introduced   + FFS: Value of 0 is included as a candidate value for the UE capability   + The details to be discussed as part of UE capability discussions * FFS: When the individual candidate is monitored, the scenario where the other linked candidate is also “overlapping” (same CORESET, DCI size, CCEs, scrambling) with a second individual candidate   Hence, w propose the following:  ***Proposal 3-2:***   * ***Remove the note from FG 23-2-1a***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | ~~[~~23-2-1~~]~~ |  |  |  | Per band |  |  |  | ~~[Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET]~~ | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition [with non-SFN TDM and/or FDM sheme] | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding FG 23-2-2, we propose to separate into two components that one is for TDM scheme and the other is for FDM consider different UE implementation complexity of processing simultaneous TDM or FDM reception in FR2.  ***Proposal 3-2: Support to separate into two components that one is for TDM scheme and the other is for FDM scheme, and remove all the brackets in FG 23-2-2.***   * + ***1. Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition with non-SFN TDM sheme***   + ***2. Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition with non-SFN FDM sheme***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | 1. Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition ~~[~~with non-SFN TDM sheme~~]~~  2. Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition with non-SFN FDM sheme | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | For FG 23-2-2, we think the wording “with non-SFN TDM and/or FDM schem” is redundant and should be remove, because its pre-requisite is FG 23-3-1 which already mentions the same thing.   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-2-2 | Two QCL TypeD for ~~[~~CORESET monitoring in~~]~~ PDCCH ~~[~~repetition~~]~~ | Support of determining two QCL-TypeD for time-domain overlapping ~~in time~~ CORESETs in the same CC or for intra-band CA ~~[~~when UE is configured with PDCCH repetition~~]~~ | ~~[~~23-2-1~~, 23-6-1, 23-6-2]~~ |  |  |  | Per band |  |  | FR2 only |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-2-2, we support to remove the bracket and keep the text.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition with non-SFN TDM and/or FDM scheme | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | **23-2-2**   * Remove [with non-SFN TDM and/or] since this FG has no relation with SFN and TDM.   **Proposal 4: Adopt the following table for Rel-17 M-TRP PDCCH.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition FDM sheme | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling | |
| Intel Corporation [11] | * for FG 23-2-2, no need to consider SFN as a reference scheme (editorial)  |  |  |  |  | | --- | --- | --- | --- | | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping in time CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition with ~~[SFN scheme or] non-SFN~~ TDM and/or FDM scheme | [23-2-1, ~~23-6-1, 23-6-2~~] | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling | |
| CMCC [13] | Besides, both FG 23-2-1and FG 23-2-2 are only used for PDCCH repetition, not SFN PDCCH. Therefore, the text of “with non-SFN scheme” in the blanket of FG 23-2-1and FG 23-2-2 should be included.  ***Proposal 3: Keep the text of “with non-SFN scheme” in FG 23-2-1 and FG 23-2-2.***  Based on the above analysis, we suggest to adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:  ***Proposal 5: Adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition ~~[~~with non-SFN TDM and/or FDM sheme~~]~~ | 23-2-1 |  | Optional with capability signalling | |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition ~~[with non-SFN TDM and/or FDM sheme]~~ | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-2-3 | PDCCH repetition for Type3 CSS | Support of PDCCH repetition for Type3 CSS |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | For FG 23-2-3, we think this extra FG is not needed because there is no much difference between USS and CSS to process PDCCH repetition operation from UE side, and no matter two PDCCH is from USS or CSS, the decoding of two PDCCH repetition is the same, i.e. separate decoding or soft combining. We think it is more suitable to capture this feature in 23-2-1 as the current yellow highlighted part. |
| OPPO [5] | |  |  |  | | --- | --- | --- | | 23-2-3 | PDCCH repetition for Type3 CSS | Support of PDCCH repetition for Type3 CSS |   Support of PDCCH repetition for Type3 CSS is agreed in RAN1#106-e without additional UE capability. Therefore, we suggest to remove FG 23-2-3.  ***Proposal 3: Suggest to remove FG 23-2-3.*** |
| CATT [6] | As we discussed in FG 23-2-1 part, PDCCH repetition for Type 3 CSS can be included in FG 23-2-1. Therefore, FG 23-2-3 can be removed.  ***Proposal-10: FG 23-2-3 can be removed.***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ~~23-2-3~~ | ~~PDCCH repetition for Type3 CSS~~ | ~~Support of PDCCH repetition for Type3 CSS~~ |  |  |  |  |  | ~~Optional with capability signalling~~ | |
| Nokia, Nokia Shanghai Bell [7] | * **23-2-3:**    + - Confirm the FG |
| NTT DOCOMO, INC. [7] | For FG23-2-3, we think this FG should be removed. As analyzed above, if a UE supports PDCCH repetition, it supports both TDM and FDM repetition and also supports repetition for Type3 CSS, thus, there is no need to have separate capability for Type3 CSS. |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] | Basically, the structure of these FGs is proper for Multi-TRP PDCCH repetition. However, PDCCH repetition for Type 3 CSS will not require additional complexity comparing with PDCCH repetition for USS. Therefore, there is no need to introduce additional capability for Type 3 CSS PDCCH repetition. The text of “including PDCCH repetition for Type 3 CSS” in the blanket of FG 23-2-1 should be included and the FG 23-2-3 should be deleted.  ***Proposal 2: Delete FG 23-2-3.***  Based on the above analysis, we suggest to adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:  ***Proposal 5: Adopt the following changes using red colour for the FGs for Multi-TRP PDCCH repetition:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | ~~23. NR\_FeMIMO~~ | ~~23-2-3~~ | ~~PDCCH repetition for Type3 CSS~~ | ~~Support of PDCCH repetition for Type3 CSS~~ |  |  | ~~Optional with capability signalling~~ | |
| Xiaomi [14] |  |
| Samsung [15] | **Proposal 10:** Not support (i.e., delete) FG 23-2-3. |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-3 | PDCCH repetition for Type3 CSS | Support of PDCCH repetition for Type3 CSS |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) [-CB] | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) [for CB]- sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  [2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]  [3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the basic feature in FG 23-3-1 and FG 23-3-1-1, we support the component 1 of the feature with the candidate values as {CB, non-CB, both}. So we propose the follow,  ***Proposal 3-3: Support the component 1 with candidate values {CB, non-CB, both} and remove the ‘-CB’ in FG 23-3-1/1-1,***  ***FG 23-3-1***   * + ***1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) - sequential mapping for repetitions larger than 2 [- cyclic mapping for 2 repetitions]***   In order to reduce the implementation complexity for a UE for the PHR calculation and report in MTRP across all CCs in a band, the max number of PHR report across CCs should be a UE capability.  ***Proposal 3-4: Support the component 2 in FG 23-3-1 and remove the corresponding bracket,***   * + ***2. The maximum number of supported PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission) is a UE capability, FFS on candidate value, which is no more than 2\*the number of supported CCs.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) ~~[-CB]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) ~~[for CB]~~- sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  ~~[~~2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)~~]~~  [3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | ~~[~~Candidate component values: {CB, non-CB, both}~~]~~ | Optional with capability signalling | |
| vivo [3] | We prefer to move component 2 in FG 23-3-1 to the relating FG 23-3-1c.  **Proposal 3-1: Following revisions on FG23-3-1 and FG23-3-1c are proposed.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) [-CB] | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) [for CB]~~- sequential mapping for repetitions larger than 2~~  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~  ~~[2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]~~  ~~[3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]~~  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling | |
| ZTE [4] | * For component 1 in FG 23-3-1, the condition of repetition number when sequential mapping should include “equal to 2”. According to the existing discussion in RAN1, sequential mapping pattern is specified as the first beam is applied to the first and second PUSCH repetitions, and the second beam is applied to the third and fourth PUSCH repetitions, and the same beam mapping pattern continues to the remaining PUSCH repetition. In addition, there is no agreement/ conclusion mentioned that sequential mapping cannot be configured for the case of repetition number equal to 2. * For component 7 in FG 23-3-1, it is NOT in line with any agreement in the previous RAN1 meetings so far, hence we think it should be removed. * For component 11 in FG 23-3-1, based on the enhanced aspects in RNA1, we fail to see any discrepancy between CB and NCB based MTRP PUSCH schemes from the perspective of UE capability, plus there is no relationship between the number of SRS resources and MTRP PUSCH related features. Hence we think it should be removed.  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1 | Multi-TRP PUSCH repetition (type A) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A)  - sequential mapping for repetitions equal to or larger than 2  - cyclic mapping for 2 repetitions  ~~[2. Support of cyclic mapping when the number of repetitions is larger than 2 for single DCI based M-TRP PUSCH repetition Type A]~~  ~~[3. Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2]~~  ~~[4. Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.) ]~~  ~~[5. Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.) ]~~  ~~[6. support of sequential mapping for single for single DCI based M-TRP PUSCH repetition Type A]~~  ~~[8. Support of A-CSI report on two PUSCH repetitions]~~  ~~[9. Support of SP-CSI report on two PUSCH repetitions]~~  2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission |  |  |  |  |  |  |  |  |  | |
| OPPO [5] | Component 1 in FG 23-3-1 is used to indicate whether multi-TRP PUSCH repetition is supported or not. If multi-TRP PUSCH repetition is supported, then 2 SRS resources are required. Therefore, there is no need to indicate number of SRS resources for multi-TRP PUSCH operations.  ***Proposal 4: For FG 23-3-1, suggest to remove“ number of SRS resources”in FFS .*** |
| CATT [6] | Component 1 in FG 23-3-1 is misleading. It seems when the number of repettitons is equal to two, only cyclic mapping can be configured. The related agreements for component 1 are as follows:   |  | | --- | | **Agreement**  **Confirm the following working assumption** (with removing the last bullet):  For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.   * The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. * FFS: Support of half-half mapping. * FFS: Additional considerations on mapping patterns (including required beam switching gaps)   **Agreement**  For multi-TRP PUCCH (scheme 1 and 3) and PUSCH (Type A and B) repetition, when the number of repetitions is equal to two, the first and second transmission occasion shall be associated with two TRPs, respectively (two UL beams or Power control parameter sets), regardless of the configured mapping pattern.   * Note: For M-TRP PUSCH type B, the number of repetitions refers to ‘nominal’ repetition. |   It can be seen from the agreements that sequential mapping also can be configured when the number of repetitions is equal to two. If sequential mapping is configured and the number of repetitions is equal to two, the first and second transmission occasions are associated with two TRPs, respectively. In order to avoid misleading, we suggest changing “sequential mapping for repetitions larger than 2” in component 1 to “sequential mapping”.  Since component 7 is not in line with any agreement in the previous RAN1 meetings, it should be removed from FG 23-3-1.  Indicating FG 23-3-1 is applied to which PUSCH transmission scheme(s) is not needed. That’s because whether FG 23-3-1 is applied to CB based PUSCH or NCB based PUSCH or both depends on which PUSCH transmission scheme(s) is supported by UE. If a UE supports FG 23-3-1 also support CB PUSCH, FG 23-3-1 shall be applied to CB based PUSCH. Similarly, if a UE supports FG 23-3-1 also support NCB PUSCH, FG 23-3-1 shall be applied to NCB based PUSCH.  UE features on supported max number of SRS resource per set for CB based and NCB based PUSCH have been defined in Rel-15, respectively. They can be applied to M-TRP PUSCH transmission directly. Therefore FFS in FG 23-3-1 can be removed.  Based on the discussions above, we have following proposal on FG 23-3-1:  ***Proposal-11: For FG 23-3-1, adopt the following:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A)~~[-CB]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) ~~[for CB]~~  - sequential mapping ~~for repetitions larger than 2~~  ~~[~~- cyclic mapping for 2 repetitions~~]~~  ~~[2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]~~  ~~[~~3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission~~]~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~ |  |  |  |  |  |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~ | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] | * + **23-3-1:**     - Component 3 needs to be confirmed in this FG. |
| NTT DOCOMO, INC. [7] | For M-TRP PUCCH, for FG23-3-1, we have following suggestion.   * Component1: the text “CB” can be removed, because this component should be common for CB and NCB. The text “cyclic mapping for 2 repetitions” should be kept, because if 2 repetitions is configured, it is cyclic mapping by default, and it should be supported by UE. * Component2 (maximum number of PHR): this component should be moved to FG23-3-1c * Component3 (dynamic switching): we support this component. * FFS: We support the FFS as well as the candidate component values.      |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions  2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission  3. Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | Candidate component values: {CB, non-CB, both} | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | **23-3-1**   * + - Remove [-CB] for feature group since it has already reflected in candidate component values.     - Component 1: Remove [for CB] since it has already reflected in candidate component values. Remove square bracket for cyclic mapping since it was agreed in RAN 1 meeting.     - Component 3: remove square bracket and support dynamic switching as a basic feature which makes it aligned with latest spec description.     - Remove FFS and add Component 4 supporting two SRS resource sets whose usage is CB or non-CB.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) -  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions[2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]  3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission  4. Support of two SRS resource sets for CB or non-CB PUSCH transmission |  |  |  |  |  |  |  |  | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling | |
| Intel Corporation [11] | * For FG 23-3-1 component 1   + support CB based mTRP PUSCH repetition as a basic feature   + the candidate component values should be {CB, CB + non-CB} such that CB based scheme is the basic UE capability   + support sequential and cyclical mapping for 2 repetitions   + remove the FFS since legacy parameters can be applied. * For FG 23-3-1, component 2 should be part of basic FG and removed. * For FG 23-3-1, component 7 should be part of basic FG and removed, since we do not have any limitation to the maximum number of PHR reporting in Rel-15/16. * For FG 23-3-1 component 11, CB based should be part of basic FG. * Add FG 23-3-1h: For NCB based PUSCH support of simultaneous precoding calculation for different associated NZP-CSI-RS within a CC (down-selection from RAN1#106b-e agreement). * Since the M-TRP PUSCH repetition Type A is based on Rel-16, only consecutive slots are considered. However, for Rel-17 coverage enhancement, non-consecutive slots can be used for PUSCH repetition type A, where the counting is based on available slots. The related coverage enhancement UE feature groups, 30-2 and 30-2a, are under discussion. Thus, if a UE has Rel-17 coverage enhancement capability and needs to support M-TRP PUSCH repetition Type A, additional UE capability to support non-consecutive slot based M-TRP PUSCH repetition Type A is needed. We propose to add FG 23-3-1i to support non-consecutive slot based M-TRP PUSCH repetition Type A, where   + prerequisite feature groups include FG 23-3-1 and [FG 30-2/30-2a].  |  |  |  |  | | --- | --- | --- | --- | | 23-3-1 | Multi-TRP PUSCH repetition (type A)~~[-CB]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) ~~[for CB]~~  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~  ~~[7. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]~~  ~~[2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]~~  ~~FFS: [11. Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources]~~ | [Candidate component values: {CB, ~~non-CB~~, ~~both~~ CB + non-CB}] | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) [-CB] | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) - sequential mapping  2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)  3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission  4. Support PUSCH operations: CB based and/or NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | 1. Candidate value {Support, not support}  2. Candidate value {1, 2, 4, 8}  3. Candidate value {Support, not support}  4. Candidate value {CB, NCB, both} | Optional with capability signalling | |
| CMCC [13] | Same as the structure of Rel-15 capability (FGs 2-14, 2-15, 2-15a, 2-15b), separate capabilities for codebook-based and non-codebook are required for M-TRP PUSCH transmission. In RAN1#103e meeting, the maximum number of SRS resource sets to two is supported for M-TRP PUSCH transmission. For codebook based PUSCH transmission, the following components should be taken into consideration:   1. Supported max number of SRS resource per set (SRS set use is configured as for codebook). 2. Supported max number of SRS resource set (SRS set use is configured as for codebook).   Similarly, for non-codebook based PUSCH transmission, the following components should be taken into consideration:   1. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook). 2. Supported max number of SRS resource set (SRS set use is configured as for non-codebook).   ***Proposal 6: Separate capabilities for codebook-based and non-codebook based M-TRP PUSCH transmission.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A)~~[~~-CB~~]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) ~~[~~for CB~~]~~  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  [7. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]  [2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]  ~~FFS: [11. Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources]~~  4. Supported max number of SRS resource per set (SRS set use is configured as for codebook).  5. Supported max number of SRS resource set (SRS set use is configured as for codebook). |  |  |  |  |  |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~ | Optional with capability signalling | | 23. NR\_FeMIMO | 23-3-1-2 | Multi-TRP PUSCH repetition (type A)-NCB | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) ~~[~~for CB~~]~~  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  [7. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]  [2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]  ~~FFS: [11. Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources]~~  4. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook).  5. Supported max number of SRS resource set (SRS set use is configured as for non-codebook). |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Xiaomi [14] | 1. On component 1, cyclic mapping is mandatory when number of repetitions is 2 and it is a basic UE feature, so we propose to remove the “[cyclic mapping for 2 repetitions]”. What’s more, we suggest to set the candidate component value as “both” because 23-3-1 can be shared by both “CB” and “NCB”. 2. On component 2, the related agreement was made in RAN1#106-e [6] as below.   **Agreement**  For PHR reporting related to M-TRP PUSCH repetition, support Option 4 as UE optional capability for a UE that supports mTRP PUSCH,   * Option 4: Calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.   From our perspective, component 2 is not in line with any agreement in the previous RAN1 FeMIMO discussion, so we suggest to remove it. FG23-3-1c can describe PHR reporting enough.   1. On component 3, from our perspective, this component indicates that the dynamic switching between S-TRP and M-TRP is supported or not. If the UE cannot support this component, then M-TRP transmission is always scheduled. So, we think component 3 should be basic FG and propose to remove this component.   ***Proposal 6: The proposed FG23-3-1 for M-TRP PUSCH repetition type A is shown as follows.***   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) [-both] | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) [for both]- sequential mapping for repetitions larger than 2  ~~[- cyclic mapping for 2 repetitions]~~  ~~[2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]~~  ~~[3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]~~  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling | |
| Samsung [15] | For FG 23-3-1 and 23-3-1-1, there were some inputs to clarify whether UE feature groups for CB and NCB should be separate or not. There are two method to clarify FG 23-3-1 and 23-3-1-1: [method 1] separate FGs for CB and NCB, [method 2] share FG for both CB and NCB and add candidate component value like {CB, NCB, both}. We think [method 2] is better because features in 23-3-1 and 23-3-1-1 can be applied for both CB and NCB and no need to make duplication. In Release 15, FG for CB and NCB should be separate to specify the different UE capability between CB and NCB. On the other hands, all features in FG 23-3-1 and FG 23-3-1-1 can be shared for both CB and NCB. If certain UEs can support mTRP PUSCH for only CB, candidate component value could be used for reporting UE capability.  Similar with a mTRP PUCCH repetition, we think that the support of up to two SRS resource sets (usage = codebook or nonCodebook) should be included as a component based on the following agreements.   |  | | --- | | Agreement (in RAN1#103-e)  For single DCI based M-TRP PUSCH repetition schemes, support codebook based PUSCH transmission with following enhancements.   * Support the indication of two SRIs.   + Alt1: Bit field of SRI shall be enhanced.   + Alt2: No changes on SRI field * Support the indication of two TPMIs.   + The same number of layers are applied for both TPMIs if two TPMIs are indicated   + The number of SRS ports between two TRPs should be same.   + FFS: Details on indicating two TPMIs (e.g, one TPMI field or two TPMI fields) * Increase the maximum number of SRS resource sets to two * FFS: configuration details of each SRS resource set (e.g., number of SRS resources in a resource set)   Agreement (in RAN1#103-e)  For single DCI based M-TRP PUSCH repetition schemes, support non-codebook based PUSCH transmission with following considerations.   * Increase the maximum number of SRS resource sets to two, and associated CSI-RS resource can be configured per SRS resource set. * FFS: Enhancements on SRI field in DCI to indicate the two beams for repetitions |   Therefore, we suggest adding new component 4 as basic feature of FG 23-3-1 and new component 2 as basic feature of FG 23-3-1-1.  **Proposal 16:** Add new component 4 as basic feature of FG 23-3-1 and FG 23-3-1-1 and share FG 23-3-1 and FG 23-3-1-1 for both CB and NCB PUSCH with candidate component values:   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) ~~[-CB]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) ~~[for CB]~~- sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  [2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]  [3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]  4. Support of up to two SRS resource sets with usage set to ‘codebook’ or ‘nonCodebook’  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | ~~[~~Candidate component values: {CB, non-CB, both}~~]~~ | Optional with capability signalling | |
| MediaTek Inc. [16] | Since codebook based PUSCH transmission is widely deployed, we prefer to make it as a basic feature of multi-TRP PUSCH repetition. We propose to change the name of FG 23-3-1 as “Basic multi-TRP PUSCH repetition”. Also, we should make multi-TRP non-codebook based PUSCH transmission as a separate FG with a similar structure as FG 2-15. For non-codebook based PUSCH transmission, a similar FG like FG 2-15b should be introduced since the number of SRS resources is doubled due to two SRS resource sets and the restriction that the two SRS resource sets should have the same number of SRS resources.  **Proposal 18: Change the name of FG 23-3-1 as “Basic multi-TRP PUSCH repetition” with the additional components:**   * **Support of codebook based PUSCH MIMO with maximum number of ports** * **Supported max number of SRS resources per set (SRS set use is configured as for codebook)**  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Basic multi-TRP PUSCH repetition | 1. Support of multi-TRP PUSCH repetition based on PUSCH repetition type A  2. Support of sequential mapping when the number of repetitions is larger than 2  3. Support of codebook based PUSCH MIMO with maximum number of ports  4. Supported max number of SRS resources per set (SRS set use is configured as for codebook) | **2-12** |  |  |  | Per FSPC |  |  |  | Component 3: {1, 2, 4}  Component 4: {1, 2} | **Optional with capability signalling** | | 23. NR\_FeMIMO | 23-3-1-2 | Multi-TRP PUSCH repetition type B | Support of multi-TRP PUSCH repetition based on PUSCH repetition type B | **23-3-1, 11-5** |  |  |  | Per FS |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | | 23. NR\_FeMIMO | 23-3-1a | Cyclic mapping for multi-TRP PUSCH repetition | Support of cyclic mapping when the number of repetitions is larger than 2 for multi-TRP PUSCH repetition | **23-3-1** |  |  |  | Per Band |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | One important remaining aspect is related to CB versus NCB differentiation. A UE should be able to indicate it supports only one of these operations for mTRP while both may be supported for legacy / sTRP. In addition, the existing CB / NCB parameters in Rel-15 corresponding FGs are not enough as two SRS resource sets are introduced for both cases for mTRP PUSCH operation (i.e., for the same number of SRS resources per SRS resource set, the total number of SRS resources is doubled for mTRP PUSCH). Hence, we would like to emphasize the following points:   * Separate and independent capabilities (two FGs) are required for codebook-based and non-codebook based mTRP PUSCH.   + For codebook-based mTRP PUSCH, the structure of Rel-15 capability (FG 2-14) including indication on max number of SRS resources need to be taken in to account, and should be extended for the case that two SRS resource sets are configured.   + For non-codebook based mTRP PUSCH, the structure of Rel-15 capability (FGs 2-15, 2-15a, 2-15b) including indication on max number of SRS resources and various capabilities for associated CSI-RS (for precoding calculation) need to be taken in to account, and should be extended for the case that two SRS resource sets / two associated CSI-RS resources are configured.   + These two FGs should be per FSPC similar to Rel-15 FGs 2-14 and 2-15. * To ensure that UE capability overhead is not increased too much, the CB and NCB capabilities can be shared between PUSCH repetition Type A and PUSCH repetition Type B as well as for some of the other FGs. This means that either FG 23-3-1 (for CB) or new FG 23-3-1-2 (for NCB) can be a prerequisite for FGs 23-3-1-1 or FGs 23-3-1a, 23-3-1b, …, 23-3-1g.   In addition, we think it would be beneficial to allow the UE to indicated that for CG mTRP PUSCH repetition, whether CG Type 1, CG Type 2, or both are supported.  Based on the discussions above, we suggest the following:  ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A) ~~[~~-CB~~]~~ | 1. Support of multi-TRP PUSCH repetition for codebook based PUSCH (based on PUSCH repetition type A) ~~[for CB]~~  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~  2. Support of two SRS resource sets with usage set to 'codebook'  3. Supported number of SRS resources in one SRS resource set  ~~[2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]~~  ~~[3. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~ | 2-14 |  |  |  | Per FSPC |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~  Component 3: {1,2,4} | Optional with capability signalling | | 23. NR\_FeMIMO | 23-3-1-2 | Multi-TRP PUSCH repetition (type A) - NCB | 1. Support of multi-TRP PUSCH repetition for non-codebook based PUSCH (based on PUSCH repetition type A)  2. Support of two SRS resource sets with usage set to 'nonCodebook'  3. Supported number of SRS resources in one SRS resource set | 2-15 |  |  |  | Per FSPC |  |  |  | Component 3: {1,2,3,4} | Optional with capability signalling | | 23. NR\_FeMIMO | 23-3-1-2a | Two associated CSI-RS resources | Support of up to two CSI-RS resources associated with the two SRS resource sets for non-codebook-based mTRP PUSCH | 2-15a  23-3-1-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-3-1-2b | CSI-RS processing framework for SRS with two associated CSI-RS resources | 1. Maximum number of periodic SRS resources associated with first or second CSI-RS per BWP  2. Maximum number of aperiodic SRS resources associated with first or second CSI-RS per BWP  3. Maximum number of semi-persistent SRS resources associated with first or second CSI-RS per BWP  4. UE can process Y SRS resources associated with first or second CSI-RS resources simultaneously in a CC. Includes P/SP/A SRS. | 23-3-1-2a |  |  |  | Per Band |  |  |  | Component 1: {1 to 8}  Component 2: {1 to 8}  Component 3: {1 to 8}  Component 4: {1 to 16} | Optional with capability signalling | |
| Ericsson [19] | On component 3, our understanding is that ‘dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission’ should be supported by a UE that supports FG 23-3-1. Hence, there is no strong need to capture this as a component in FG 23-3-1.  The other open issue is if FG 23-3-1 should support both CB based and NCB based PUSCH. We think it makes sense to split FG23-3-1 into two FGs specific for CB-based and NCB-based PUSCH. Similarly, FG 23-3-1-1 should be split into two FGs for CB-based and NCB-based PUSCH.   1. Remove Components 3 from FG 23-3-1. 2. Split FG 23-3-1 into two feature groups, one for CB-based PUSCH and the other for non-CB based PUSCH. |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-3-1a | Cyclic mapping | Support of cyclic mapping when the number of repetitions is larger than 2 for single DCI based M-TRP PUSCH repetition Type A |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1a | Cyclic mapping | Support of cyclic mapping when the number of repetitions is larger than 2 for single DCI based M-TRP PUSCH repetition Type A | 23-3-1 |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-3-1a, we have following suggestion.   * Remove “for single DCI based M-TRP PUSCH repetition Type A”, because this FG should be common for repetition Type A and Type B.      |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1a | Cyclic mapping | Support of cyclic mapping when the number of repetitions is larger than 2 |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | For FG 23-3-1a/b/c/e/f/g, we are open to both ways (Way1: duplicate FG 23-3-1a/b/c/e/f/g for FG 23-3-1-1, Way2: share FG 23-3-1a/b/c/e/f/g for both FG 23-3-1 and FG 23-3-1-1). However, some of FG 23-3-1a/b/c/e/f/g cannot be supported for either FG 23-3-1 or FG 23-3-1-1 by the UE. Similarly, certain UEs can support some of FG 23-3-1a/b/c/e/f/g for either CB or NCB. Therefore, we think candidate component values for FG 23-3-1a/b/c/e/f/g are needed if those FGs are shared for both FG 23-3-1 and FG 23-3-1-1. As examples of candidate component values, we can consider {‘typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}.  **Proposal 17:** If FG 23-3-1a/b/c/e/f/g are shared for both FG 23-3-1 and FG 23-3-1-1, discuss the necessity of candidate component values for FG 23-3-1a/b/c/e/f/g to consider that some capabilities cannot be supported for either FG 23-3-1 or FG 23-3-1-1 and either CB or NCB by the UE. As examples of candidate component values, we can consider {typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}. |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1a | Cyclic mapping | Support of cyclic mapping when the number of repetitions is larger than 2 for single DCI based M-TRP PUSCH repetition Type A | 23-3-1 or 23-3-1-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-3-1b | Second TPC field | Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2 |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1b | Second TPC field | Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2 | 23-3-1 |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | For FG 23-3-1a/b/c/e/f/g, we are open to both ways (Way1: duplicate FG 23-3-1a/b/c/e/f/g for FG 23-3-1-1, Way2: share FG 23-3-1a/b/c/e/f/g for both FG 23-3-1 and FG 23-3-1-1). However, some of FG 23-3-1a/b/c/e/f/g cannot be supported for either FG 23-3-1 or FG 23-3-1-1 by the UE. Similarly, certain UEs can support some of FG 23-3-1a/b/c/e/f/g for either CB or NCB. Therefore, we think candidate component values for FG 23-3-1a/b/c/e/f/g are needed if those FGs are shared for both FG 23-3-1 and FG 23-3-1-1. As examples of candidate component values, we can consider {‘typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}.  **Proposal 17:** If FG 23-3-1a/b/c/e/f/g are shared for both FG 23-3-1 and FG 23-3-1-1, discuss the necessity of candidate component values for FG 23-3-1a/b/c/e/f/g to consider that some capabilities cannot be supported for either FG 23-3-1 or FG 23-3-1-1 and either CB or NCB by the UE. As examples of candidate component values, we can consider {typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}. |
| MediaTek Inc. [16] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1b | Second TPC field for multi-TRP PUSCH repetition | Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2 | **23-3-1** |  |  |  | Per Band |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1b | Second TPC field | Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2 | 23-3-1 or 23-3-1-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.) |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] | We prefer to move component 2 in FG 23-3-1 to the relating FG 23-3-1c.  **Proposal 3-1: Following revisions on FG23-3-1 and FG23-3-1c are proposed.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | 1. Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.)  2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission) |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| ZTE [4] | * For FG 23-3-1c, it is in line with previous agreement in RAN1,hence we think it can be approved.   *.*   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1c | Two PHR reporting | Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.) | 23-3-1 |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-3-1c, we support the text in yellow.     |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | 1.Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.)  2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission) |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | For FG 23-3-1a/b/c/e/f/g, we are open to both ways (Way1: duplicate FG 23-3-1a/b/c/e/f/g for FG 23-3-1-1, Way2: share FG 23-3-1a/b/c/e/f/g for both FG 23-3-1 and FG 23-3-1-1). However, some of FG 23-3-1a/b/c/e/f/g cannot be supported for either FG 23-3-1 or FG 23-3-1-1 by the UE. Similarly, certain UEs can support some of FG 23-3-1a/b/c/e/f/g for either CB or NCB. Therefore, we think candidate component values for FG 23-3-1a/b/c/e/f/g are needed if those FGs are shared for both FG 23-3-1 and FG 23-3-1-1. As examples of candidate component values, we can consider {‘typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}.  **Proposal 17:** If FG 23-3-1a/b/c/e/f/g are shared for both FG 23-3-1 and FG 23-3-1-1, discuss the necessity of candidate component values for FG 23-3-1a/b/c/e/f/g to consider that some capabilities cannot be supported for either FG 23-3-1 or FG 23-3-1-1 and either CB or NCB by the UE. As examples of candidate component values, we can consider {typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}. |
| MediaTek Inc. [16] | For FG 23-3-1c “Two PHR reporting”, we propose to simplify the component description as “Support of reporting up to two PHRs per CC for multi-TRP PUSCH repetition”.  **Proposal 21: For FG 23-3-1c, change the component description as “Support of reporting up to two PHRs per CC for multi-TRP PUSCH repetition”.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | Support of reporting up to two PHRs per CC for multi-TRP PUSCH repetition | **23-3-1** |  |  |  | Per Band |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.) | 23-3-1 or 23-3-1-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-3-1e | A-CSI report | Support of A-CSI report on two PUSCH repetitions |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1d | A-CSI report | Support of A-CSI report on two PUSCH repetitions | 23-3-1 |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | For FG 23-3-1a/b/c/e/f/g, we are open to both ways (Way1: duplicate FG 23-3-1a/b/c/e/f/g for FG 23-3-1-1, Way2: share FG 23-3-1a/b/c/e/f/g for both FG 23-3-1 and FG 23-3-1-1). However, some of FG 23-3-1a/b/c/e/f/g cannot be supported for either FG 23-3-1 or FG 23-3-1-1 by the UE. Similarly, certain UEs can support some of FG 23-3-1a/b/c/e/f/g for either CB or NCB. Therefore, we think candidate component values for FG 23-3-1a/b/c/e/f/g are needed if those FGs are shared for both FG 23-3-1 and FG 23-3-1-1. As examples of candidate component values, we can consider {‘typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}.  **Proposal 17:** If FG 23-3-1a/b/c/e/f/g are shared for both FG 23-3-1 and FG 23-3-1-1, discuss the necessity of candidate component values for FG 23-3-1a/b/c/e/f/g to consider that some capabilities cannot be supported for either FG 23-3-1 or FG 23-3-1-1 and either CB or NCB by the UE. As examples of candidate component values, we can consider {typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}. |
| MediaTek Inc. [16] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1e | A-CSI multiplexing | Support of A-CSI report on two PUSCH repetitions | **23-3-1** |  |  |  |  |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1e | A-CSI report | Support of A-CSI report on two PUSCH repetitions | 23-3-1 or 23-3-1-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-3-1f | SP-CSI report | Support of SP-CSI report on two PUSCH repetitions |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1e | SP-CSI report | Support of SP-CSI report on two PUSCH repetitions | 23-3-1 |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | For FG 23-3-1a/b/c/e/f/g, we are open to both ways (Way1: duplicate FG 23-3-1a/b/c/e/f/g for FG 23-3-1-1, Way2: share FG 23-3-1a/b/c/e/f/g for both FG 23-3-1 and FG 23-3-1-1). However, some of FG 23-3-1a/b/c/e/f/g cannot be supported for either FG 23-3-1 or FG 23-3-1-1 by the UE. Similarly, certain UEs can support some of FG 23-3-1a/b/c/e/f/g for either CB or NCB. Therefore, we think candidate component values for FG 23-3-1a/b/c/e/f/g are needed if those FGs are shared for both FG 23-3-1 and FG 23-3-1-1. As examples of candidate component values, we can consider {‘typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}.  **Proposal 17:** If FG 23-3-1a/b/c/e/f/g are shared for both FG 23-3-1 and FG 23-3-1-1, discuss the necessity of candidate component values for FG 23-3-1a/b/c/e/f/g to consider that some capabilities cannot be supported for either FG 23-3-1 or FG 23-3-1-1 and either CB or NCB by the UE. As examples of candidate component values, we can consider {typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}. |
| MediaTek Inc. [16] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1f | SP-CSI multiplexing | Support of SP-CSI report on two PUSCH repetitions | **23-3-1** |  |  |  |  |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1f | SP-CSI report | Support of SP-CSI report on two PUSCH repetitions | 23-3-1 or 23-3-1-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-3-1g | CG PUSCH transmission | Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.) |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1f | CG PUSCH transmission | Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.) | 23-3-1 |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | For FG 23-3-1a/b/c/e/f/g, we are open to both ways (Way1: duplicate FG 23-3-1a/b/c/e/f/g for FG 23-3-1-1, Way2: share FG 23-3-1a/b/c/e/f/g for both FG 23-3-1 and FG 23-3-1-1). However, some of FG 23-3-1a/b/c/e/f/g cannot be supported for either FG 23-3-1 or FG 23-3-1-1 by the UE. Similarly, certain UEs can support some of FG 23-3-1a/b/c/e/f/g for either CB or NCB. Therefore, we think candidate component values for FG 23-3-1a/b/c/e/f/g are needed if those FGs are shared for both FG 23-3-1 and FG 23-3-1-1. As examples of candidate component values, we can consider {‘typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}.  **Proposal 17:** If FG 23-3-1a/b/c/e/f/g are shared for both FG 23-3-1 and FG 23-3-1-1, discuss the necessity of candidate component values for FG 23-3-1a/b/c/e/f/g to consider that some capabilities cannot be supported for either FG 23-3-1 or FG 23-3-1-1 and either CB or NCB by the UE. As examples of candidate component values, we can consider {typeA’, ‘typeB’, ‘both’} and {‘CB’, ‘NCB’, ‘both’}. |
| MediaTek Inc. [16] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1d | Multi-TRP CG PUSCH transmission | Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.) | **23-3-1** |  |  |  | Per Band |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1g | CG PUSCH transmission | 1. Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.)  2. Supported type of configured grant for multi-TRP PUSCH repetition | 23-3-1 or 23-3-1-2 |  |  |  | Per Band |  |  |  | Component 2: {Type1, Type2, both} | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-3-1-1 [-CB] | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) [for CB]  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | ***FG 23-3-1-1***   * + ***1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B)***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 ~~[-CB]~~ | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[for CB]~~  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | ~~[~~Candidate component values: {CB, non-CB, both}~~]~~ | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | * For FG 23-3-1-1, the FFS part should be removed because of the same reason of component 11 in FG 23-3-1.  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-1-1 | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B)  ~~FFS: discuss details (to be discussed after type A is stable~~ |  |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] | Similar as FG 23-3-1, indicating FG 23-3-1-1 is applied to which PUSCH transmission scheme(s) and the FFS on the support PUSCH operations are not needed.  ***Proposal-12: For FG 23-3-1-1, adopt the following:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 | Multi-TRP PUSCH repetition (type B) ~~[-CB]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[for CB]~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources]~~ |  |  |  |  |  |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~ | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] | * + **23-3-1-1**:     - Confirm the FG. Details to be further discussed based on structure of 23-3-1. |
| NTT DOCOMO, INC. [7] | For FG23-3-1-1, we have following suggestion.   * Component1: similar as FG23-3-1, the text “CB” should be removed. And similar as FG23-3-1, support of “sequential mapping for repetitions larger than 2” and “cyclic mapping for 2 repetitions” should be added. * A new component of “support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission” should be added similar as FG23-3-1. * FFS: we support the FFS as well as the candidate component values.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 ~~[-CB]~~ | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions  2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission  3. Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | Candidate component values: {CB, non-CB, both} | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | * For FG 23-3-1-1 component 1,   + support CB based mTRP PUSCH repetition as a basic feature   + the candidate component values should be {CB, CB + non-CB}.  |  |  |  |  | | --- | --- | --- | --- | | 23-3-1-1 | Multi-TRP PUSCH repetition (type B) ~~[-CB]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ) ~~[for CB]~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~ | [Candidate component values: {CB, ~~non-CB~~, ~~both~~ CB + non-CB}] | |  |  |  |  | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 [-CB] | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B)  2. Support PUSCH operations: CB based and/or NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling | |
| CMCC [13] | Same as the structure of Rel-15 capability (FGs 2-14, 2-15, 2-15a, 2-15b), separate capabilities for codebook-based and non-codebook are required for M-TRP PUSCH transmission. In RAN1#103e meeting, the maximum number of SRS resource sets to two is supported for M-TRP PUSCH transmission. For codebook based PUSCH transmission, the following components should be taken into consideration:   1. Supported max number of SRS resource per set (SRS set use is configured as for codebook). 2. Supported max number of SRS resource set (SRS set use is configured as for codebook).   Similarly, for non-codebook based PUSCH transmission, the following components should be taken into consideration:   1. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook). 2. Supported max number of SRS resource set (SRS set use is configured as for non-codebook).   ***Proposal 6: Separate capabilities for codebook-based and non-codebook based M-TRP PUSCH transmission.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 | Multi-TRP PUSCH repetition (type B) ~~[~~-CB~~]~~ | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[~~for CB~~]~~  ~~FFS: discuss details (to be discussed after type A is stable~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~  2. Supported max number of SRS resource per set (SRS set use is configured as for codebook).  3. Supported max number of SRS resource set (SRS set use is configured as for codebook). |  |  |  |  |  |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~ | Optional with capability signalling | | 23. NR\_FeMIMO | 23-3-1-3 | Multi-TRP PUSCH repetition (type B) -NCB | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[~~for CB~~]~~  ~~FFS: discuss details (to be discussed after type A is stable~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~  2. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook).  3. Supported max number of SRS resource set (SRS set use is configured as for non-codebook). |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Xiaomi [14] | 1. On component 1, based on the discussion in PUCCH repetition type A, the candidate component value can also be set as “both” for PUSCH repetition type B.   ***Proposal 7: The proposed FG23-3-1-1 for M-TRP PUSCH repetition type B is shown as follows.***   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 [-both] | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) [for both]  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling | |
| Samsung [15] | For FG 23-3-1 and 23-3-1-1, there were some inputs to clarify whether UE feature groups for CB and NCB should be separate or not. There are two method to clarify FG 23-3-1 and 23-3-1-1: [method 1] separate FGs for CB and NCB, [method 2] share FG for both CB and NCB and add candidate component value like {CB, NCB, both}. We think [method 2] is better because features in 23-3-1 and 23-3-1-1 can be applied for both CB and NCB and no need to make duplication. In Release 15, FG for CB and NCB should be separate to specify the different UE capability between CB and NCB. On the other hands, all features in FG 23-3-1 and FG 23-3-1-1 can be shared for both CB and NCB. If certain UEs can support mTRP PUSCH for only CB, candidate component value could be used for reporting UE capability.  Similar with a mTRP PUCCH repetition, we think that the support of up to two SRS resource sets (usage = codebook or nonCodebook) should be included as a component based on the following agreements.   |  | | --- | | Agreement (in RAN1#103-e)  For single DCI based M-TRP PUSCH repetition schemes, support codebook based PUSCH transmission with following enhancements.   * Support the indication of two SRIs.   + Alt1: Bit field of SRI shall be enhanced.   + Alt2: No changes on SRI field * Support the indication of two TPMIs.   + The same number of layers are applied for both TPMIs if two TPMIs are indicated   + The number of SRS ports between two TRPs should be same.   + FFS: Details on indicating two TPMIs (e.g, one TPMI field or two TPMI fields) * Increase the maximum number of SRS resource sets to two * FFS: configuration details of each SRS resource set (e.g., number of SRS resources in a resource set)   Agreement (in RAN1#103-e)  For single DCI based M-TRP PUSCH repetition schemes, support non-codebook based PUSCH transmission with following considerations.   * Increase the maximum number of SRS resource sets to two, and associated CSI-RS resource can be configured per SRS resource set. * FFS: Enhancements on SRI field in DCI to indicate the two beams for repetitions |   Therefore, we suggest adding new component 4 as basic feature of FG 23-3-1 and new component 2 as basic feature of FG 23-3-1-1.  **Proposal 16:** Add new component 4 as basic feature of FG 23-3-1 and FG 23-3-1-1 and share FG 23-3-1 and FG 23-3-1-1 for both CB and NCB PUSCH with candidate component values:   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 ~~[for CB]~~ | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[for CB]~~  2. Support of up to two SRS resource sets with usage set to ‘codebook’ or ‘nonCodebook’  FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources |  |  |  |  |  |  |  |  | ~~[~~Candidate component values: {CB, non-CB, both}~~]~~ | Optional with capability signalling | |
| MediaTek Inc. [16] | **Proposal 19: Add FG 23-3-1-1 “Multi-TRP PUSCH repetition – Non-codebook based” with the following components:**   * **Support of multi-TRP non-codebook based PUSCH repetition** * **Maximum number of supported layers** * **Supported maximum number of SRS resources per set (SRS set use is configured as for non-codebook transmission)** * **Maximum number of simultaneous transmitted SRS resources at one symbol**  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 | Multi-TRP PUSCH repetition – Non-codebook based | 1. Support of multi-TRP non-codebook based PUSCH repetition  2. Maximum number of supported layers  3. Supported maximum number of SRS resources per set (SRS set use is configured as for non-codebook transmission)  4. Maximum number of simultaneous transmitted SRS resources at one symbol | **23-3-1, 2-15** |  |  |  | Per FSPC |  |  |  | Component 3: {1,2,4}  Component 4: {1,2,3,4}  Component 5: {1,2,3,4} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 4-1: Adopt the following for Rel-17 mTRP PUSCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1 ~~[-CB]~~ | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[for CB]~~  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~ | 23-3-1 or 23-3-1-2 |  |  |  | Per FS |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~ | Optional with capability signalling | |
| Ericsson [19] | 1. Split FG 23-3-1-1 into two feature groups, one for CB-based PUSCH and the other for non-CB based PUSCH. |

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| 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)- sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  [2. Support of up to two PUCCH spatial relation per PUCCH resource] | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] | **Proposal 3-2: Following revisions on FG23-3-2 and FG23-3-3 are proposed.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)~~- sequential mapping for repetitions larger than 2~~  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~  [2. Support of up to two PUCCH spatial relations/power controls per PUCCH resource] | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| ZTE [4] | * For component 1 in FG 23-3-2, the condition of “equal to 2” should be added due to the same reason of component 1 in FG 23-3-1. * For component 2 in FG 23-3-2, we can ve agreeable of it in principle. However, note that up to two spatial relations can be activated per PUCCH resource in FR2 but two power control parameter sets can be activated per PUCCH resource in FR1, the case of MTRP PUCCH in FR1 should be included.  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-2 | Multi-TRP PUCCH repetition-inter-slot | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  ~~2. Support of PUCCH repetition scheme 3 (intra-slot repetition)~~  - sequential mapping for repetitions equal to or larger than 2  - cyclic mapping for 2 repetitions  [2. Support of up to two PUCCH spatial relation or two power control parameter sets per PUCCH resource]  ~~32. Support of cyclic mapping for beam mapping/power control parameter set mapping [when the number of repetitions is larger than 2] for both PUCCH repetitions scheme 1 and 3 when the number of repetitions is larger than 2~~  ~~43. Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats [1\_0 /] 1\_1 / 1\_2~~ | FFS |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] | Similarly as that for M-TRP PUSCH repetition, sequential mapping for M-TRP PUCCH repetition is a basic feature and can be configured when the number of repetitions is equal to two.  For Multi-TRP PUCCH repetition, two power control parameter sets are always configured. Since spatial relation info may not be configured for FR1, we suggest including power control parameter sets in component 2.  ***Proposal-13: For M-TRP PUCCH repetition, adopt the following changes:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition-inter-slot | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  - sequential mapping ~~for repetitions larger than 2~~  ~~[~~- cyclic mapping for 2 repetitions ~~]~~  ~~[~~2. Support of up to two PUCCH spatial relation/power control parameter sets per PUCCH resource~~]~~ | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For M-TRP PUCCH, for FG23-3-2, we have following suggestion.   * Component1: the text in bracket should be kept. If 2 repetitions is configured, it is cyclic mapping by default, and it should be supported by UE. * Component2: this component should be removed. If UE supports M-TRP PUCCH repetition, it means UE supports two PUCCH spatial relations/power control parameters per PUCCH resource. There is no need to have a separate component.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | * + - Component 1: Remove square bracket for cyclic mapping since it was agreed in RAN 1 meeting.     - Component 2: RAN 2 agreed to introduce a new IE for power control for mTRP FR 1 operation. So we can revise it as follows: Support of up to two PUCCH spatial relation per PUCCH resource for FR 2 and up to [two PC sets] per PUCCH resource for FR 1.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions  2. Support of up to two PUCCH spatial relation per PUCCH resource for FR 2 and up to [two PC sets] per PUCCH resource for FR 1. | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | * For FG 23-3-2 component 1, support sequential and cyclical mapping for 2 repetitions. * For FG 23-3-2 component 2, support up to two PUCCH spatial relation per PUCCH resource.      |  |  |  |  | | --- | --- | --- | --- | | 23-3-2 | Multi-TRP PUCCH repetition-inter-slot | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions ~~]~~  ~~[~~2. Support of up to two PUCCH spatial relation per PUCCH resource~~]~~ |  | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)- sequential mapping | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| CMCC [13] | Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource should be basic feature for UE supported M-TRP PUCCH inter or intra-slot repetition. So, component 2 in FG 23-3-2 should be modified to “Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource” and remove the corresponding bracket. This component should be also added in FG 23-3-x as a basic component.  ***Proposal 7: Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource as basic feature in FG 23-3-2***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition-inter-slot | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  ~~2. Support of PUCCH repetition scheme 3 (intra-slot repetition)~~  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions ]  ~~[~~2. Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource~~]~~  ~~32. Support of cyclic mapping for beam mapping/power control parameter set mapping [when the number of repetitions is larger than 2] for both PUCCH repetitions scheme 1 and 3 when the number of repetitions is larger than 2~~  ~~43. Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats [1\_0 /] 1\_1 / 1\_2~~ | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Xiaomi [14] | 1. On component 1, cyclic mapping is mandatory when number of repetitions is 2 and it is a basic UE feature, so we suggest to remove the “[cyclic mapping for 2 repetitions]”. 2. On component 2, the related agreement was made in RAN1#103-e [8] as below.   **Agreement**  For multi-TRP TDM-ed PUCCH transmission schemes,   * Support the use of a single PUCCH resource * Up to two spatial relation info’s can be activated per PUCCH resource via MAC CE * FFS: Required enhancements for FR1 * FFS: Use of multiple PUCCH resources.   Based on the agreement, we think component 2 should be basic FG and propose to remove this component.  ***Proposal 8: The proposed FG23-3-2 for M-TRP PUCCH scheme 1 is shown as follows.***   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)- sequential mapping for repetitions larger than 2  ~~[- cyclic mapping for 2 repetitions]~~  ~~[2. Support of up to two PUCCH spatial relation per PUCCH resource]~~ |  | Optional with capability signalling | |
| Samsung [15] | In RAN1#107b-e, we suggested to add component 2 ‘Support of up to two PUCCH spatial relation per PUCCH resource’ as basic feature for FG 23-3-2. However, this statement is only for FR2. To cover not only FR2 but also FR1, we propose the following for component 2 in FG 23-3-2 and add the modified component 2 in FG 23-3-3 (FG for multi-TRP PUCCH repetition-intra-slot).  **Proposal 15:** Support the following modification for component 2 in FG 23-3-2 to cover both FR1 and FR2 and add the modified component 2 in FG 23-3-3:   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)- sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  ~~[~~2. Support of up to two power control parameter sets per PUCCH resource in FR1 and up to two PUCCH spatial relation info per PUCCH resource in FR2~~]~~ | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| MediaTek Inc. [16] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | Support of multi-TRP PUCCH inter-slot repetition |  |  |  |  | Per FS |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | | 23. NR\_FeMIMO | 23-3-2-1 | Multi-TRP PUCCH intra-slot repetition | Support of multi-TRP PUCCH intra-slot repetition | **23-3-2** |  |  |  | Per FS |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | | 23. NR\_FeMIMO | 23-3-2a | Cyclic mapping for multi-TRP PUCCH repetition | Support of cyclic mapping when the number of repetitions is larger than 2 for multi-TRP PUCCH repetition | **23-3-2** |  |  |  | Per Band |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | | 23. NR\_FeMIMO | 23-3-2b | Second TPC field for multi-TRP PUCCH repetition | Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2 | **23-3-2** |  |  |  | Per Band |  |  |  | {Supported, Not supported} | **Optional with capability signalling** | |
| Lenovo [17] | It was agreed in RAN1#104bis-e [6] that a MAC CE indicates two power control sets for multi-TRP PUCCH repetition in FR1. However, the maximum number of configured power control sets is not discussed in RAN1 meeting. And there is an LS from RAN2 which inquires about the number of configured power control sets for PUCCH in FR1 [7], however, this wasn’t been discussed on MIMO UE features. Therefore, we propose to introduce a new component of FG 23-3-2 and FG 23-3-3 corresponding to the maximum number of power control sets configured for multi-PUCCH in FR1.   1. For each of FG 23-3-2 and FG 23-3-3, introduce a new component “the maximum number of power control sets configured for multi-PUCCH in FR1” |
| Qualcomm Incorporated [18] | The following aspects need to be considered for mTRP PUCCH repetition capability:   * Supported PUCCH format(s) need to be indicated for each of the Scheme 1 and Scheme 3, i.e., a bitmap of size 5 can be added as a component to indicate support for PUCCH formats 0-4 for both 23-3-2 and 23-3-3. * Updating two beams / power control parameters for a group of PUCCH resources requires a UE capability with a pre-requisite of corresponding Rel-16 feature in the case of one beam (i.e., FG 16-1b-3)   Hence, we have the following proposal:  ***Proposal 5-1: Adopt the following for Rel-17 mTRP PUCCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  ~~[2. Support of up to two PUCCH spatial relation per PUCCH resource]~~  2. Supported PUCCH formats for this scheme | ~~FFS~~ |  |  |  | Per FS |  |  |  | Component 2: A bit map of size 5 for PUCCH format 0-4. At least one value of the bitmap should be set to 1. | Optional with capability signalling | | 23. NR\_FeMIMO | 23-3-2d | Updating two Spatial relation or two sets of power control parameters for PUCCH group | Support of updating two Spatial Relation Info’s / two sets of power control parameters for a group of PUCCH resources in a CC by MAC-CE | 16-1b-3  23-3-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-3-2b |  | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | FFS |  |  |  |  |  |  |  | FFS: candidate values | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | * For FG 23-3-2b, the candidate component values can include 4 and 8 based on the previous agreements in RAN1 as follows.  |  |  | | --- | --- | | ***Agreement*** *(in RAN1#105-e)*  *Confirm the working assumption with removing brackets on [consecutive] and adding UE capability.*   * *For PUCCH reliability enhancement, support multi-TRP intra-slot repetition (Scheme 3) for all PUCCH formats.*   + *The same PUCCH resource carrying UCI is repeated for X = 2 ~~[~~consecutive~~]~~ sub-slots within a slot.*   + *Refer the design details related to sub-slot configurations (e.g. other values of X) to Rel-17 eIIoT* * *Note1: The decision of supporting scheme 3 is only applicable for multi-TRP operation.*   *This feature is optional.*  ***Agreement*** *(in RAN1#107-e)*  *For sub-slot based PUCCH repetition, the following agreement from Cov. Enh. WI for slot-based PUCCH repetition is adopted also for sub-slot based PUCCH repetition:*   |  | | --- | | *Agreement*   * *In Rel-17, reuse the Rel-16 PUCCH repetition factors 2, 4, 8.* * *Do not support PUCCH repetition factor larger than 8 In Rel-17.* | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-2b |  | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | FFS |  |  |  |  |  |  |  | FFS: candidate component values: {4, 8} | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2b |  | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | * For FG 23-3-2b, the candidate component values can be {4, 8} for all PUCCH formats.  |  |  |  |  | | --- | --- | --- | --- | | 23-3-2b |  | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | Candidate component values: {4, 8} | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 5-1: Adopt the following for Rel-17 mTRP PUCCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2b | Cyclic mapping for multi-TRP PUCCH repetition | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | ~~FFS~~  23-3-2 |  |  |  | Per Band |  |  |  | ~~FFS: candidate values~~ | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-3-2c |  | Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2 | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-2c |  | Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2 | FFS |  |  |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 5-1: Adopt the following for Rel-17 mTRP PUCCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-2c | Second TPC field for multi-TRP PUCCH repetition | Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2 | ~~FFS~~  23-3-2 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions] | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] | **Proposal 3-2: Following revisions on FG23-3-2 and FG23-3-3 are proposed.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~ | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-3-x | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions equal to or larger than 2  - cyclic mapping for 2 repetitions | FFS |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] | Similarly as that for M-TRP PUSCH repetition, sequential mapping for M-TRP PUCCH repetition is a basic feature and can be configured when the number of repetitions is equal to two.  For Multi-TRP PUCCH repetition, two power control parameter sets are always configured. Since spatial relation info may not be configured for FR1, we suggest including power control parameter sets in component 2.  ***Proposal-13: For M-TRP PUCCH repetition, adopt the following changes:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping ~~for repetitions larger than 2~~  ~~[~~- cyclic mapping for 2 repetitions~~]~~ | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-3-3, similar as FG23-3-2, the text in bracket should be kept.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | * + - Remove square bracket for cyclic mapping since it was agreed in RAN 1 meeting. |
| Intel Corporation [11] | * For FG 23-3-x component 1, support sequential and cyclical mapping for 2 repetitions.  |  |  |  |  | | --- | --- | --- | --- | | 23-3-x | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~ |  | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| CMCC [13] | Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource should be basic feature for UE supported M-TRP PUCCH inter or intra-slot repetition. So, component 2 in FG 23-3-2 should be modified to “Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource” and remove the corresponding bracket. This component should be also added in FG 23-3-x as a basic component.  ***Proposal 7: Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource as basic feature in FG 23-3-2 and FG 23-3-x.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-x | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  2. Support of up to two PUCCH spatial relation / up to two sets of power control parameters per PUCCH resource | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Xiaomi [14] | 1. On component 1, similar as PUCCH repetition scheme 1, we propose to remove “[cyclic mapping for 2 repetitions]”.   ***Proposal 9: The proposed FG23-3-3 for M-TRP PUCCH scheme 3 is shown as follows.***   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  ~~[- cyclic mapping for 2 repetitions]~~ |  | Optional with capability signalling | |
| Samsung [15] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | 1.Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  2. Support of up to two power control parameter sets per PUCCH resource in FR1 and up to two PUCCH spatial relation info per PUCCH resource in FR2 | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| MediaTek Inc. [16] |  |
| Lenovo [17] | It was agreed in RAN1#104bis-e [6] that a MAC CE indicates two power control sets for multi-TRP PUCCH repetition in FR1. However, the maximum number of configured power control sets is not discussed in RAN1 meeting. And there is an LS from RAN2 which inquires about the number of configured power control sets for PUCCH in FR1 [7], however, this wasn’t been discussed on MIMO UE features. Therefore, we propose to introduce a new component of FG 23-3-2 and FG 23-3-3 corresponding to the maximum number of power control sets configured for multi-PUCCH in FR1.   1. For each of FG 23-3-2 and FG 23-3-3, introduce a new component “the maximum number of power control sets configured for multi-PUCCH in FR1” |
| Qualcomm Incorporated [18] | The following aspects need to be considered for mTRP PUCCH repetition capability:   * Supported PUCCH format(s) need to be indicated for each of the Scheme 1 and Scheme 3, i.e., a bitmap of size 5 can be added as a component to indicate support for PUCCH formats 0-4 for both 23-3-2 and 23-3-3.   ***Proposal 5-1: Adopt the following for Rel-17 mTRP PUCCH UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  2. Supported PUCCH formats for this scheme | ~~FFS~~  23-3-2  25-3 |  |  |  | Per FS |  |  |  | Component 2: A bit map of size 5 for PUCCH format 0-4. At least one value of the bitmap should be set to 1. | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  [2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI]  [3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI] |  |  |  |  |  |  |  |  | [Component 2 candidate values: {1,2,3,7}]  [Component 3 candidate values: {0,1,2,3,7}]    [Note: case1 and case2 cannot be enabled simultaneously] | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] | Similar to the discussions on UE feature for <Enhancements on Multi-beam Operation>, we propose the following:  ***Proposal 3-5: Support the component 2/3 in FG 23-4 as follows and remove the corresponding brackets***   * + ***2. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs, with candidate values {0, 1, 2, 3, 4, 5, 6, 7};***   + ***3. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs, with candidate values {0, 1, 2, 3, 4, 5, 6, 7};***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  ~~[~~2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI~~]~~  ~~[~~3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI~~]~~ |  |  |  |  |  |  |  |  | ~~[~~Component 2 candidate values: {1,2,3,4,5,6,7}~~]~~  ~~[~~Component 3 candidate values: {0,1,2,3,4,5,6,7}~~]~~    [Note: case1 and case2 cannot be enabled simultaneously] | Optional with capability signalling | |
| vivo [3] | **Proposal 4-1: Following revision on IntCell-mTRP UE feature is proposed:**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  ~~[~~2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI~~]~~  ~~[~~3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different from the configuration in component 2 ~~with SSB time domain positions and periodicity of the serving cell PCI]~~ |  |  |  |  |  |  |  |  | ~~[~~Component 2 candidate values: {1,2,3,7}~~]~~    ~~[~~Component 3 candidate values: {0,1,2,3,7}~~]~~      ~~[~~Note: case1 and case2 cannot be enabled simultaneously~~]~~ | Optional with capability signalling | |
| ZTE [4] | For FG 23-3-4, we have the following comments:   * For component 3, the current draft description is NOT in line with the previous agreement in RAN1 as follows. Note that case 1 means the configurations of SSB time domain positions and periodicity of the additional PCIs **is the same as** SSB time domain positions and periodicity of the serving cell PCI, hence case 2 should capture the complementary set of case 1, which is the configurations of SSB time domain positions and periodicity of the additional PCIs **is fully or partially different with** SSB time domain positions and periodicity of the serving cell PCI. * For the candidate values of component 2 and component 3, the value 0 in component 3 should be removed. Given that the description of the note below, when only case 2 is enabled and then the UE reports component 3 candidate value is 0, that is inconsistent with this FG because no additional PCI can be used for MTRP inter-cell operation.  |  | | --- | | ***Agreement*** *(in RAN1#106bis-e)*  *Support two independent X values (X1, X2) are reported as a UE capability for two different assumptions on additional SSB time domain position and periodicity with respect to serving cell SSB.*   * *X1 (Case 1)= The maximum number of configured additional PCIs when each configuration~~s~~ of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI* * *X2 (Case 2)= The maximum number of configured additional PCIs when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1* * *Note: By definition, Case 1 and Case 2 cannot be enabled simultaneously* * *Supported values for X1 and X2 include~~s~~ at least 0,1,2,3 and 7. FFS on other values* * *This UE capability has FR1 and FR2 differentiation (FFS : Whether this UE capability is per UE or per band)* |   According to the above check points, we have the following proposal.  ***Proposal 8:*** *Update the yellow parts in 23-4 as follows.*   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  [2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI]  [3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is fully or partially different with SSB time domain positions and periodicity of the serving cell PCI]  ~~[2. Support of X>1 (max number of PCIs different from serving cell)]~~  ~~[3. Supported max number of RRC-configured PCIs different from serving cell PCI for [FR1/case1] (X1)] [SSB time domain positions or periodicity of additional PCIs is not exactly the same as serving cell PCI)]~~  ~~[4. Supported max number of RRC-configured PCIs different from serving cell PCI for [FR2/case2] (X2)] [SSB time domain positions and periodicity are exactly the same among the additional PCIs and the same as serving cell PCI]~~  ~~[5. default case to be supported, e.g., case2 with X2=1]~~ |  |  |  |  |  |  |  |  | [Component 2 candidate values: {1,2,3,7}]  [Component 3 candidate values: {1,2,3,7}]    [Note: case1 and case2 cannot be enabled simultaneously] | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | Component 2 is well aligned with the agreement. But component 3 needs to be updated to be aligned with the agreement, which should be ‘not according to the case in component 2’. The deployment scenario in component 2 is important for commercial NW, hence, it could be defined as a default case for inter-cell MTRP operation, i.e., candidate value of 0 is not needed for component 2.  Regarding the note, it is true that case1 and case2 cannot be enabled simultaneously. However, it is related to NW configuration instead of UE feature, thus, the note can be removed.  **Proposal 5: Adopt the following for Rel-17 beam management for M-TRP.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI  3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to the case in component 2 |  |  |  |  |  |  |  |  | Component 2 candidate values: {1,2,3,7}  Component 3 candidate values: {0,1,2,3,7} | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | Regarding UE capabilities for inter-cell mTRP, components 2 and 3 should be kept   |  |  |  |  | | --- | --- | --- | --- | | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  ~~[~~2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI~~]~~  ~~[~~3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI~~]~~ | Per band | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI  3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI |  |  |  |  |  |  |  |  | Component 2 candidate values: {0, 1,2,3,7}  Component 3 candidate values: {0,1,2,3,7}    [Note: case1 and case2 cannot be enabled simultaneously] | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | An agreement with respective to the number of additional PCI(s) different from serving cell associated with the TCI state as shown follows [9]:  ***Agreement***  *Support two independent X values (X1, X2) are reported as a UE capability for two different assumptions on additional SSB time domain position and periodicity with respect to serving cell SSB.*   * *X1 (Case 1)= The maximum number of configured additional PCIs when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI* * *X2 (Case 2)= The maximum number of configured additional PCIs when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1* * *Note: By definition, Case 1 and Case 2 cannot be enabled simultaneously* * *Supported values for X1 and X2 include~~s~~ at least 0,1,2,3 and 7. FFS on other values* * *This UE capability has FR1 and FR2 differentiation (FFS : Whether this UE capability is per UE or per band)*   We have already agreed that the candidate values for both X1 and X2 include {0,1,2,3,7} and the number of additional PCI(s) different from serving cell associated with the TCI state for FR1 and FR2 are different.  ***Proposal 10: Revise FG-23-4 as follows.***   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  [2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI] ()  [3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI]  [4.Supported values of X1 and X2 for FR1 and FR2] |  |  |  |  | [Component 4 candidate values for FR1: {0,1,2,3,7}  candidate values for FR2: {0,1,2,3,7}  ]  [Note: case1 and case2 cannot be enabled simultaneously] | Optional with capability signalling | |
| Samsung [15] | For component 23-4, we support to confirm/agree the definitions of X1 and X2, i.e., X1 is the maximum number of configured additional PCIs when each configuration of SSB time domain positions and periodicities of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI, and X2 is the maximum number of configured additional PCIs when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI. Support candidate values for both X1 and X2 as {1, 2, 3, 7}. We do not think it is necessary to report 0 for X2 because 1 as the minimum capability for X2 should be sufficient.  **Proposal 18:** Support confirming/agreeing definitions of X1 and X2 in FG 23-4; for both components 2 and 3 in FG 23-4, support candidate values {1, 2, 3, 7}. |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | The following agreement needs to be implemented, and the language of components 2 and 3 should be aligned with this agreement.  **Agreement**  Support two independent X values (X1, X2) are reported as a UE capability for two different assumptions on additional SSB time domain position and periodicity with respect to serving cell SSB.   * X1 (Case 1)= The maximum number of configured additional PCIs when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI * X2 (Case 2)= The maximum number of configured additional PCIs when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1 * Note: By definition, Case 1 and Case 2 cannot be enabled simultaneously * Supported values for X1 and X2 include at least 0,1,2,3 and 7. FFS on other values * This UE capability has FR1 and FR2 differentiation (FFS : Whether this UE capability is per UE or per band)   Furthermore, we prefer to add value 0 to Component 2 and add a note that UE needs to indicate a non-zero value for at least one of component 2 or component 3. This allows UE to support either Case 1 or Case 2, which have different complexity with respect to rate matching as well as L1-RSRP measurements.  Hence, we have the following proposal:  ***Proposal 6-1: Adopt the following for Rel-17 inter-cell mTRP UE features (modifications in red).***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  ~~[~~2. The maximum number of configured additional PCIs is X1 (Case 1) when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI~~]~~  ~~[~~3. The maximum number of configured additional PCIs is X2 (Case 2) when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1 ~~different with SSB time domain positions and periodicity of the serving cell PCI]~~ |  |  |  |  | Per Band |  |  |  | ~~[~~Component 2 candidate values: {0,1,2,3,7}~~]~~  ~~[~~Component 3 candidate values: {0,1,2,3,7}~~]~~  Note: UE indicates a non-zero value for at least one of component 2 or component 3  ~~[~~Note: case1 and case2 cannot be enabled simultaneously~~]~~ | Optional with capability signalling | |
| Ericsson [19] | Regarding Component 3 and 4, the carefully drafted formulations in the agreements should be used.   1. Indication of parameter X1 for Case 1, providing the supported max number of RRC-configured PCIs different from serving cell PCI when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI 2. Indication of parameter X2 for Case 2, providing the supported max number of RRC-configured PCIs different from serving cell PCI when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1   A note can be provided that X2=1 is the default in case RAN2 decided in a signalling structure that requires a default case.   1. Adopt revised formulation proposed in Section 2.2.2 of this contribution for components 3 and 4 of FG 23-4.   The Rel-17 Inter-cell mTRP is an extension of Rel-16 Multi-DCI based Multi-TRP functionality. FG 16-2a which indicates UE is capable of CORESETPoolIndex configuration shall be supported as a prerequisite feature group for FG 23-4.   1. Add FG16-2a as prerequisite feature group for FG 23-4. |

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| 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets  [2. Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs]  [3. Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs] |  |  |  |  |  |  |  |  | Component 1 candidate values: {1,2,3,4}  Component 2 candidate values: FFS  Component 3 candidate values: FFS  FFS: If FG 23-5-1a is not introduced, the relationship of this FG with FG 16-1g/16-1g-1 needs to be further clarified | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | * + Regarding #. RS for both CMR sets (component-2/3), we are open to have some further discussion.  |  |  |  | | --- | --- | --- | | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets  [2. Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs]  [3. Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs] | |
| OPPO [5] | The components 2 and 3 shall be kept in 23-5-1. In Rel-17 group based L1-RSRP measurement, the UE is provided with two sets of CMR and the UE is required to measured and report CRI/SSBRI from both CMR sets. Thus, the total number of SSBs or CSI-RS resources in both CMR sets shall be part of UE processing capability.  ***Proposal 6: On FG23-5-1: keep components 2 and 3.*** |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] | * + **23-5-1:**      - OK to confirm components 2 and 3 |
| NTT DOCOMO, INC. [7] | For 23-5-1, the component 2 and 3 could be removed. In Rel-15, max number of SSB/CSI-RS for beam measurement for L1-RSRP is defined, regardless of non-group based or group-based beam reporting, which could be reused for this Rel-17 feature. If a new UE feature has to be introduced for Rel-17 group based L1-RSRP beam reporting, component 2 is sufficient.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets |  |  |  |  |  |  |  |  | Component 1 candidate values: {1,2,3,4} | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | **23-5-1**   * + - Component 2 and 3: It should be removed and can be covered by the separate row of 23-5-1a or existing 16-1g.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets |  |  |  |  |  |  |  |  | Component 1 candidate values: {1,2,3,4} | Optional with capability signalling | |
| Intel Corporation [11] | Regarding 23-5-1 and 23-5-1a, it was brought up in RAN1#107b-e on the inter-relation with 16-1g and 16-1g-1. In general, we think that restrictions on the number of measurements and measurement configurations should encompass multi-beam, inter-cell and multi-TRP FGs so there is no need to discuss such limitation in parallel for different sub-topics. In terms of whether 16-1g and 16-1g-1 should also apply to Rel-17 feMIMO measurements, we are open to discuss it if it does not cause under-reporting of capabilities for Rel-16. We are also open to have new FGs similar to 16-1g and 16-1g-1 for Rel-17.   |  |  |  |  | | --- | --- | --- | --- | | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets  [2~~3.~~ Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs]  [3~~4.~~ Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs] | Per band | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets  2. Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs  3. Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs |  |  |  |  |  |  |  |  | Component 1 candidate values: {1,2,3,4}  Component 2 candidate values: FFS  Component 3 candidate values: FFS  FFS: If FG 23-5-1a is not introduced, the relationship of this FG with FG 16-1g/16-1g-1 needs to be further clarified | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | We support components 2 and 3 in FG 23-5-1. We suggest candidate values for component 2 as {1, 2, 3, 4} and component 3 as {8, 16, 32, 64}. For FG 23-5-1a, the maximum number of CSI-RS and/or SSB resources per NBI-RS set needs to be defined, which is needed to complete RAN2 signalling design.  **Proposal 19:** Support components 2 and 3 in FG 23-5-1 with candidate values {1, 2, 3, 4} and {8, 16, 32, 64} respectively; support to add/specify maximum number of different CSI-RS and/or SSB resources per NBI-RS set in FG 23-5-1a. |
| MediaTek Inc. [16] | On components 2 and 3 in current FG 23-5-1, we think they can be counted as a part of FG 16-1g/16-1g-1. No need to additionally report these values for L1-RSRP measurements.  **Proposal 22: Remove components 2 and 3 from current FG 23-5-1, and add a note in FG 16-1g/16-1g-1 to clarify L1-RSRP measurements associated with Rel-17 group based L1-RSRP reporting enhancements (FG 23-5-1) are also taken into account**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets  ~~[2. Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs]~~  ~~[3. Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs]~~ |  |  |  |  |  |  |  |  | Componet 1: Candidate values: {1,2,3,4} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 7-1***: For FG 23-5-1 on the enhanced group based L1-RSRP report (R1-2200780), suggest to consider the following changes.   * For component 3, 4   + Suggest to include them to the FG 23-5-1a, or add a note to clarify the resources in FG 23-5-1 are counted in FG 16-1g |
| Ericsson [19] | Regarding Component 2, this is more of a description of the whole feature rather than a useful component.  On Component 5, two CMR resource sets are already captured in 38.214 and is needed to operate this feature. So, we do not see the need to capture this as a component in this FG.   1. Remove Components 2 and 5 from FG 23-5-1. |

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| 23. NR\_FeMIMO | 23-5-1a | Resources [for beam management , PL measurement, BFD, RLM, and new beam identification] | Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations  If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted |  |  |  |  |  |  |  |  | Component 1 candidate values: FFS | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | With the latest draft CRs for Rel-17 FeMIMO, some configurations for Rel-15/16 beam measurement/reporting/failure-recovery are reused for beam measurement/reporting/failure-recovery for multi-TRP scenario in Rel-17. In this case, it is necessary to clarify that the consumed UE processing capability for multi-TRP scenario in Rel-17 are included in the reported UE capability in FG 16-1g/16-1g-1 (accounting for all beam-related measurements). We propose the following:  ***Proposal 3-6: Clarify that the supported number of RSs for beam measurement/reporting/failure-recovery for multi-TRP scenario in Rel-17 are included in FG 16-1g/16-1g-1, and support FG 23-5-1a and remove brackets.***  A UE needs to turn on two panels simultaneously to measure two CMR resource sets with two different QCL-TypeD assumptions in FR2, which would result in high UE implementation complexity. So we propose:  ***Proposal 3-7: Add a new FG 23-5-1b as follows***  ***FG 23-5-1b: Applying two QCL TypeD for group based L1-RSRP reporting enhancement***   * + ***Simultaneous reception of CSI-RS/SSB across two CMR sets with different QCL-TypeD assumptions on the same OFDM symbol***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-1a | Resources ~~[~~for beam management , PL measurement, BFD, RLM, and new beam identification~~]~~ | Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations  If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted |  |  |  |  |  |  |  |  | Component 1 candidate values: FFS | Optional with capability signalling | | 23. NR\_FeMIMO | 23-5-1b | Two QCL TypeD for group based L1-RSRP reporting enhancements | 1. Simultaneous reception of CSI-RS/SSB across two CMR sets with different QCL-TypeD assumptions on the same OFDM symbol |  |  |  |  |  |  |  | FR2 only |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | * + Regarding FG 23-5-1a, as we mentioned in Section 1, we think that instead of introducing a duplicated FG, the legacy FG 16-1g/1g-1 can be reused with some necessary clarification for that in Rel-17 TS 38.306.  |  |  |  | | --- | --- | --- | | ~~23-5-1a~~ | ~~Resources [for beam management , PL measurement, BFD, RLM, and new beam identification]~~ | ~~Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations~~  ~~If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted~~ | |
| OPPO [5] | The motivation of 23-5-1a is to report the total number of RS resources that the UE is capable of processing for beam measurement, including BM, PL, BFD, RLM and new beam identification functions. In our view, this FG shall be kept for rel17 since new beam measurement and reporting and new beam failure recovery function were introduced.  ***Proposal 7: Keep the FG 23-5-1a*** |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For 23-5-1a, it is also not needed as Rel-16 has introduced max number of resources for beam management, pathloss measurement, BFD, RLM and new beam identification, which could be reused for this Rel-17 feature.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | * + - Prefer to keep this row considering the number of increased beam measurement related resources in Rel-17, e.g., increased BFD-RSs from increased number of BFD-RS sets, inter-cell beam measurement. Similar discussion is ongoing for component 12, 13 of **23-1-2** with regard to inter-cell beam management, it seems to be natural to cover the component 12, 13 of **23-1-2** in this row, too. |
| Intel Corporation [11] | Regarding 23-5-1 and 23-5-1a, it was brought up in RAN1#107b-e on the inter-relation with 16-1g and 16-1g-1. In general, we think that restrictions on the number of measurements and measurement configurations should encompass multi-beam, inter-cell and multi-TRP FGs so there is no need to discuss such limitation in parallel for different sub-topics. In terms of whether 16-1g and 16-1g-1 should also apply to Rel-17 feMIMO measurements, we are open to discuss it if it does not cause under-reporting of capabilities for Rel-16. We are also open to have new FGs similar to 16-1g and 16-1g-1 for Rel-17.   |  |  |  |  | | --- | --- | --- | --- | | 23-5-1a | Resources [for beam management , PL measurement, BFD, RLM, and new beam identification] | Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations  If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted |  | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-1a | Resources [for beam management , PL measurement, BFD, RLM, and new beam identification] | Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations  If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted |  |  |  |  |  |  |  |  | Component 1 candidate values: {1, 2, 4, 8} | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] | FG 23-5-1 Group based L1-RSRP Beam reporting enhancements  As mentioned above, we don't think separate reported values are needed, and they can be counted as a part of FG 16-1g/16-1g-1. We suggest to remove this FG.  **Proposal 23: Remove FG 23-5-1a.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | ~~23-5-1a~~ | ~~Resources [for beam management , PL measurement, BFD, RLM, and new beam identification]~~ | ~~Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations~~  ~~If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted~~ |  |  |  |  |  |  |  |  | ~~Component 1 candidate values: FFS~~ | **~~Optional with capability signalling~~** | |
| Lenovo [17] | New features of beam management to support multi-TRP operation is introduced in Rel-17. For example, the number of resources for beam management may be doubled for a cell configured with multi-TRP operation. Based on the Rel-16 principle, all the resources for beam management, BFD and NBI for multi-TRP operation in one cell should be counted as part of FG 23-5-1a. Therefore, FG 23-5-1a is needed for NR\_feMIMO.   1. FG 23-5-1a is needed and the resources in both FG 23-5-1 and 23-5-2 for beam management, BFD and NBI should be part of FG 23-5-1a |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  2. [Support of Rel-17 M-TRP BFR based on two BFD-RS sets]  [3. Support PUCCH-SR resource for MTRP BFRQ]  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP |  |  |  |  |  |  |  |  | [Candidate values: {1, 2,…}] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | To reflect UE processing capability on number of CCs with beam failure recovery running, there needs be to a UE feature on maximum number of CCs on which spCell/SCell/MTRP BFR in Rel-15/16/17 can be configured. We then propose the following:  ***Proposal 3-8: Add a new component in FG 23-5-2 as follows***   * + ***5. The maximum number of CCs configured with BFR (including spCell/SCell/MTRP BFR in Rel-15/16/17), with candidate values {1, 2, 3, 4, 5, 6, 7, 8, 9}***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  2. [Support of Rel-17 M-TRP BFR based on two BFD-RS sets]  [3. Support PUCCH-SR resource for MTRP BFRQ]  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP  5. The maximum number of CCs configured with BFR (including spCell/SCell/MTRP BFR in Rel-15/16/17) |  |  |  |  |  |  |  |  | [Candidate values: {1, 2,…}]  5. Candidate values: {1, 2, 3, 4, 5, 6, 7, 8, 9} | Optional with capability signalling | |
| vivo [3] | **Proposal 5-1:** **We** **suggest to revise the FG 23-5-2a as following**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  ~~2. [Support of Rel-17 M-TRP BFR based on two BFD-RS sets]~~  ~~[3. Support PUCCH-SR resource for MTRP BFRQ]~~  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP | [Candidate values: {1, 2,…}] | Optional with capability signalling | |
| ZTE [4] | * + For mTRP-BFR, 2 BFD-RS sets should be supported, and so we do not think that we need the component-2 in FG 23-5-2.   + Regarding Component 3 in FG 23-5-2, as for SCell-BFR, PUCCH-SR should be mandatorily supported for a UE, and due to the same reason, we think that at least one PUCCH-SR should be supported as in a basic feature.  |  |  |  | | --- | --- | --- | | 23-5-2 | MTRP BFR enhancements | 1. ~~Support of~~ the maximum number of supported BFD-RS resources per set  ~~2. [Support of Rel-17 M-TRP BFR based on two BFD-RS sets]~~  ~~[~~3. Support PUCCH-SR resource for MTRP BFRQ~~]~~  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP | |
| OPPO [5] | In FG 23-5-2, the component 2 can be removed since reporting the component 1 can indicate the supporting of per TRP BFR. And the component 3 shall be kept since supporting SR for mTRP BFR shall be an optional UE feature. Even for the case without configuring SR for mTRP BFR, the UE still can send mTRP BFRQ in any uplink grant.  ***Proposal 8: In FG 23-5-2: delete component 2 and keep component 3.***  For component 2: it shall be removed because the basic function of FG 23-5-2 is per-TRP BFR. For components 3, 4, 5 and 7: we are fine to keep them. For component 6: the current description is not accurate and we do not think it is needed too. If it is kept, we suggest to change it to “6. The maximum number SR configuration for MTRP BFR”. For component 8: it is not needed.  ***Proposal 10: On FG23-5-2:***   * ***Keep components 3/4/5/7.*** * ***Remove component 2 and 8.*** * ***For component 6: remove it or change it to “the maximum number of SR configurations for MTRP BFR”*** |
| CATT [6] | The following agreement related to the number of BFD-RS sets was achieved in RAN1#104-e.   |  | | --- | | **Agreement**  For M-TRP BFR   * Support 2 BFD-RS sets per BWP, and up to N resources per BFD-RS set   + FFS: value of N (e.g. fixed in specification, or UE capability) * FFS: number of BFD RSs across all BFD-RS sets per DL BWP (e.g. fixed maximum value or UE capability) |   For UEs who support MTRP BFR enhancements, two BFD-RS sets should also be supported. Therefore, Component 2 is basic feature of FG 23-5-2, and related brackets can be removed. For PUCCH-SR resource, UEs who support MTRP BFR enhancements can be configured with zero PUCCH resource. Therefore, Component 3 can be removed from FG 23-5-2 and combined with FG 23-5-2a.  ***Proposal-14: Feature group 23-5-2 can be revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-5-2 | MTRP BFRenhancements | 1. Support of the maximum number of BFD-RS resources per set  2. ~~[~~Support of Rel-17 M-TRP BFR based on two BFD-RS sets~~]~~  ~~[3. Support PUCCH-SR resource for MTRP BFRQ]~~  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP |  |  |  |  | [Candidate values: {1, 2,…}] | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For 23-5-2, component 2 is naturally supported for MTRP BFR and separate component is not needed. To make the description more complete, ‘two BFD-RS sets’ can be added into component 1. For PUCCH-SR for BFR, Rel-16 does not introduce related UE feature, hence, it is assumed that one PUCCH-SR for BFR could be baseline so that component 3 can be kept.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set, for two BFD-RS sets  3. Support of one PUCCH-SR resource for MTRP BFRQ  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP |  |  |  |  |  |  |  |  | Candidate values: {1, 2} | Optional with capability signalling | |
| Spreadtrum Communications [9] | Regarding component 2 and 3, we think they are the basic factors for MTRP BFR enhancement. We are fine to keep them in FG23-5-2.  ***Proposal 5: For FG23-5-2, suggest to remove the brackets on component 2 and component 3.*** |
| LG Electronics [10] | * + - Component 2: It can be redundant, since component 1 and 4 already imply that the UE supports M-TRP BFR with two BFD-RS sets.     - Component 3: It is not needed if FG 23-5-2a is introduced.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP |  |  |  |  |  |  |  |  | [Candidate values: {1, 2,…}] | Optional with capability signalling | |
| Intel Corporation [11] | * FG 23-5-2, components 2 and 3 are okay but component 2 is the FG description.      |  |  |  |  | | --- | --- | --- | --- | | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  [2. Support of Rel-17 M-TRP BFR based on two BFD-RS sets]  [3. [Support of one PUCCH-SR resource for MTRP BFRQ]  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP | Per band | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  2. Support of Rel-17 M-TRP BFR based on two BFD-RS sets  3. Support PUCCH-SR resource for MTRP BFRQ  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP  5. Support of TRP-specific BFR for inter-cell mTRP operation |  |  |  |  |  |  |  |  | 1. Candidate values {1, 2}  4. Candidate values: {2, 3, 4} | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | As for component 1 in FG 23-5-2, according to the agreement in RAN1-106 e-meeting [6] listed below, the candidate value can be ‘1’. Since for cell specific BFR-set, the maximum number of BFD-RS resources per set can be ‘2’, it is reasonable to support ‘2’ as well. While for the candidate value larger than ‘2’, we don’t have essential reasons to support it.  ***RAN1-106 e-meeting-Agreement***  *The maximum number of BFD-RS resources per set is a UE capability, including a possible candidate value of 1 in Rel.17.*  While for the component 4 in FG23-5-2, “Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP”, we support it in principle according to the agreement in RAN1-104b e-meeting [10]. Since the maximum number of BFD-RS resources across two BFD-RS sets per BWP is {1, 2}, the candidate value of “Support of the maximum number of BFD-RS resources across two BFD-RS sets per BWP” can be {2, 3, 4}.  And for component 3, since there is a separate FG 23-5-2a, it is better to delete it.  ***RAN1-104b e-meeting-Agreement***  *On BFD-RS of TRP-specific BFR*   * *BFD-RS resource number:*    + *The total number of RSs in two BFR-RS sets per DL BWP is a UE capability*   + *On the maximum number of RS per BFD-RS set, down-select from the following two alternatives in RAN1#105-e*     - *Alt1: max value is 2*     - *Alt2: max value is a UE capability, including possible candidate value of 1*   ***Proposal 11: Support component 1 and component 4 in FG23-5-2, and delete component 3.***   1. Support component 1 “Support of the maximum number of BFD-RS resources per set” with candidate value {1, 2} only. 2. Support component 4 by updating to “Support of the maximum number of BFD-RS resources across two BFD-RS sets per BWP” with candidate value {2, 3, 4}. 3. Delete component 3. |
| Samsung [15] | We support FG 23-5-2 in principle. Support candidate values {1, 2} for component 1 in FG 23-5-2, and candidate values {1, 2, 3, 4} for component 4 in FG 23-5-2.  **Proposal 20:** Support FG 23-5-2 for MTRP BFR enhancements. Support candidate values {1, 2} for component 1, and {1, 2, 3, 4} for component 4 in FG 23-5-2. |
| MediaTek Inc. [16] | FG 23-5-1 Group based L1-RSRP Beam reporting enhancements  On components 2 and 3 in current FG 23-5-1, we think they can be counted as a part of FG 16-1g/16-1g-1. No need to additionally report these values for L1-RSRP measurements.  **Proposal 22: Remove components 2 and 3 from current FG 23-5-1, and add a note in FG 16-1g/16-1g-1 to clarify L1-RSRP measurements associated with Rel-17 group based L1-RSRP reporting enhancements (FG 23-5-1) are also taken into account**  On components 2 and 3 in current FG 23-5-2, they should be supported as the basic components.  **Proposal 24: Support components 2 and 3 in current FG 23-5-2**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  2. ~~[~~Support of Rel-17 M-TRP BFR based on two BFD-RS sets~~]~~  ~~[~~3. Support PUCCH-SR resource for MTRP BFRQ~~]~~  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP |  |  |  |  |  |  |  |  | Component 1: [Candidate values: {1, 2}]  Component 7: {2, 3, 4} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 7-2***: For FG 23-5-2 on the mTRP BFR enhancement (R1-2200780), suggest to consider the following changes.   * For component 2   + Suggest to remove the bracket, and move it to be the 1st component * For component 6   + It can be removed and add candidate value of 0 for the 1st component of the FG 23-5-2a |
| Ericsson [19] | On Component 2, two BFD-RS sets are already captured in 38.213 and is needed to operate this feature. So, we do not see the need to capture this as a component in this FG.   1. Remove Components 2 from FG 23-5-2. |

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| 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  [2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)] |  |  |  |  |  |  |  |  | Component candidate values: {[0,1], 2} | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] | **Proposal 5-1:** **We** **suggest to revise the FG 23-5-2a as following**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  ~~[~~2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)~~]~~ | Component candidate values: {~~[~~0,1~~]~~, 2} | Optional with capability signalling | |
| ZTE [4] | * + Regarding Component 1 in FG 23-5-2a, as we discussed for above Component 3 in FG 23-5-2, the component value of [0, 1] is not needed.   + Regarding Component 2 in FG 23-5-2a, if we introduce more than one PUCCH-SR, straightforwardly we need to support the association between a BFD-RS resource set on sPCell and a PUCCH SR resource.  |  |  |  | | --- | --- | --- | | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  🡪 Component candidate values: {~~[0,1],~~ 2}  ~~[2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)]~~ | |
| OPPO [5] | In FG 23-5-2a, the component 2 shall be kept. In previous RAN1 agreement, supporting such a association is indicated through a UE capability signalling:   |  | | --- | | **Agreement**  Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR.   * FFS: Configure an association between a BFD-RS set on SCell and a PUCCH-SR resource / SR configuration for per TRP BFR   A UE capability signaling is introduced for indicating the support of this association. Above applies only for multi-DCI case. |   ***Proposal 9: In FG 23-5-2a: keep component 2.*** |
| CATT [6] | The following agreement related to the number of BFD-RS sets was achieved in RAN1#104-e.   |  | | --- | | **Agreement**  For M-TRP BFR   * Support 2 BFD-RS sets per BWP, and up to N resources per BFD-RS set   + FFS: value of N (e.g. fixed in specification, or UE capability) * FFS: number of BFD RSs across all BFD-RS sets per DL BWP (e.g. fixed maximum value or UE capability) |   For UEs who support MTRP BFR enhancements, two BFD-RS sets should also be supported. Therefore, Component 2 is basic feature of FG 23-5-2, and related brackets can be removed. For PUCCH-SR resource, UEs who support MTRP BFR enhancements can be configured with zero PUCCH resource. Therefore, Component 3 can be removed from FG 23-5-2 and combined with FG 23-5-2a.  For FG 23-5-2a, it was agreed in RAN1#106b-e that a UE capability signaling is introduced for indicating the support of this association (between BFD-RS resource set on sPCell and a PUCCH SR resource). Therefore, the brackets in Component 2 can be removed. It was also agreed that a UE configured with TRP-specific BFR can be configured with 1 PUCCH-SR resource in a cell group. Similar to SCell BFR, 0 is also a candidate value of PUCCH-SR configuration. Thus brackets related to candidate values can be removed.  ***Proposal-14: Feature group 23-5-2 can be revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  ~~[~~2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)~~]~~ |  |  |  |  | Component 1 candidate values: {~~[~~0,1~~]~~, 2} | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For 23-5-2a, candidate value of 2 is needed for component 1. As one PUCCH-SR for BFR is baseline, there is no need to support candidate values of 0 and 1. For component 2, we have related agreement so it should be kept.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2) |  |  |  |  |  |  |  |  | Component candidate values: {2} | Optional with capability signalling | |
| Spreadtrum Communications [9] | In RAN1#106bis-e meeting, we have the following agreement on association between BFD-RS set and PUCCH-SR resource.  **Agreement**  Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR.   * FFS: Configure an association between a BFD-RS set on SCell and a PUCCH-SR resource / SR configuration for per TRP BFR   A UE capability signaling is introduced for indicating the support of this association. Above applies only for multi-DCI case.  Thus, we prefer to remove the bracket on component 2 of FG23-5-2a. Regarding the default behavior, i.e., if UE not supporting the capability, in our understanding, it means that it is up to UE’s implementation to determine the association between BFD-RS set and PUCCH-SR resource.  ***Proposal 6: For FG23-5-2a, suggest to remove the brackets on component 2.*** |
| LG Electronics [10] | * + - Component 1: Prefer to revise the component 1 as below, since we think there is no need to introduce value range. All UE must support at least one PUCCH-SR for BFRQ as Rel-16 BFR. All we need to define is to indicate whether to support two PUCCH-SR resources or not.     - Component 2: Based on the below agreement, square bracket can be removed.   **Agreement**  Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR.   * FFS: Configure an association between a BFD-RS set on SCell and a PUCCH-SR resource / SR configuration for per TRP BFR   A UE capability signaling is introduced for indicating the support of this association. Above applies only for multi-DCI case.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Support of two PUCCH-SR resources for MTRP BFRQ  2. Association between BFD-RS resource set on SpCell and a PUCCH SR resource |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | * FG 23-5-2a, component 2: We don’t think this is needed, a UE supporting 2 PUCCH-SR resources should naturally support association. If association is not supported, a single PUCCH-SR resource with repetition can be used.  |  |  |  |  | | --- | --- | --- | --- | | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  ~~[2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)]~~ |  | |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2) |  |  |  |  |  |  |  |  | Component candidate values: {0,1, 2} | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | In addition, according to the agreement in RAN1-106b e-meeting [9] listed as below, A UE capability signaling is introduced for indicating the support of the association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR. Thus we prefer to keep component 2 in FG23-5-2a.  ***RAN1-106b e-meeting-Agreement***  *Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR.*   * *FFS: Configure an association between a BFD-RS set on SCell and a PUCCH-SR resource / SR configuration for per TRP BFR*   *A UE capability signaling is introduced for indicating the support of this association. Above applies only for multi-DCI case.*  ***Proposal 12: keep component 2 in FG23-5-2a,***   * 2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2) |
| Samsung [15] | For PUCCH-SR resource configuration (FG 23-5-2a), we support to confirm/agree component 2, which is based on RAN1 agreements. We support candidate values {1, 2} for component 1 in FG 23-5-2a.  **Proposal 21:** Support FG 23-5-2a for PUCCH-SR resource configuration for MTRP BFR. Support candidate values {1, 2} for component 1 in FG 23-5-2a. |
| MediaTek Inc. [16] | On components 2 in current FG 23-5-2a, according to the following agreement, UE should be able to report whether to support the association between a BFD-RS set on SpCell and a PUCCH-SR resource by capability signaling. Thus, component 2 should be included in a separate FG to let UE reports whether support or not.   |  | | --- | | **Agreement from RAN1#106b**  Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR.   * FFS: Configure an association between a BFD-RS set on SCell and a PUCCH-SR resource / SR configuration for per TRP BFR   A UE capability signaling is introduced for indicating the support of this association. Above applies only for multi-DCI case. |   **Proposal 25: Components 2 in current FG 23-5-2a should be included in a separate FG 23-5-2b**   |  |  |  | | --- | --- | --- | | 23-5-2b | PUCCH SR resource association | Association between BFD-RS resource set on SpCell and a PUCCH SR resource (if the max number of PUCCH-SR resources for MTRP BFRQ is two) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  ~~[2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)]~~ |  |  |  |  |  |  |  |  | Component candidate values: {[0,1], 2} | Optional with capability signalling | | 23. NR\_FeMIMO | 23-5-2b | PUCCH SR resource association | Association between BFD-RS resource set on SpCell and a PUCCH SR resource (if the max number of PUCCH-SR resources for MTRP BFRQ is two) |  |  |  |  |  |  |  |  |  | **Optional with capability signalling** | |
| Lenovo [17] | According to RAN1 agreement, component 1 of FG 23-5-2a should be defined per cell group according to RAN1 agreement.   1. For FG 23-5-2a, component 1 should be revised as “Max number of PUCCH-SR resources for MTRP BFRQ per cell group”   The following agreement was made in RAN1#106bis-e [4]   |  | | --- | | **Agreement**  Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource/SR configuration for per TRP BFR.   * A UE capability signaling is introduced for indicating the support of this association. * Above applies only for multi-DCI case. |   Therefore, component 2 of FG 23-5-2a is needed to align with RAN1 agreement.   1. Component 2 of FG 23-5-2a is needed based on RAN1 agreement |
| Qualcomm Incorporated [18] | ***Proposal 7-3***: For FG 23-5-2a on the PUCCH-BFR resources for mTRP BFRQ (R1-2200780), suggest to consider the following changes.   * For component 2   + Suggest to remove the bracket based on the agreement on UE capability for association. The agreement is simple and clear, and should not have any ambiguity. We can also check with companies involved in the lengthy WI online discussion |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling [single TRP/] SFN Scheme A PDSCH [and default QCL assumption with one or two TCI states for PDCCH] |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the report type of FG23-6 for HST, we prefer FSPC. A finer report type will enable the chipest/UE vendor to implement and operator/gNB vendor to depoly this advanced feature with basic functions as soon as possible. Being a typical use case of mTRP, this feature needs more processing requirements in UE implementation. Like the legacy Rel-16 multi-DCI multi-TRP capability, this FG can also be FSPC.  ***Proposal 3-9: The report type of FG23-6 for HST should be FSPC.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling [single TRP/] SFN Scheme A PDSCH [and default QCL assumption with one or two TCI states for PDCCH] |  |  |  |  | ~~[Per band or per FS or~~ FSPC] |  |  |  |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | Firstly, with respect to transmission scheme combinations, the following five options have been supported for Rel-17 SFN based MTRP HST in RAN1, which should be completely captured in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b.   * Scheme A (scheme 1) PDCCH + Rel-17 Scheme A (scheme 1) PDSCH * Scheme A (scheme 1) PDCCH + Single-TRP PDSCH * Scheme B (scheme 2) PDCCH + Rel-17 Scheme B (scheme 2) PDCCH * Single-TRP PDCCH + Rel-17 Scheme A (scheme 1) PDCCH * Single-TRP PDCCH + Rel-17 Scheme B (scheme 2) PDCCH   Secondly, regarding the part of “default QCL assumption with one or two TCI states for PDCCH” in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b, it is somehow unrelated to these FGs and should be removed for avoiding any ambiguity.  Thirdly, we prefer per band reporting type from the perspective of gNB scheduling.  ***Proposal 10:*** *Update the yellow parts in 23-6-1 ~ 23-6-2b as follows.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. ~~[~~Support of SFN scheme A for PDCCH~~]~~ scheduling single TRP/ SFN Scheme A PDSCH ~~and~~  ~~2. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH]~~ |  |  |  |  | Per band | |
| OPPO [5] |  |
| CATT [6] | For SFN schemes based HST enhancements, several FGs (23-6-1 ~ 23-6-4) are listed in [1]. Acoording to the agreements in previous meetings, we have the following comments for these FGs.  **23-6-1/2 Scheme 1 / TRP based pre-compensation for PDSCH and PDCCH**  Based on the agreement in RAN1#107 e-meeting, the rule of default beam(s) for PDSCH/PDCCH is determined by the different combinations of transmission scheme for PDSCH and PDCCH, thus it is reasonable that if UE supports scheme A for PDCCH/PDSCH, the UE can also support default beam(s) for PDCCH/PDSCH.  Furthermore, based on the agreement in RAN1#106 and #106bis e-meeting, the following combinations of the transmission schemes was supported:   * *Single-TRP PDCCH + Rel-17 Scheme 1 PDSCH* * *Single-TRP PDCCH + Rel-17 TRP-based pre-compensation PDSCH* * *Rel-17 scheme 1 PDCCH + single-TRP PDSCH with UE capability*   It can be seen that only the combination of Rel-17 scheme 1 PDCCH and single-TRP PDSCH is supported with additional UE capability. Therefore, if SFN scheme A for PDSCH and PDCCH are listed in separate sub-capibilities, supporting of SFN scheme A for PDCCH scheduling single TRP PDSCH should be listed in an additional feature group.  Based on the above analysis, we have the following proposal:   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-1 | SFN scheme A (scheme 1) for ~~PDSCH and~~ PDCCH | 1. Support of SFN scheme A for PDCCH scheduling ~~[single TRP/]~~ SFN Scheme A PDSCH ~~[~~and default QCL assumption with one or two TCI states for PDCCH~~]~~ |  |  |  |  |  | Optional with capability signalling | | 23-6-1a | SFN scheme A (scheme 1) for single TRP PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling single TRP PDSCH and default QCL assumption with one or two TCI states for PDCCH |  |  |  |  |  |  | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG23-6-1/23-6-1a and FG23-6-2/23-6-2a,   + During the RAN1 discussion for Rel.17 HST, the assumption of the basic operation is a combination of “1) SFN-PDCCH + SFN-PDSCH”, and some UE vendors claim difficulty of supporting other combinations. Hence, the basic capability of FG23-6-1 and FG23-6-2 should be the combination of “1) SFN-PDCCH + SFN-PDSCH”, and other combinations should be reported as optional FGs. The other combinations are “2) S-TRP PDCCH + SFN-PDSCH” and “3) SFN-PDCCH + S-TRP PDSCH”. Note that 3) is only supported in SFN scheme A (FG23-6-1/23-6-1a) based on the previous agreements. * Report granularity:   + We believe FG23-6-1/23-6-1a/23-6-1b/23-6-2/23-6-2a/23-6-2b can be reported per band.   **Proposal: Adopt the following for HST-SFN deployment**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling [single TRP/] SFN Scheme A PDSCH [and default QCL assumption with one or two TCI states for PDCCH] |  |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] | For component 1, the second bracket and content in it should be deleted, for the sake of that there is no default QCL assumptions for COREET. In addition, default QCL assumption is only considered in FR2, and it is not proper as one basic feature for both FR1 and FR2.  In RAN1#106bis-e, we have the following agreement on the combination of PDCCH transmission and PDSCH transmission.  **Agreement**  Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH   * This is optional UE feature * Note: The support of such combination scheme is for URLLC use-case only.   Thus, we think scheme A PDCCH scheduling single TRP PDSCH should be one separated FG/component. Even if one UE supports SFN scheme A PDCCH scheduling scheme A PDSCH, it also have the freedom not to support single TRP PDSCH scheduled by scheme A PDCCH.  ***Proposal 7: For component 1 of FG 23-6-1, suggest to delete ‘[and default QCL assumption with two TCI states for PDCCH]’***  ***Proposal 8: Suggest to split component 1 of FG 23-6-1 as below:***   * ***Component 1: Support of SFN scheme A for PDCCH scheduling SFN scheme A PDSCH*** * ***Component 2: Support of SFN scheme A for PDCCH scheduling single TRP PDSCH***   + - ***Candidate value: {Support, not support}*** |
| LG Electronics [10] | **23-6-1**   * + - Default QCL assumption for PDCCH is not clear to us because TCI state(s) for PDCCH can be explicitly configured by RRC/MAC-CE. So, the description for default QCL assumption should be removed.     - The scheme combination for SFN scheme A PDCCH and single TRP PDSCH was agreed. So, a capability for this scheme combination should be supported. It can be supported by a separate FG as 23-6-1b.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling SFN Scheme A PDSCH |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-6-1c | SFN scheme A (scheme 1) for PDCCH only | 1. Support of SFN scheme A for PDCCH scheduling single TRP PDSCH |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | Regarding UE capability to support of SFN scheme for PDSCH and PDDCH. According to current structure of FG 23-6-x, separate UE capabilities are defined for SFN scheme for PDSCH and for PDSCH + PDCCH. In this case the corresponding UE capabilities should allow all possible combinations of the transmission schemes agreed during Rel-17 work item phase (i.e., SFN Scheme A for PDCCH scheduling single TRP and single TRP PDCCH scheduling SFN PDSCH Scheme A). At the same time current description of FGs 23-6-1 and 23-6-1b doesn’t allow support of SFN Scheme A for PDCCH scheduling single TRP PDSCH.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. ~~[~~Support of SFN scheme A for PDCCH~~]~~ scheduling ~~[~~single TRP/~~]~~ and SFN Scheme A PDSCH ~~and~~ ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ | 23-6-1b | ~~[~~Per band ~~or per FS or FSPC]~~ |  | Optional with capability signalling | |
| Apple [12] | * Default beam related description in FG 23-6-1/1b and FG 23-6-2/2b should be removed. It is unclear the scope of the described default beam.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling SFN Scheme A PDSCH |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | As for the component 1 “1. Support of SFN scheme A for PDCCH scheduling [single TRP/] SFN Scheme A PDSCH [and default QCL assumption with one or two TCI states for PDCCH]” in FG23-6-1, since the title is “SFN scheme A (scheme 1) for PDSCH and PDCCH”, it is better to only include SFN Scheme A PDCCH with SFN scheme A PDSCH in the description. While for SFN scheme A for PDCCH only, a separate FG 23-6-1c is necessary.  ***Proposal 13: Revise the component 1 in FG23-6-1 as below.***  1. Support of SFN scheme A for PDCCH scheduling ~~[single TRP/]~~ SFN Scheme A PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~  ***Proposal 14: Propose FG23-6-1c of SFN Scheme A for PDCCH only as below.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1c | SFN scheme A (scheme 1) for PDCCH only | 1. Support of SFN scheme A for PDCCH scheduling single TRP PDSCH |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| Samsung [15] | Based on the discussion in RAN1#107b-e, the latest version of FGs (23-6-1, 23-6-1a, 23-6-1b, 23-6-2, 23-6-2b, 23-6-3, 23-6-4, 23-6-4a) have been agreed for HST-SFN.  Regarding FGs for SFN scheme A (FG 23-6-1 and 23-6-1b), we think that the current formulation is “SFN scheme A (scheme 1) for PDSCH and PDCCH”, and “SFN scheme A (scheme 1) for PDSCH only”, which is not appropriate, since separate RRC parameter for PDCCH and PDSCH was agreed. Hence, our suggestion is to support SFN scheme A (scheme 1) for PDCCH and PDSCH, separately. Similar approach can be applied to FGs for SFN scheme B (FG 23-6-2 and 23-6-2b).  **Proposal 22:** Support FG 23-6-1 as “SFN scheme A (scheme 1) for PDCCH”, FG 23-6-1b as “SFN scheme A (scheme 1) for PDSCH”, FG 23-6-2 as “SFN scheme B (TRP based pre-compensation) for PDCCH”, and FG 23-6-2b as “SFN scheme B (TRP based pre-compensation) for PDSCH”. |
| MediaTek Inc. [16] |  |
| Lenovo [17] | It was agreed in RAN1#106bis-e [4] that the support of the combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH is UE optional. In addition to available FG 23-6-1 and FG 23-6-1b, we propose adding a new FG 23-6-1c “SFN scheme A (scheme 1) for PDCCH only” for supporting SFN scheme A for PDCCH scheduling single TRP PDSCH.   1. For FG 23-6-1, add new FG 23-6-1c to support of SFN scheme A for PDCCH scheduling single TRP PDSCH |
| Qualcomm Incorporated [18] | FG 23-6-1 indicates the support of SFN scheme A (scheme 1) for both PDCCH and PDSCH while FG 23-6-1b indicates the support of SFN scheme A only for PDSCH. The description of both FGs should be updated by removing most of the yellow text. In addition, a new FG 23-6-1c should be added for the indication of the support the combination for Rel-17 SNF PDCCH scheme 1 and single-TPR PDSCH based on RAN1 agreement in RAN1 meeting #106bis-e.   |  | | --- | | **Agreement**  Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH   * This is optional UE feature * Note: The support of such combination scheme is for URLLC use-case only. |   ***Proposal 8-1: For FG 23-6-1, remove the yellow text of “[single TRP/]” and “[and default QCL assumption with one or two TCI states for PDCCH]”***   * ***Support per FS reporting granularity.***   ***Proposal 8-3: Add new FG 23-6-1c for the support of SFN scheme A PDCCH and single TRP PDSCH.***   * ***Support per FS reporting granularity.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling ~~[single TRP/]~~ SFN Scheme A PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ |  |  |  |  | Per FS |  |  |  |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-6-1c | SFN scheme A for PDCCH for URLLC | Support of SFN scheme A for PDCCH and single TRP PDSCH |  |  |  |  | Per FS |  |  |  |  |  | |
| Ericsson [19] | PDSCH performance is the essential part of HST SFN enhancement, PDCCH alone using SFN is less essential but important for signalling and beam association for PDSCH. FG 23-6-1 and FG 23-6-2 each provides the basic function for the supported SFN scheme. The components in the basic feature group of each scheme shall include a complete set of functions for the essential HST configuration. In our understanding the component 2 – Support of scheme A/B for PDSCH and default QCL assumption with two TCI states for PDSCH – is the essential part of HST functionality. The common search space configuration is shared with both legacy UE and HST UE, therefore CORESET for DCI 1\_0 associated with CSS schedules the system information and paging need to be Single TRP configuration, which is also essential functionality to be included in the basic feature group. With these in mind, we suggest starting with a simple fomulated UE feature as many other companies suggested on RAN1#107bis-e meeting as below. Whether the two components shall be split to two features or supported together as basic HST-SFN can still be discussed on this meeting.   |  |  |  |  | | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) | 1. SFN scheme A for PDSCH 2. SFN scheme A for PDSCH and PDCCH |  1. Adopt the above proposal as the starting discussion point for basic HST-SFN UE feature.   Besides the SFN scheme A for PDSCH as listed in 23-6-1, we need a separate UE feature group for supporting SFN scheme A PDCCH with single-TRP PDSCH, which has been agreed on RAN1#106bis-e meeting.  **Agreement**  Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH   * This is optional UE feature * Note: The support of such combination scheme is for URLLC use-case only.  1. Add a new feature group in 23-6-x for supporting SFN scheme A PDCCH and single-TRP PDSCH. |

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| 23. NR\_FeMIMO | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-1[b]] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the report type of FG23-6 for HST, we prefer FSPC. A finer report type will enable the chipest/UE vendor to implement and operator/gNB vendor to depoly this advanced feature with basic functions as soon as possible. Being a typical use case of mTRP, this feature needs more processing requirements in UE implementation. Like the legacy Rel-16 multi-DCI multi-TRP capability, this FG can also be FSPC.  ***Proposal 3-9: The report type of FG23-6 for HST should be FSPC.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-1[b]] |  |  |  | ~~[Per band or per FS or~~ FSPC~~]~~ |  |  |  |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | Firstly, with respect to transmission scheme combinations, the following five options have been supported for Rel-17 SFN based MTRP HST in RAN1, which should be completely captured in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b.   * Scheme A (scheme 1) PDCCH + Rel-17 Scheme A (scheme 1) PDSCH * Scheme A (scheme 1) PDCCH + Single-TRP PDSCH * Scheme B (scheme 2) PDCCH + Rel-17 Scheme B (scheme 2) PDCCH * Single-TRP PDCCH + Rel-17 Scheme A (scheme 1) PDCCH * Single-TRP PDCCH + Rel-17 Scheme B (scheme 2) PDCCH   Secondly, regarding the part of “default QCL assumption with one or two TCI states for PDCCH” in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b, it is somehow unrelated to these FGs and should be removed for avoiding any ambiguity.  Thirdly, we prefer per band reporting type from the perspective of gNB scheduling.  ***Proposal 10:*** *Update the yellow parts in 23-6-1 ~ 23-6-2b as follows.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and ~~SFN~~ PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-1[b]] |  |  |  | Per band | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG23-6-1/23-6-1a and FG23-6-2/23-6-2a,   + During the RAN1 discussion for Rel.17 HST, the assumption of the basic operation is a combination of “1) SFN-PDCCH + SFN-PDSCH”, and some UE vendors claim difficulty of supporting other combinations. Hence, the basic capability of FG23-6-1 and FG23-6-2 should be the combination of “1) SFN-PDCCH + SFN-PDSCH”, and other combinations should be reported as optional FGs. The other combinations are “2) S-TRP PDCCH + SFN-PDSCH” and “3) SFN-PDCCH + S-TRP PDSCH”. Note that 3) is only supported in SFN scheme A (FG23-6-1/23-6-1a) based on the previous agreements. * Report granularity:   + We believe FG23-6-1/23-6-1a/23-6-1b/23-6-2/23-6-2a/23-6-2b can be reported per band.   **Proposal: Adopt the following for HST-SFN deployment**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-1[b]] |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-1[b]] | ~~[~~Per band ~~or per FS or FSPC]~~ |  | Optional with capability signalling | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 8-4: The prerequisite of FG 23-6-1a should be FG 23-6-1 or FG 23-6-1b***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | 23-6-1 or 23-6-1b |  |  |  | Per FS |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH] |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the report type of FG23-6 for HST, we prefer FSPC. A finer report type will enable the chipest/UE vendor to implement and operator/gNB vendor to depoly this advanced feature with basic functions as soon as possible. Being a typical use case of mTRP, this feature needs more processing requirements in UE implementation. Like the legacy Rel-16 multi-DCI multi-TRP capability, this FG can also be FSPC.  ***Proposal 3-9: The report type of FG23-6 for HST should be FSPC.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH] |  |  |  |  | ~~[Per band or per FS or~~ FSPC~~]~~ |  |  |  |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | Firstly, with respect to transmission scheme combinations, the following five options have been supported for Rel-17 SFN based MTRP HST in RAN1, which should be completely captured in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b.   * Scheme A (scheme 1) PDCCH + Rel-17 Scheme A (scheme 1) PDSCH * Scheme A (scheme 1) PDCCH + Single-TRP PDSCH * Scheme B (scheme 2) PDCCH + Rel-17 Scheme B (scheme 2) PDCCH * Single-TRP PDCCH + Rel-17 Scheme A (scheme 1) PDCCH * Single-TRP PDCCH + Rel-17 Scheme B (scheme 2) PDCCH   Secondly, regarding the part of “default QCL assumption with one or two TCI states for PDCCH” in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b, it is somehow unrelated to these FGs and should be removed for avoiding any ambiguity.  Thirdly, we prefer per band reporting type from the perspective of gNB scheduling.  ***Proposal 10:*** *Update the yellow parts in 23-6-1 ~ 23-6-2b as follows.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH scheduled by single TRP/ Scheme A PDCCH |  |  |  |  | Per band | |
| OPPO [5] |  |
| CATT [6] | |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-1~~b~~c | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH [only scheduled by ~~[~~single TRP/ Scheme A~~]~~ PDCCH~~] [~~and default QCL assumption with one or two TCI states for PDSCH] |  |  |  | ~~[FR1 only]~~ |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG23-6-1/23-6-1a and FG23-6-2/23-6-2a,   + During the RAN1 discussion for Rel.17 HST, the assumption of the basic operation is a combination of “1) SFN-PDCCH + SFN-PDSCH”, and some UE vendors claim difficulty of supporting other combinations. Hence, the basic capability of FG23-6-1 and FG23-6-2 should be the combination of “1) SFN-PDCCH + SFN-PDSCH”, and other combinations should be reported as optional FGs. The other combinations are “2) S-TRP PDCCH + SFN-PDSCH” and “3) SFN-PDCCH + S-TRP PDSCH”. Note that 3) is only supported in SFN scheme A (FG23-6-1/23-6-1a) based on the previous agreements. * Report granularity:   + We believe FG23-6-1/23-6-1a/23-6-1b/23-6-2/23-6-2a/23-6-2b can be reported per band.   **Proposal: Adopt the following for HST-SFN deployment**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH] |  |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] | To align with the name of FG23-6-1b, we prefer to remove scheme A for PDCCH.  ***Proposal 9: For component 1 of FG 23-6-1b, prefer to remove ‘scheme A’ in the first bracket.*** |
| LG Electronics [10] | * + - Default QCL assumption for PDSCH is defined as a separate FG. The description for default QCL assumption should be removed.     - The capability for the scheme combination of SFN scheme A PDSCH and SFN scheme A PDCCH is defined 23-6-1. So, we do not need to consider this combination in this FG.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH only scheduled by single TRP PDCCH |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | Regarding UE capability to support of SFN scheme for PDSCH and PDDCH. According to current structure of FG 23-6-x, separate UE capabilities are defined for SFN scheme for PDSCH and for PDSCH + PDCCH. In this case the corresponding UE capabilities should allow all possible combinations of the transmission schemes agreed during Rel-17 work item phase (i.e., SFN Scheme A for PDCCH scheduling single TRP and single TRP PDCCH scheduling SFN PDSCH Scheme A). At the same time current description of FGs 23-6-1 and 23-6-1b doesn’t allow support of SFN Scheme A for PDCCH scheduling single TRP PDSCH.  It should be noted that implementation of scheme B is simpler, UE indicating support of SFN scheme A should also indicate support SFN scheme B, which can be achieved by making FG 23-6-1b pre-requisite for FG 23-6-2b. Moreover, to reduce testing efforts associated with support of SFN scheme A for PDCCH, UE should be allowed to report support of SFN scheme A only for PDSCH (i.e. without PDCCH) as part of FG 23-6-1b or FG 23-6-2b should be considered as pre-requisite for all other FGs.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH ~~[only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH]~~ |  | [Per band ~~or per FS or FSPC]~~ |  | Optional with capability signalling | |
| Apple [12] | * Default beam related description in FG 23-6-1/1b and FG 23-6-2/2b should be removed. It is unclear the scope of the described default beam.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | While for the component 1 “1. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH]” in FG23-6-1b, since the title is “SFN scheme A (scheme 1) for PDSCH only”, it is better to only include SFN Scheme A PDSCH in the description.  ***Proposal 15: Revise the component 1 in FG23-6-1b as below.***  1. Support of SFN scheme A for PDSCH ~~[~~only scheduled by ~~[~~single TRP~~/ Scheme A]~~ PDCCH~~] [and default QCL assumption with one or two TCI states for PDSCH]~~ |
| Samsung [15] | Based on the discussion in RAN1#107b-e, the latest version of FGs (23-6-1, 23-6-1a, 23-6-1b, 23-6-2, 23-6-2b, 23-6-3, 23-6-4, 23-6-4a) have been agreed for HST-SFN.  Regarding FGs for SFN scheme A (FG 23-6-1 and 23-6-1b), we think that the current formulation is “SFN scheme A (scheme 1) for PDSCH and PDCCH”, and “SFN scheme A (scheme 1) for PDSCH only”, which is not appropriate, since separate RRC parameter for PDCCH and PDSCH was agreed. Hence, our suggestion is to support SFN scheme A (scheme 1) for PDCCH and PDSCH, separately. Similar approach can be applied to FGs for SFN scheme B (FG 23-6-2 and 23-6-2b).  **Proposal 22:** Support FG 23-6-1 as “SFN scheme A (scheme 1) for PDCCH”, FG 23-6-1b as “SFN scheme A (scheme 1) for PDSCH”, FG 23-6-2 as “SFN scheme B (TRP based pre-compensation) for PDCCH”, and FG 23-6-2b as “SFN scheme B (TRP based pre-compensation) for PDSCH”. |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 8-2: For FG 23-6-1b, remove the yellow text of “[and default QCL assumption with one or two TCI states for PDCCH]” and update the description to reflect the support of SFN PDSCH scheduled by single TRP PDCCH.***   * ***Support per FS reporting granularity.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH ~~[~~only scheduled by ~~[~~single TRP/ ~~Scheme A]~~ PDCCH~~]~~ ~~[and default QCL assumption with one or two TCI states for PDSCH]~~ |  |  |  |  | Per FS |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH [and default QCL assumption with one or two TCI states for PDCCH] | [23-6-1] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the report type of FG23-6 for HST, we prefer FSPC. A finer report type will enable the chipest/UE vendor to implement and operator/gNB vendor to depoly this advanced feature with basic functions as soon as possible. Being a typical use case of mTRP, this feature needs more processing requirements in UE implementation. Like the legacy Rel-16 multi-DCI multi-TRP capability, this FG can also be FSPC.  ***Proposal 3-9: The report type of FG23-6 for HST should be FSPC.***  For FG 23-6-2 and FG 23-6-2b, we don’t see the reason to force the schemeB-capable UEs to support SFN scheme A. In fact, as gNB has pre-compensated the frequency shift, schemeB needs less processing, while in schemeA, UE has to handle the frequency shift by itself. Therefore, we propose the following:  ***Proposal 3-10: Remove the pre-requesite of FG 23-6-1 for FG 23-6-2 and FG 23-6-2b***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH [and default QCL assumption with one or two TCI states for PDCCH] | ~~[23-6-1]~~ |  |  |  | ~~[Per band or per FS or~~ FSPC] |  |  |  |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | Firstly, with respect to transmission scheme combinations, the following five options have been supported for Rel-17 SFN based MTRP HST in RAN1, which should be completely captured in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b.   * Scheme A (scheme 1) PDCCH + Rel-17 Scheme A (scheme 1) PDSCH * Scheme A (scheme 1) PDCCH + Single-TRP PDSCH * Scheme B (scheme 2) PDCCH + Rel-17 Scheme B (scheme 2) PDCCH * Single-TRP PDCCH + Rel-17 Scheme A (scheme 1) PDCCH * Single-TRP PDCCH + Rel-17 Scheme B (scheme 2) PDCCH   Secondly, regarding the part of “default QCL assumption with one or two TCI states for PDCCH” in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b, it is somehow unrelated to these FGs and should be removed for avoiding any ambiguity.  Thirdly, we prefer per band reporting type from the perspective of gNB scheduling.  ***Proposal 10:*** *Update the yellow parts in 23-6-1 ~ 23-6-2b as follows.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. ~~[~~Support of SFN scheme B for PDCCH~~]~~ scheduling SFN Scheme B PDSCH  ~~2. Support of SFN scheme B for PDSCH only [and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH]~~ | [23-6-1] |  |  |  | Per band | |
| OPPO [5] |  |
| CATT [6] | For SFN schemes based HST enhancements, several FGs (23-6-1 ~ 23-6-4) are listed in [1]. Acoording to the agreements in previous meetings, we have the following comments for these FGs.  **23-6-1/2 Scheme 1 / TRP based pre-compensation for PDSCH and PDCCH**  Based on the agreement in RAN1#107 e-meeting, the rule of default beam(s) for PDSCH/PDCCH is determined by the different combinations of transmission scheme for PDSCH and PDCCH, thus it is reasonable that if UE supports scheme A for PDCCH/PDSCH, the UE can also support default beam(s) for PDCCH/PDSCH.  Furthermore, based on the agreement in RAN1#106 and #106bis e-meeting, the following combinations of the transmission schemes was supported:   * *Single-TRP PDCCH + Rel-17 Scheme 1 PDSCH* * *Single-TRP PDCCH + Rel-17 TRP-based pre-compensation PDSCH* * *Rel-17 scheme 1 PDCCH + single-TRP PDSCH with UE capability*   It can be seen that only the combination of Rel-17 scheme 1 PDCCH and single-TRP PDSCH is supported with additional UE capability. Therefore, if SFN scheme A for PDSCH and PDCCH are listed in separate sub-capibilities, supporting of SFN scheme A for PDCCH scheduling single TRP PDSCH should be listed in an additional feature group.  Based on the above analysis, we have the following proposal:  ***Proposal-15: For Scheme 1 / TRP based pre-compensation for PDSCH and PDCCH, the UE features 23-6-1 ~ 23-6-2 are revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH ~~[~~and default QCL assumption with one or two TCI states for PDCCH~~]~~ | [23-6-1] |  |  |  |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] | * For FG23-6-1/23-6-1a and FG23-6-2/23-6-2a,   + During the RAN1 discussion for Rel.17 HST, the assumption of the basic operation is a combination of “1) SFN-PDCCH + SFN-PDSCH”, and some UE vendors claim difficulty of supporting other combinations. Hence, the basic capability of FG23-6-1 and FG23-6-2 should be the combination of “1) SFN-PDCCH + SFN-PDSCH”, and other combinations should be reported as optional FGs. The other combinations are “2) S-TRP PDCCH + SFN-PDSCH” and “3) SFN-PDCCH + S-TRP PDSCH”. Note that 3) is only supported in SFN scheme A (FG23-6-1/23-6-1a) based on the previous agreements.   + “FR2 only” for FG23-6-4 is incorrect. For FG23-6-4, the threshold of *timeDurationForQCL* is only reported in FR2. In RAN1 agreements for HST and Rel.15/16/17 spec., the UE behavior of no TCI state field is captured as “scheduling offset equal or larger than the threshold, if applicable”. This is because the UE behavior of no TCI state field in FR1is specified. However, in the current UE feature list, there is no FG to report the support of no TCI state field in FR1. Hence, we suggest to add “(if applicable)” in component 2 and update as “FR2 only for component 1/3”. * Report granularity:   + We believe FG23-6-1/23-6-1a/23-6-1b/23-6-2/23-6-2a/23-6-2b can be reported per band.   **Proposal: Adopt the following for HST-SFN deployment**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH [and default QCL assumption with one or two TCI states for PDCCH] | 23-6-1 |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] | * + - Suggest to remove the text related to default QCL assumption for PDCCH with the same reason as 23-6-1.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH | [23-6-1] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. ~~[~~Support of SFN scheme B for PDCCH~~]~~ scheduling SFN Scheme B PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ | ~~[23-6-1]~~  23-6-2b | ~~[~~Per band ~~or per FS or per FSPC]~~ |  | Optional with capability signalling | |
| Apple [12] | * Default beam related description in FG 23-6-1/1b and FG 23-6-2/2b should be removed. It is unclear the scope of the described default beam.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH | [23-6-1] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | As for the component 1 “1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH [and default QCL assumption with one or two TCI states for PDCCH]” in FG23-6-2, we propose to delete the description on default QCL assumption for PDCCH.  ***Proposal 16: Revise the component 1 in FG23-6-2 as below***  1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ |
| Samsung [15] | Based on the discussion in RAN1#107b-e, the latest version of FGs (23-6-1, 23-6-1a, 23-6-1b, 23-6-2, 23-6-2b, 23-6-3, 23-6-4, 23-6-4a) have been agreed for HST-SFN.  Regarding FGs for SFN scheme A (FG 23-6-1 and 23-6-1b), we think that the current formulation is “SFN scheme A (scheme 1) for PDSCH and PDCCH”, and “SFN scheme A (scheme 1) for PDSCH only”, which is not appropriate, since separate RRC parameter for PDCCH and PDSCH was agreed. Hence, our suggestion is to support SFN scheme A (scheme 1) for PDCCH and PDSCH, separately. Similar approach can be applied to FGs for SFN scheme B (FG 23-6-2 and 23-6-2b).  **Proposal 22:** Support FG 23-6-1 as “SFN scheme A (scheme 1) for PDCCH”, FG 23-6-1b as “SFN scheme A (scheme 1) for PDSCH”, FG 23-6-2 as “SFN scheme B (TRP based pre-compensation) for PDCCH”, and FG 23-6-2b as “SFN scheme B (TRP based pre-compensation) for PDSCH”.  In order to identify two QCL-TypeD properties to receive SFNed PDCCH, since FG 23-2-2 is used for PDCCH repetition, a separate FG supporting to identify two QCL-TypeD properties for SFNed PDCCH which two TCIs have been activated on a CORESET should be needed.  **Proposal 23:** Support separate FG as identifying two QCL-TypeD properties for SFNed PDCCH. |
| MediaTek Inc. [16] |  |
| Lenovo [17] | For FG group 23-6-2, the pre-requisite FG 23.6.1 should be removed. This pre-requisite does not match any agreement made so far. Besides, Scheme B is a network-based approach and intended to do support UEs that are not capable of supporting Scheme A, and hence including FG 23.6.1 to be a pre-requisite of FG 23.6.2 is unjustified.   1. For FG 23-6-2, remove the pre-requisite FG 23-6-1   Additionally, it was agreed in RAN1#107-e [5] that SFN Scheme B is supported in both FR1 and FR2 with UE capability at least per FR. Hence, we suggest restricting FG 23-6-2 to FR1, and add a separate FG for support of SFN Scheme B in FR2, such that FG 23-6-2 is a pre-requisite of the FG corresponding to SFN Scheme B support in FR2   1. Limit capability interpretation for frequency range of FG 23-6-2 to FR1 2. Add a new FG for SFN Scheme B support in FR2, with FG 23-6-2 as a pre-requisite |
| Qualcomm Incorporated [18] | FG 23-6-2 indicates the UE support of SFN scheme B (TRP pre-compensation) for both PDCCH and PDSCH while FG 23-6-2b indicates the support of SFN scheme A only for PDSCH. The description of both FGs should be updated by removing most of the yellow text that is not clear. In addition, SFN scheme B was introduced to reduce UE demod complexity as compared to SFN scheme A. It doesn’t make to make sense to make SFN scheme A (high demod complexity) as prerequisite to support SFN scheme B (lower complexity and simpler demod).  ***Proposal 8-5: For FG 23-6-2, remove the yellow text of “[and default QCL assumption with one or two TCI states for PDCCH]”***   * ***Support per FS reporting granularity.*** * ***Remove the prerequisite of FG 23-6-1***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ | ~~[23-6-1]~~ |  |  |  | Per FS |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] | On type of feature groups, we have the following agreement from RAN1#107-e meeting, that the UE capability is at least per FR.  **Agreement**  TRP-based pre-compensation scheme for PDSCH / PDCCH is supported in both FR1 and FR2 with UE capability at least per FR   1. For 23-6-2, the type for the feature groups shall be per UE with FR1-FR2 DIFF set to “Yes”. |

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| 23. NR\_FeMIMO | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-2[b]] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the report type of FG23-6 for HST, we prefer FSPC. A finer report type will enable the chipest/UE vendor to implement and operator/gNB vendor to depoly this advanced feature with basic functions as soon as possible. Being a typical use case of mTRP, this feature needs more processing requirements in UE implementation. Like the legacy Rel-16 multi-DCI multi-TRP capability, this FG can also be FSPC.  ***Proposal 3-9: The report type of FG23-6 for HST should be FSPC.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-2[b]] |  |  |  | ~~[Per band or per FS or~~ FSPC~~]~~ |  |  |  |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | Firstly, with respect to transmission scheme combinations, the following five options have been supported for Rel-17 SFN based MTRP HST in RAN1, which should be completely captured in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b.   * Scheme A (scheme 1) PDCCH + Rel-17 Scheme A (scheme 1) PDSCH * Scheme A (scheme 1) PDCCH + Single-TRP PDSCH * Scheme B (scheme 2) PDCCH + Rel-17 Scheme B (scheme 2) PDCCH * Single-TRP PDCCH + Rel-17 Scheme A (scheme 1) PDCCH * Single-TRP PDCCH + Rel-17 Scheme B (scheme 2) PDCCH   Secondly, regarding the part of “default QCL assumption with one or two TCI states for PDCCH” in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b, it is somehow unrelated to these FGs and should be removed for avoiding any ambiguity.  Thirdly, we prefer per band reporting type from the perspective of gNB scheduling.  ***Proposal 10:*** *Update the yellow parts in 23-6-1 ~ 23-6-2b as follows.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and ~~SFN~~ PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-2[b]] |  |  |  | Per band | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG23-6-1/23-6-1a and FG23-6-2/23-6-2a,   + During the RAN1 discussion for Rel.17 HST, the assumption of the basic operation is a combination of “1) SFN-PDCCH + SFN-PDSCH”, and some UE vendors claim difficulty of supporting other combinations. Hence, the basic capability of FG23-6-1 and FG23-6-2 should be the combination of “1) SFN-PDCCH + SFN-PDSCH”, and other combinations should be reported as optional FGs. The other combinations are “2) S-TRP PDCCH + SFN-PDSCH” and “3) SFN-PDCCH + S-TRP PDSCH”. Note that 3) is only supported in SFN scheme A (FG23-6-1/23-6-1a) based on the previous agreements. * Report granularity:   + We believe FG23-6-1/23-6-1a/23-6-1b/23-6-2/23-6-2a/23-6-2b can be reported per band.   **Proposal: Adopt the following for HST-SFN deployment**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-2[b]] |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-2[b]] | ~~[~~Per band ~~or per FS or FSPC]~~ |  | Optional with capability signalling | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 8-6: The prerequisite of FG 23-6-2a should be FG 23-6-2 or FG 23-6-2b.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | 23-6-2 or 23-6-2b |  |  |  | Per FS |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH [only and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH] | [23-6-1] |  |  |  | [Per band or per FS or per FSPC] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | Regarding the report type of FG23-6 for HST, we prefer FSPC. A finer report type will enable the chipest/UE vendor to implement and operator/gNB vendor to depoly this advanced feature with basic functions as soon as possible. Being a typical use case of mTRP, this feature needs more processing requirements in UE implementation. Like the legacy Rel-16 multi-DCI multi-TRP capability, this FG can also be FSPC.  ***Proposal 3-9: The report type of FG23-6 for HST should be FSPC.***  For FG 23-6-2 and FG 23-6-2b, we don’t see the reason to force the schemeB-capable UEs to support SFN scheme A. In fact, as gNB has pre-compensated the frequency shift, schemeB needs less processing, while in schemeA, UE has to handle the frequency shift by itself. Therefore, we propose the following:  ***Proposal 3-10: Remove the pre-requesite of FG 23-6-1 for FG 23-6-2 and FG 23-6-2b***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH [only and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH] | ~~[23-6-1]~~ |  |  |  | ~~[Per band or per FS or per~~ FSPC~~]~~ |  |  |  |  | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | Firstly, with respect to transmission scheme combinations, the following five options have been supported for Rel-17 SFN based MTRP HST in RAN1, which should be completely captured in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b.   * Scheme A (scheme 1) PDCCH + Rel-17 Scheme A (scheme 1) PDSCH * Scheme A (scheme 1) PDCCH + Single-TRP PDSCH * Scheme B (scheme 2) PDCCH + Rel-17 Scheme B (scheme 2) PDCCH * Single-TRP PDCCH + Rel-17 Scheme A (scheme 1) PDCCH * Single-TRP PDCCH + Rel-17 Scheme B (scheme 2) PDCCH   Secondly, regarding the part of “default QCL assumption with one or two TCI states for PDCCH” in FG 23-6-1, FG 23-6-1b, FG 23-6-2 and FG 23-6-2b, it is somehow unrelated to these FGs and should be removed for avoiding any ambiguity.  Thirdly, we prefer per band reporting type from the perspective of gNB scheduling.  ***Proposal 10:*** *Update the yellow parts in 23-6-1 ~ 23-6-2b as follows.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH scheduled by single TRP/ Scheme B PDCCH | [23-6-1] |  |  |  | Per band | |
| OPPO [5] |  |
| CATT [6] | For SFN schemes based HST enhancements, several FGs (23-6-1 ~ 23-6-4) are listed in [1]. Acoording to the agreements in previous meetings, we have the following comments for these FGs.  **23-6-1/2 Scheme 1 / TRP based pre-compensation for PDSCH and PDCCH**  Based on the agreement in RAN1#107 e-meeting, the rule of default beam(s) for PDSCH/PDCCH is determined by the different combinations of transmission scheme for PDSCH and PDCCH, thus it is reasonable that if UE supports scheme A for PDCCH/PDSCH, the UE can also support default beam(s) for PDCCH/PDSCH.  Furthermore, based on the agreement in RAN1#106 and #106bis e-meeting, the following combinations of the transmission schemes was supported:   * *Single-TRP PDCCH + Rel-17 Scheme 1 PDSCH* * *Single-TRP PDCCH + Rel-17 TRP-based pre-compensation PDSCH* * *Rel-17 scheme 1 PDCCH + single-TRP PDSCH with UE capability*   It can be seen that only the combination of Rel-17 scheme 1 PDCCH and single-TRP PDSCH is supported with additional UE capability. Therefore, if SFN scheme A for PDSCH and PDCCH are listed in separate sub-capibilities, supporting of SFN scheme A for PDCCH scheduling single TRP PDSCH should be listed in an additional feature group.  Based on the above analysis, we have the following proposal:  ***Proposal-15: For Scheme 1 / TRP based pre-compensation for PDSCH and PDCCH, the UE features 23-6-1 ~ 23-6-2 are revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH ~~[~~only and default QCL assumption with two TCI states for PDSCH~~] [~~scheduled by ~~[~~single TRP/Scheme B~~]~~ PDCCH~~]~~ | [23-6-1] |  |  |  |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG23-6-1/23-6-1a and FG23-6-2/23-6-2a,   + During the RAN1 discussion for Rel.17 HST, the assumption of the basic operation is a combination of “1) SFN-PDCCH + SFN-PDSCH”, and some UE vendors claim difficulty of supporting other combinations. Hence, the basic capability of FG23-6-1 and FG23-6-2 should be the combination of “1) SFN-PDCCH + SFN-PDSCH”, and other combinations should be reported as optional FGs. The other combinations are “2) S-TRP PDCCH + SFN-PDSCH” and “3) SFN-PDCCH + S-TRP PDSCH”. Note that 3) is only supported in SFN scheme A (FG23-6-1/23-6-1a) based on the previous agreements. * Report granularity:   + We believe FG23-6-1/23-6-1a/23-6-1b/23-6-2/23-6-2a/23-6-2b can be reported per band.   **Proposal: Adopt the following for HST-SFN deployment**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH [only and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH] | 23-6-1 |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] | Since FG23-6-2 has yet included SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH, to avoid duplication, we prefer to remove ‘scheme B’ in second bracket.  ***Proposal 10: For component 1 of FG 23-6-2b, prefer to remove ‘scheme B’ in the second bracket.*** |
| LG Electronics [10] | * + - Suggest to remove the text related to default QCL assumption for PDSCH with the same reason as 23-6-1b.     - Suggest to revise the wording to be aligned with 23-6-1b.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH only scheduled by single TRP PDCCH | [23-6-1] |  |  |  | [Per band or per FS or per FSPC] |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | It should be noted that implementation of scheme B is simpler, UE indicating support of SFN scheme A should also indicate support SFN scheme B, which can be achieved by making FG 23-6-1b pre-requisite for FG 23-6-2b. Moreover, to reduce testing efforts associated with support of SFN scheme A for PDCCH, UE should be allowed to report support of SFN scheme A only for PDSCH (i.e. without PDCCH) as part of FG 23-6-1b or FG 23-6-2b should be considered as pre-requisite for all other FGs.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH ~~[only and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH]~~ | ~~[23-6-1]~~  23-6-1b | ~~[~~Per band ~~or per FS or per FSPC]~~ |  | Optional with capability signalling | |
| Apple [12] | * Default beam related description in FG 23-6-1/1b and FG 23-6-2/2b should be removed. It is unclear the scope of the described default beam.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH ‘ | [23-6-1] |  |  |  | [Per band or per FS or per FSPC] |  |  |  |  | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | As for the component 1 “1. Support of SFN scheme B for PDSCH [only and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH]” in FG23-6-2b, since the title is “SFN scheme B (TRP based pre-compensation) for PDSCH only”, we propose to delete the description on default QCL assumption for PDSCH and the SFN scheme B PDCCH.  ***Proposal 17: Revise the component 1 in FG23-6-2b as below***  1. Support of SFN scheme B for PDSCH ~~[~~only ~~and default QCL assumption with two TCI states for PDSCH] [~~scheduled by ~~[~~single TRP~~/Scheme B]~~ PDCCH~~]~~ |
| Samsung [15] | Based on the discussion in RAN1#107b-e, the latest version of FGs (23-6-1, 23-6-1a, 23-6-1b, 23-6-2, 23-6-2b, 23-6-3, 23-6-4, 23-6-4a) have been agreed for HST-SFN.  Regarding FGs for SFN scheme A (FG 23-6-1 and 23-6-1b), we think that the current formulation is “SFN scheme A (scheme 1) for PDSCH and PDCCH”, and “SFN scheme A (scheme 1) for PDSCH only”, which is not appropriate, since separate RRC parameter for PDCCH and PDSCH was agreed. Hence, our suggestion is to support SFN scheme A (scheme 1) for PDCCH and PDSCH, separately. Similar approach can be applied to FGs for SFN scheme B (FG 23-6-2 and 23-6-2b).  **Proposal 22:** Support FG 23-6-1 as “SFN scheme A (scheme 1) for PDCCH”, FG 23-6-1b as “SFN scheme A (scheme 1) for PDSCH”, FG 23-6-2 as “SFN scheme B (TRP based pre-compensation) for PDCCH”, and FG 23-6-2b as “SFN scheme B (TRP based pre-compensation) for PDSCH”. |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 8-7: For FG 23-6-2b, remove the yellow text of “[and default QCL assumption with one or two TCI states for PDCCH]” and update the description to reflect the support of SFN scheme B PDSCH scheduled by single TRP PDCCH.***   * ***Support per FS reporting granularity.*** * ***Remove the prerequisite of FG 23-6-1***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH ~~[only and default QCL assumption with two TCI states for PDSCH]~~ ~~[~~scheduled by ~~[~~single TRP~~/Scheme B]~~ PDCCH~~]~~ | ~~[23-6-1]~~ |  |  |  | Per FS |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-6-3 | Simultaneous activation of two TCI states for PDCCH across multiple CCs (HST/URLLC) | Support of simultaneous activation of two TCI states for CORESETs with the same CORESET ID in all BWPs across a set of configured component carriers by single MAC-CE | 23-6-1 or 23-6-2 |  |  |  | Per UE |  | Yes |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | For FG 23-6-3 on support of simultaneous activation of two TCI states for PDCCH across multiple CCs [2], is not needed from our view. That’s because whether UE supports such feature can completely be inferred by the existing Rel-16 UE FG 16-1b-1 combined with the Rel-17 FG 23-6-1 or 23-6-2.   |  |  |  | | --- | --- | --- | | 16-1b-1 | TCI state activation across multiple CCs | 1. Support of Simultaneous TCI state activation across multiple CCs: PDCCH, PDSCH |   As we know, for a UE support FG 16-1b-1, some configured CCs in which TCI states can be simultaneously updated for CORESETs with the same ID should share the same RF chain or similar channel conditions for analog beamforming. This is regardless of the number of activated TCI states for each CORESET. So, as long as UE supports FG 16-1b-1, and also supports FG 23-6-1 or 23-6-2, it is natural for this UE to support simultaneous activation of two TCI states across set of configured component carriers.   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  |  |  |  | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-3 | Simultaneous activation of two TCI states for PDCCH across multiple CCs (HST/URLLC) | Support of simultaneous activation of two TCI states for CORESETs with the same CORESET ID in all BWPs across a set of configured component carriers by single MAC-CE | 23-6-1 or 23-6-2 |  |  |  | Per UE |  | Yes |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-6-4 | Default DL beam setup for SFN | 1. Support of PDSCH reception using default beam for Rel-17 enhanced SFN scheme when PDSCH is scheduled with offset less than threshold  2. Support PDSCH reception using default beam for Rel-17 enhanced SFN scheme when TCI field is not present in DCI when PDSCH is scheduled with offset equal or larger than the threshold  3. Support aperiodic CSI-RS reception using default beam for Rel-17 enhanced SFN scheme when scheduling offset is less than threshold | [23-6-1, 23-6-2] |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG 23-6-4/23-6-4a,   + Pre-requisite feature should not be “23-6-1, 23-6-2”. If the pre-requisite feature is “ 23-6-1, 23-6-2”, it means UE supporting FG 23-6-4/23-6-4a should support both “ 23-6-1, 23-6-2”. However, FG 23-6-1 and FG 23-6-2 are independent features, and it is possible that UE supports either FG 23-6-1 or FG 23-6-2. One possible solution is to make FG23-6-1 as basic FG for HST, and make FG23-6-1 as pre-requisite feature of FG 23-6-2 and FG 23-6-4 and FG23-6-4a. We believe the most of functions of FG23-6-1 are included in FG23-6-2.   + “FR2 only” for FG23-6-4 is incorrect. For FG23-6-4, the threshold of *timeDurationForQCL* is only reported in FR2. In RAN1 agreements for HST and Rel.15/16/17 spec., the UE behavior of no TCI state field is captured as “scheduling offset equal or larger than the threshold, if applicable”. This is because the UE behavior of no TCI state field in FR1is specified. However, in the current UE feature list, there is no FG to report the support of no TCI state field in FR1. Hence, we suggest to add “(if applicable)” in component 2 and update as “FR2 only for component 1/3”.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-4 | Default DL beam setup for SFN | 1. Support of PDSCH reception using default beam for Rel-17 enhanced SFN scheme when PDSCH is scheduled with offset less than threshold  2. Support PDSCH reception using default beam for Rel-17 enhanced SFN scheme when TCI field is not present in DCI when PDSCH is scheduled with offset equal or larger than the threshold (if applicable)  3. Support aperiodic CSI-RS reception using default beam for Rel-17 enhanced SFN scheme when scheduling offset is less than threshold | 23-6-1 |  |  |  | Per band |  | FR2 only for component 1/3 |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-4 | Default DL beam setup for SFN | 1. Support of PDSCH reception using default beam for Rel-17 enhanced SFN scheme when PDSCH is scheduled with offset less than threshold  2. Support PDSCH reception using default beam for Rel-17 enhanced SFN scheme when TCI field is not present in DCI when PDSCH is scheduled with offset equal or larger than the threshold  3. Support aperiodic CSI-RS reception using default beam for Rel-17 enhanced SFN scheme when scheduling offset is less than threshold | ~~[~~23-6-1, 23-6-2~~]~~ |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-6-4a | Default UL beam setup for SFN | 1. Support of single-TRP PUCCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  2. Support of single-TRP PUSCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  3. Support of single-TRP SRS resource transmission using default beam when enhanced SFN PDCCH transmission scheme is configured | [23-6-1, 23-6-2] |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | * For FG 23-6-4/23-6-4a,   + Pre-requisite feature should not be “23-6-1, 23-6-2”. If the pre-requisite feature is “ 23-6-1, 23-6-2”, it means UE supporting FG 23-6-4/23-6-4a should support both “ 23-6-1, 23-6-2”. However, FG 23-6-1 and FG 23-6-2 are independent features, and it is possible that UE supports either FG 23-6-1 or FG 23-6-2. One possible solution is to make FG23-6-1 as basic FG for HST, and make FG23-6-1 as pre-requisite feature of FG 23-6-2 and FG 23-6-4 and FG23-6-4a. We believe the most of functions of FG23-6-1 are included in FG23-6-2.   + “FR2 only” for FG23-6-4 is incorrect. For FG23-6-4, the threshold of *timeDurationForQCL* is only reported in FR2. In RAN1 agreements for HST and Rel.15/16/17 spec., the UE behavior of no TCI state field is captured as “scheduling offset equal or larger than the threshold, if applicable”. This is because the UE behavior of no TCI state field in FR1is specified. However, in the current UE feature list, there is no FG to report the support of no TCI state field in FR1. Hence, we suggest to add “(if applicable)” in component 2 and update as “FR2 only for component 1/3”.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-4a | Default UL beam setup for SFN | 1. Support of single-TRP PUCCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  2. Support of single-TRP PUSCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  3. Support of single-TRP SRS resource transmission using default beam when enhanced SFN PDCCH transmission scheme is configured | 23-6-1 |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-4a | Default UL beam setup for SFN | 1. Support of single-TRP PUCCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  2. Support of single-TRP PUSCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  3. Support of single-TRP SRS resource transmission using default beam when enhanced SFN PDCCH transmission scheme is configured | ~~[~~23-6-1, 23-6-2~~]~~ |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode [selection] of mode 1 with X=0 [and/or] mode 2 4. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis] 5. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 6. [Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs] 7. Maximum total number of CMRs for NCJT measurement [per CC/across all CCs] 8. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs] 9. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs] 10. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement] 11. [A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC] 12. [A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs] | FFS |  |  |  | [Per band and per BC] |  |  |  | [Component 2 candidate value set: {[0, 2, 3,] 4, 5, 6, 7, 8}]  [Component 3 candidate value set: { mode 1 with X=0, mode 2, both]  Component 5 candidate values:   1. [{2, 4, 8, 12, 16, 24, 32}] 2. {2, 4, 8, 12, 16[, 24, 32]} 3. [{1,2,3,4 … 64}] 4. {2,3,4 … 64} 5. [{4,5,6, …, 256}] 6. {2,3,4, …, 256}   [Component 6: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}]  [Component 7: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}]  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N~~max~~=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode [selection] of mode 1 with X=0 [and/or] mode 2 4. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    * 1. ~~[Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]~~      2. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis      3. ~~[Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs]~~      4. Maximum total number of CMRs for NCJT measurement ~~[per CC/~~across all CCs]      5. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]~~      6. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [~~per CC/~~across all CCs]      7. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]~~ 5. ~~[A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC]~~ 6. ~~[A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs]~~ | FFS |  |  |  | [Per band and per BC] |  |  |  | [Component 2 candidate value set: {[0, 2, 3,] 4, 5, 6, 7, 8}]  [Component 3 candidate value set: { mode 1 with X=0, mode 2, both]  Component 5 candidate values:   1. ~~[{2, 4, 8, 12, 16, 24, 32}]~~ 2. {2, 4, 8, 12, 16[, 24, 32]} 3. ~~[{1,2,3,4 … 64}]~~ 4. {~~1,~~2,3,4 … ~~1~~64} 5. ~~[{4,5,6, …, 256}]~~ 6. {2,3,4, …, 256}   ~~[Component 6: The list can have maximum of 16 pairs.~~  ~~- Y1: {1 to 4}~~  ~~- Y2: {1 to 8}]~~  ~~[Component 7: The list can have maximum of 16 pairs.~~  ~~- X1: {1 to 16}~~  ~~- X2: {1 to 32}]~~  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling | |
| vivo [3] | The following agreements has been reached at the RAN1’s meetings. According to the agreement, we believe that N=1 and Ks =2 can be a basic feature due to the calculation of NCJT measurement hypothesis and N=2 and Ks>2 can be an optional feature. However, in current FG23-7-1, there is a component to indicate the maximum number of NZP CSI-RS resources in one CSI-RS resource set but did not have a component to indicate the maximum number of NZP CSI-RS resource pairs in one CSI-RS resource set. Therefore, we suggest that a unified design should be considered for the number of NZP CSI-RS resources and the number of NZP CSI-RS resource pairs.   |  | | --- | | **Agreement**  For CSI measurement associated to a reporting setting CSI-ReportConfig for NCJT, the UE can be configured with Ks ≥ 2 NZP CSI-RS resources in a CSI-RS resource set for CMR and N ≥ 1 NZP CSI-RS resource pairs whereas each pair is used for a NCJT measurement hypothesis   * Configure UE with two CMR groups with Ks=K1+K2 CMRs. CMR pairs are determined from two CMR groups by following method(s).   + K1 and K2 are the number of CMRs in two groups respectively. FFS K1=K2 or different K1/K2.   + Note that CMRs in each CMR group can be used for both NCJT and Single-TRP measurement hypotheses   + N CMR pairs are higher-layer configured by selecting from all possible pairs     - signalling mechanism can be discussed further, e.g. using a bitmap     - FFS: Whether MAC-CE or RRC+MAC CE indication is needed     - FFS: how to support NCJT measurement hypotheses in FR2 * Support N=1 and Ks =2, FFS other maximal values of N>1 and Ks>2 * Note: for CPU/resource/port occupation, NCJT hypothesis is considered separately from single TRP hypothesis   **Agreement**  With regarding to the maximal values of *Nmax* for *N, Ks,max* for *Ks*:   * Support of *Nmax*=2 is a UE optional feature * Support of *Ks,max*=*X* is a UE optional feature   + *X* can be up to 8 and other candidate values can be discussed as part of UE features * FFS: Default value of *Nmax*, *Ks,max* * FFS: Which combinations of *N*<=*Nmax*, *Ks*<=*Ks,max* are supported |   FG 23-7-2 seems redundant of what we have in FG 23-7-1 in latest agreement in R1-2200780, e.g.,  A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]   * + 1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]     2. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis     3. [Maximum total number of CMRs for ~~calculated~~ single-TRP measurement ~~hypotheses~~] [per CC/across all CCs]     4. Maximum total number of CMRs for ~~calculated~~ NCJT measurement ~~hypotheses~~ [per CC/across all CCs]     5. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]     6. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs]     7. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]   Therefore, we can also consider this FG and FG 23-7-1 together.  We also suggest to consider the number of NZP CSI-RS resources and the number of NZP CSI-RS resource pairs together. As the feature of the number of NZP CSI-RS resource pairs is a separate FG as given in FG 23-7-4, we prefer to keep FG 23-7-3 as a separate FG.  **Proposal 7-1:** **We suggest to consider FG 23-7-2 and FG 23-7-1 together and suggest following updates in FG23-7-1 and FG23-7-3.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks~~,max~~=2 3. CSI report mode ~~[~~selection~~]~~ of mode 1 with X=0 [and/or] mode 2 4. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis] 5. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 6. [Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs] 7. Maximum total number of CMRs for NCJT measurement [per CC/across all CCs] 8. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs] 9. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs] 10. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement] 11. [A list of (Y1,Y2): UE can process Y1 NCJT CSI measurement hypotheses and Y2 sTRP CSI measurement hypothes~~i~~es simultaneously in a CC] 12. [A list of (X1,X2): UE can process X1 NCJT CSI measurement hypotheses and X2 sTRP CSI measurement hypothes~~i~~es simultaneously across all CCs] | FFS |  |  |  | [Per band and per BC] |  |  |  | ~~[Component 2 candidate value set: {[0, 2, 3,] 4, 5, 6, 7, 8}]~~  [Component 3 candidate value set: { mode 1 with X=0, mode 2, both]  Component 5 candidate values:   1. [{2, 4, 8, 12, 16, 24, 32}] 2. {2, 4, 8, 12, 16[, 24, 32]} 3. [{1,2,3,4 … 64}] 4. {2,3,4 … 64} 5. [{4,5,6, …, 256}] 6. {2,3,4, …, 256}   [Component 6: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}]  [Component 7: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}]  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling | |
| ZTE [4] | * + For component-4, we can NOT support the component a/c/e/g that is related to normal sTRP-CSI measurement. Then, if considering a list of combination (although we do not identify clear necessity), the normal UE capability report using the triplet of {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for NCJT. That means that FG 23-7-2 should be considered together.   + For component-5 and 6, we have already increased the number of occupied CPU(s) compared with s-TRP CSI calculation, and therefore the legacy UE capability report for CPU(s) should be sufficient.  |  |  |  | | --- | --- | --- | | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode ~~[~~selection~~]~~ of mode 1 with X=0 ~~[~~and~~/or]~~ mode 2 4. A list of ~~[supported combinations, up to 16, across all CCs simultaneously, where each combination is]~~    1. ~~[Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]~~ 5. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 6. ~~[Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs]~~ 7. Maximum total number of CMRs for NCJT measurement [per CC/across all CCs] 8. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]~~ 9. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs] 10. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]~~ 11. ~~[A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC]~~ 12. ~~[A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs]~~ | |
| OPPO [5] | It was discussed in the past meeting whether both mode 1 with X=0 and mode 2 should be mandatory feature for UE supporting mTRP CSI enhancement. In our opinion, UE is not needed to support both modes. For a UE only supporting mode 1 with X=0, gNB can acquire S-TRP CSI via another CSI report configuration in legacy way. For a UE only supporting mode 2, gNB can acquire the optimal transmission scheme directly via CSI feedback. Hence, for FG 23-7-1, UE can report the capability of supporting mode 1 with X=0 only, mode 2 only or both modes.  ***Proposal 14: For CSI report mode in 23-7-1, support UE capability to report one of mode 1 with X=0 or mode 2 or both modes.***  It was agreed that UE can report the maximal supported number of CMRs within a set as Ks,max. In FR1, the same CMRs can be reused for S-TRP and NC-JT, and Ks=2 can satisfy most use cases for M-TRP. In FR2, if UE supports CMR sharing between S-TRP and NC-JT or if UE only supports option 1 with X=0, it can also report Ks,max=2 as the minimal capability. Hence, for UE capability, the minimal supported value of Ks,max should be 2.  ***Proposal 15: For mTRP CSI, support Ks,max=2 as basic component in 23-7-1, and Ks,max>2 as optional feature/component.*** |
| CATT [6] | Firstly, for the Features of CSI Enhancement for Multi-TRP, we support that UE reports the basic capability of the value of Ks,max in FG 23-7-1 and additionally reports the enhanced capability of Ks,max =8 in FG 23-7-3.  Secondly, according to the agreement on CSI feedback mode, we propose both Mode1 with X=0 and Mode2 should be both incldued in the basic FG, not for selection only one. For FG 23-7-1a of supporting additional CSI report mode 1, its prerequisite feature group should be FG 23-7-1.  Finally, for the number of Tx ports or CMRs, we support separate component should be listed for each measure hypothesis, but it seems unnecessary that UE reporting the total number of Tx ports per CC or across all CCs. Therefore, our suggestion is to delete the capabilities of the total number of Tx ports per CC or across all CCs for each measure hypothesis.  ***Proposal-20: For CSI enhancement for Multi-TRP, the UE feature 23-7-1 is revised as follows:***   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1  2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max  3. CSI report mode ~~[selection]~~ of mode 1 with X=0 ~~[~~and~~/or]~~ mode 2  4. A list of ~~[~~supported combinations, up to 16, across all CCs simultaneously, where each combination is~~]~~  a) ~~[~~Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis~~]~~  b) Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis  c) ~~[~~Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs~~]~~  d) Maximum total number of CMRs for NCJT measurement ~~[~~per CC/across all CCs~~]~~  ~~e) [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]~~  ~~f) Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs]~~  g) ~~[~~Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement~~]~~  5. ~~[~~A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC~~]~~  6. ~~[~~A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs~~]~~ |  |  |  |  |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] | * **23-7-1:**   + - Component 2: it was agreed to discuss the default value of with UE capability. In our view the minimum value should be because, if *sharedCMR* is absent and *N* = 1, *M*1 = *K*1 - 1 and *M*2 = *K*2 – 1 (see R1-2112472, Sec. 6.3.1.1.2), hence , and the minimum value of   **Agreement**(RAN1#105-e)  For a CSI-RS resource set with Ks NZP CSI-RS resources configured for CMR and N NZP CSI-RS resource pairs configured for NCJT measurement hypotheses, study following default value of Ks,max,   * Alt 1: Ks,max = 4 * Alt 2: Ks,max = 2 * Alt 3: Ks,max = 4 for FR2, and Ks,max = 2 for FR1 * Note that default value means the minimal supported value for Ks,max in UE capability reporting, if UE support this feature.   **Conclusion:** (RAN1#106-e)  Default value of Ks, max can be discussed later with Rel-17 MIMO UE capability.   * Component 3: our preference is to support reporting mode 1 with X=0 by default as it is the simplest reporting mode and it was agreed to support wideband reporting with this mode. Besides it is a useful mode to test NCJT CSI performance requirements in RAN4 and to support 4-layer DL in FR2.   **Agreement**  For a CSI report associated with a Multi-TRP/panel NCJT measurement hypothesis configured by single CSI reporting setting, the UE can be configured with pmi-FormatIndicator=widebandPMI and cqi-FormatIndicator=widebandCQI only for Mode 1 with X=0   * New component x: timing restriction for a CMR pair (X=1 or 2). Candidate value set: {X=1,X=2}   In RAN1#106bis-e, it was agreed to introduce a timing restriction in the configuration of the two CMRs is a Resource Pair for NCJT measurement, such that they can be configured either within the same slot () or in two consecutive slots () without downlink/uplink switching between the two resources:  **A****greement**  For CSI measurement associated with a CSI-ReportingConfig for NCJT, support two CMRs within the same CMR pair configured for NCJT measurement hypothesis to be restricted within X continuous slot(s) without DL/UL switch between two CMRs   * X=1, 2   + whereas X=1 implying the same slot and X=2 implying two adjacent slots * FFS other restrictions for FR2 * FFS whether UE capability is needed for X=2 |
| NTT DOCOMO, INC. [7] | For 23-7-1, the candidate value of component 2 could start from 4. For component 3, it is better to define default CSI report mode for MTRP CSI instead of CSI report mode selection. On the other hand, the UE supporting mode 2 could easily support mode 1 with X=0, hence, we suggest supporting both mode 1 with X=0 and mode 2 in component 3. For component 4, 5, 6, we’re okay to keep them.  **Proposal: Adopt the following for Rel-17 M-TRP CSI.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N~~max~~=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode of mode 1 with X=0 and mode 2 4. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is    * 1. Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis      2. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis      3. Maximum total number of CMRs for single-TRP measurement [per CC/across all CCs]      4. Maximum total number of CMRs for NCJT measurement [per CC/across all CCs]      5. Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses [per CC/across all CCs]      6. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs]      7. Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement 5. A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC 6. A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs | FFS |  |  |  | [Per band and~~/~~ per BC] |  |  |  | Component 2 candidate value set: { 4, 5, 6, 7, 8}  Component 4 candidate values:   1. [{2, 4, 8, 12, 16, 24, 32}] 2. {2, 4, 8, 12, 16[, 24, 32]} 3. [{1,2,3,4 … 64}] 4. {2,3,4 … ~~1~~64} 5. [{4,5,6, …, 256}] 6. {2,3,4, …, 256}   [Component 5: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}]  [Component 6: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}]  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling | | 23. NR\_FeMIMO | 23-7-1a | Additional CSI report mode 1 selection | Maximum value of numberOfSingleTRP-CSI-Mode1 |  |  |  |  |  |  |  |  | Component 1 candidate value set: {X=1, X=2} | Optional with capability signalling | |
| Spreadtrum Communications [9] | For component 1, we prefer to add ‘N’ before ‘NZP CSI-RS resource pairs’, to make it more clear on the definition of N.  ***Proposal 11: Suggest to revise component 1 of FG23-7-1 as ‘Support of N NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1’.***  For component 2, regarding the candidate values, we prefer to keep ‘2’. In LTE NC-JT, only two CMR resources are configured to be measured for one CSI report. Likewise, at least for FR1, Ks,max =2 is OK for NR system. For FR2, Ks,max =4 seems to be capable of providing more measurement results with the assumption of multiple different beams in a CSI report. However, beam measurement and reporting could be firstly carried out before CSI acquisition, and proper beam could be selected out for CSI measurement. Thus, we think Ks,max =2 cam be used for both FR1 and FR2.  ***Proposal 12: For component 2 of FG23-7-1, the candidate values should include ‘2’.***  For g in component 4, we suggest to remove the bracket, since we have the following agreement in RAN1#104e.  **Agreement**  For CSI measurement associated to a reporting setting CSI-ReportConfig for NCJT, [at least for multi-DCI based and single-DCI based schemes (scheme 1a)], NZP CSI-RS resources for channel measurement are associated to different TRPs/TCI states at resource level   * CMRs corresponding to different TRPs respectively shall be configured within the same resource set (i.e. scheme 1-2) and have the same number of ports among CMRs. * At least ‘typeI-SinglePanel’ codebook is supported   + FFS: Other codebook types * Note that RAN1 shall strive to finalize NCJT CSI enhancement with single reporting setting firstly. * The support of larger than 32 ports across two CMRs is optional for a UE supporting Rel. 17 mTRP CSI   ***Proposal 13: Suggest to remove the bracket for g in component 4 of FG23-7-1.*** |
| LG Electronics [10] | **23-7-1**   * + - Regarding candidate value set for component 2, the need of value 0 is not clear. And, value 2 is needed for both mode 1 with X=0 and mode 2, so it should be supported.     - Regarding component 3, candidate value set is already clearly described, so we prefer to simplify the description of this component.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode 4. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis] 5. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 6. [Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs] 7. Maximum total number of CMRs for NCJT measurement [per CC/across all CCs] 8. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs] 9. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs] 10. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement] 11. [A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC] 12. [A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs] | FFS |  |  |  | [Per band and per BC] |  |  |  | Component 2 candidate value set: { 2, 3, 4, 5, 6, 7, 8}  Component 3 candidate value set: { mode 1 with X=0, mode 2, both}  Component 5 candidate values:   1. [{2, 4, 8, 12, 16, 24, 32}] 2. {2, 4, 8, 12, 16[, 24, 32]} 3. [{1,2,3,4 … 64}] 4. {2,3,4 … 64} 5. [{4,5,6, …, 256}] 6. {2,3,4, …, 256}   [Component 6: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}]  [Component 7: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}]  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling | |
| Intel Corporation [11] | At the last RAN1 meeting it was proposed to support UE capability with list of combinations with 7 entries in each combination (Component 4 in FG 23-7-1). The motivation behind this proposal is to address the issue of PMI calculation complexity for NCJT CSI hypothesis. For NCJT CSI Type I PMI codebook is used, however, the PMI search complexity can be considerably higher for NCJT CSI comparing to STRP CSI with the same Type I PMI codebook. In our view introduction of Component 4 in FG 23-7-1 doesn’t fully address the issue since multiple PMI codebooks can be used together with NCJT CSI including Type II PMI codebooks. Thus, it is better to consider the NCJT CSI as a separate codebook for FG 23-9-5. In this case for Component 4 in FG 23-7-1 subcomponents b, d and f in combination with FG 23-9-5 are sufficient to control the PMI search complexity at the UE, i.e. subcomponents a, c, e, g can be removed.  For the CPU occupancy, in our view CPUs for STRP and NCJT can be considered together since it was already agreed that NCJT CSI occupies 2 CPUs per resource pair. The difference in PMI calculation complexity can be controlled by limiting the number of ports or resources (e.g. by using FG 23-9-5 and FG 23-7-1).  For a UE implementation it can be the case that PMI search for NCJT CSI doesn’t consider impact of interference created by NCJT transmission. For such UE implementation the complexity of PMI search for STRP CSI with Type I PMI codebook is the same as for NCJT CSI. Thus, in this case Type I PMI codebook capabilities introduced in Rel-15 can be used for NCJT. In order to decrease UE capability overhead some mechanism is needed to indicate that UE can support Multi-TRP CSI with the same number of ports/resources as for STRP with Type I PMI codebook. So, the following note can be introduced: “Note: If the list of combinations in Component 4 is empty then the maximum number of ports and resources for NCJT measurement hypothesis is reused from Type I PMI codebook capabilities”.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode [selection] of mode 1 with X=0 [and/or] mode 2 4. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    1. ~~[Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]~~ 5. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 6. ~~[Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs]~~ 7. Maximum total number of CMRs for NCJT measurement ~~[per CC/~~across all CCs~~]~~ 8. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]~~ 9. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses ~~[per CC/~~across all CCs~~]~~ 10. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]~~ 11. ~~[A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC]~~ 12. ~~[A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs]~~ | [Component 2 candidate value set: {[0, 2, 3,] 4, 5, 6, 7, 8}]  [Component 3 candidate value set: { mode 1 with X=0, mode 2, both]  Component 5 candidate values:   1. ~~[{2, 4, 8, 12, 16, 24, 32}]~~ 2. {2, 4, 8, 12, 16[, 24, 32]} 3. ~~[{1,2,3,4 … 64}]~~ 4. {2,3,4 … 64} 5. ~~[{4,5,6, …, 256}]~~ 6. {2,3,4, …, 256}   ~~[Component 6: The list can have maximum of 16 pairs.~~  ~~- Y1: {1 to 4}~~  ~~- Y2: {1 to 8}]~~  ~~[Component 7: The list can have maximum of 16 pairs.~~  ~~- X1: {1 to 16}~~  ~~- X2: {1 to 32}]~~  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214  Note: If the list of combinations in Component 4 is empty then the maximum number of ports and resources for NCJT measurement hypothesis is reused from Type I PMI codebook capabilities | [Per band and per BC] | |
| Apple [12] | * UE should be able to independently indicate whether UE supports (1) Mode 1 X= 0 (2) Mode 1 X= 1(3) Mode 1 X= 2 (4) Mode 2. When UE only supports mode 1 X=0, The maximum Ks,max can be 0 |
| CMCC [13] | In addition, we think the minimum value of Ks,max should be Ks,max = 4. At least in FR2, if the CMR sharing between Single-TRP and NCJT is not supported, at least 4 resources are needed in resource set. Two NZP CSI-RS resources are used for NCJT measurement hypothesis, while the other two NZP CSI-RS resources are used for two different Single-TRP measurement hypotheses. Therefore, the candidate value set in component 2 of FG 23-7-1 should be {4, 5, 6, 7, 8}.  ***Proposal 9: The candidate value set in component 2 of FG 23-7-1 should be {4, 5, 6, 7, 8}.***  Besides, the total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement hypothesis should be twice as the number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis, since the resources pair associated with one NCJT measurement hypothesis consist of two resources and the two resources have the same Tx ports. It means in component 4 of FG 23-7-1 the number of g) is twice as the number of b) in the combination. Therefore, we suggest to delete the “g) Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement” in component 4 of FG 23-7-1 since the number of g) is useless.  ***Proposal 10: Delete the “g) Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement” in component 4 of FG 23-7-1.***  Based on the above analysis, we suggest to adopt the following changes using red colour for the FGs for Multi-TRP CSI:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode [selection] of mode 1 with X=0 [and/or] mode 2 4. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis] 5. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 6. [Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs] 7. Maximum total number of CMRs for NCJT measurement [per CC/across all CCs] 8. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs] 9. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs] 10. ~~[~~~~Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]~~ 11. [A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC] 12. [A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs] | FFS | [Per band and per BC] | ~~[~~Component 2 candidate value set: {~~[0, 2, 3,]~~ 4, 5, 6, 7, 8}~~]~~  [Component 3 candidate value set: { mode 1 with X=0, mode 2, both]  Component 5 candidate values:   1. [{2, 4, 8, 12, 16, 24, 32}] 2. {2, 4, 8, 12, 16[, 24, 32]} 3. [{1,2,3,4 … 64}] 4. {2,3,4 … 64} 5. [{4,5,6, …, 256}] 6. {2,3,4, …, 256}   [Component 6: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}]  [Component 7: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}]  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | |
| Xiaomi [14] |  |
| Samsung [15] | In RAN1#107b-e, the basic structure of FGs (23-7-1, 23-7-1a) has been agreed with some remaining details on the candidate values for the corresponding components. Regarding FG 23-7-1, we would like to include the following components as UE basic feature  **Proposal 24:** *Support 23-7-1, i.e., basic features of CSI enhancement for Multi-TRP.*   * *Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis*    + *Include candidate values up to 16 Tx ports per resource as a basic feature, i.e., {2, 4, 8, 12, 16}*   + *For candidates values greater than 16, support it as a separate optional feature in* FG 23-7-2 |
| MediaTek Inc. [16] | As Ks is the number of NZP CSI-RS resources in one CSI-RS resource set, rather than the number of single-TRP measurement hypotheses, the minimum number should be 2 to accommodate at least one resource pair. Also, supporting Mode 1 with X=0 requires a configuration of only 2 CMRs, so it does not make sense demanding minimum 4 CMRs in a CSI-RS resource set.  **Proposal 27**: The candidate values of Component 2 in FG 23-7-1 are 2, 3, 4, 5, 6, 7, 8.  As CSI report mode 2 has higher complexity than mode 1 with X=0, mode 2 should not be considered as a basic feature of multi-TRP CSI.  **Proposal 28**: Component 3 of FG 23-7-1 is named “CSI report mode selection” with candidate values {mode 1 with X=0, both mode 1 with X=0 and mode 2}.  For Component 4, although we prefer each combination having 6 values for finer reporting of UE’s capability on operations involving both NCJT and single-TRP, we can compromise with each combination having 4 values, including   * Maximum number of Tx ports in one NZP CSI-RS resource: {4, 8, 12, 16, 24, 32} * Maximum number of NZP CSI-RS resources: {from 0 to 63} * Maximum number of resource pairs: {from 1 to 8} * Maximum number of total Tx ports of NZP CSI-RS resources: {4, 8, 12, …, 256}   In this way, at least in the resource level UE does not need to underreport its capability for single-TRP CSI calculations.  **Proposal 29**: Revise Component 4 of FG 23-7-1 as   * A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is   {   * Maximum number of Tx ports in one NZP CSI-RS resource: {4, 8, 12, 16, 24, 32} * Maximum number of NZP CSI-RS resources: {from 0 to 63} * Maximum number of resource pairs: {from 1 to 8} * Maximum number of total Tx ports of NZP CSI-RS resources: {4, 8, 12, …, 256}   }   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of two resource groups and one resource pair in one CSI-RS resource set and support of Type-I single-panel codebook with codebook mode set to ‘Mode 1’ 2. Maximum number of NZP CSI-RS resources in one CSI resource set: Ks,max 3. CSI report mode selection 4. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is   {   * 1. Maximum number of Tx ports in one NZP CSI-RS resource: {4, 8, 12, 16, 24, 32}   2. Maximum number of NZP CSI-RS resources: {from 0 to 63}   3. Maximum number of resource pairs: {from 1 to 8}   4. Maximum number of total Tx ports of NZP CSI-RS resources: {4, 8, 12, …, 256}   **}** |  |  |  |  | Per band and Per BC |  |  |  | Component 2: Candidate values: {2, 3, 4, 5, 6, 7, 8}  Component 3: Candidate values: {Mode 1 only, Both Mode 1 and Mode 2}  Note: Only NZP CSI-RS resources associated with Type I single-panel codebook are considered here. | **Optional with capability signalling** | |
| Lenovo [17] | For Feature group 23-7-1, it was agreed in RAN1#106bis-e [4] that for CSI measurement associated with a CSI-ReportingConfig for NCJT, two CMRs within the same CMR pair configured for NCJT measurement hypothesis are restricted within K continuous slot(s) without DL/UL switch between two CMRs, where K=1,2. We propose setting K=2 as a basic feature of CSI Enhancement for Multi-TRP under FG 23-7-1, whereas K=1 is set as an optional feature.   1. For the basic UE FG 23-7-1 for CSI enhancements under multi-TRP, add a component indicating that two CMRs within the same CMR pair configured for NCJT measurement hypothesis are restricted within K=2 continuous slots 2. Add an optional UE FG for CSI enhancements under multi-TRP, indicating that two CMRs within the same CMR pair configured for NCJT measurement hypothesis are restricted within K=1 slot   Also, for sub-components (e), (f), and (g) of component 5 in FG 23-7-1, the granularity in the number of CSI-RS ports is set to one, which in our opinion has no benefit for UE features. Using a granularity of 2*a*, e.g., a=2,4 would suffice. For instance, we propose the candidate values for sub-components 5(e), 5(f) and 5(g) in FG 23-7-1 to be {4, 8, 16, 32, 64, 128, 256}.   1. For sub-components 5(e), 5(f) and 5(g) of FG 23-7-1, increase the granularity of the candidate values, e.g., {4, 8, 16, 32, 64, 128, 256} |
| Qualcomm Incorporated [18] | The main issue to address based on the discussions in the previous meeting is that for a given NCJT measurement hypothesis, in order to properly take into account inter-layer interference, a joint search is needed across the codebooks associated with two CMRs. This complexity is obviously more than just double of a given sTRP measurement hypothesis. For example, if UE evaluates 8 PMI/RI hypos for a given sTRP CSI, UE may need to evaluate up to 8\*8=64 hypos for a given NCJT CSI for optimal results and not just 16 hypos, where the exact additional complexity may depend on UE implementation. In order to address the UE complexity issue in the presence of NCJT CSI (across all CCs and all CSI report settings even when some of them are not configured with NCJT CSI), we see two possible Alts:   * **Alt1**: Separate the CPU/resource/port occupation budget for NCJT CSI versus sTRP CSI.   + In component 4 of FG 23-7-1, the values of a, c, and f (currently in bracket) are included in each reported list   + Components 5 and 6 (currently in bracket) are also needed. * **Alt2**: Allow a UE to report a different list of triplets when CSI for both NCJT and sTRP CSIs are configured for different codebook combinations of sTRP CSI   + The existing FG 23-7-1 is to report capability for NCJT only (i.e., in the absence of sTRP CSI). Hence, in component 4 of FG 23-7-1, the values of a, c, and f are removed, and component 5 and 6 are changed to report one value for NCJT only (instead of a list for both NCJT and sTRP).   + Add a new FG 23-7-1b so that UE can report list of triplets for different codebook combinations of the form of (NCJT, one or more codebooks for sTRP).     - In order to limit the number of codebook combinations, it is reasonable to bundle NCJT CSI (which is defined only for Type1 SP codebook) and sTRP CSI for Type1 SP codebook. This corresponds to codebook 1=” NCJT+Type 1 SP (for sTRP)”     - To further limit the number of codebook combinations, the possible choice for {codebook2, codebook3} can be limited to more useful/practical cases. Also, a {Null, Null} possibility is needed, i.e., to report triplets for {NCJT+Type 1 SP (for sTRP), Null, Null}.   Even though our preference is still Alt1 due to more flexibility for UE capability signalling, Alt2 can be accepted as a compromise so that additional discussions wrt mixed codebooks can be avoided as Alt2 already captures it.  In addition to the discussions above (regarding Alt1 versus Alt2 to address the UE complexity associated with NCJT CSI), the following points need to be considered:   * Candidate values for component 2 of FG 23-7-1 needs to be {2,3,4,5,6,7,8}. A value smaller than 2 is not needed since at least 2 CMRs are needed for NCJT. Also, both {2,3} should be included as they are valid configuration. * Candidate values for component 3 of FG 23-7-1 should be {mode 1 with X=0, mode 2, both}. In the corresponding agreement, we have “for the UE supporting option 1”, which implies that mode 1 is not mandatory for mTRP CSI. * A component 7 should be added to FG 23-7-1, which is to indicate the supported codebook mode for NCJT CSI. Note that for sTRP Type1 SP, UE reports the supported codebook mode through component 2 of FG 2-36. * FG 23-7-1 (and/or FG 23-7-1b in Alt2 discussed above) should be reported per band and separately per band combination. This is same as legacy behaviour for reporting triplets for each codebook / codebook combination per band and separately per band combination.   ***Proposal 10-1: Adopt the following for Rel-17 mTRP CSI UE features (modifications in red). Both Alt1 and Alt2 discussed above are included in the table below from which one of them needs to be selected.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1 (Alt1) | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode ~~[~~selection~~]~~ of mode 1 with X=0 ~~[~~and/or~~]~~ mode 2 4. A list of ~~[~~supported combinations, up to 16, across all CCs simultaneously, where each combination is~~]~~ 5. ~~[~~Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis~~]~~ 6. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 7. ~~[~~Maximum total number of CMRs for single-TRP measurement~~] [per CC/across all CCs]~~ 8. Maximum total number of CMRs for NCJT measurement ~~[per CC/across all CCs]~~ 9. ~~[~~Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses~~] [per CC/across all CCs]~~ 10. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses ~~[per CC/across all CCs]~~ 11. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]~~ 12. ~~[~~A list of (Y1,Y2): UE can process Y1 NCJT CSI and Y2 sTRP CSI measurement hypothesis simultaneously in a CC~~]~~ 13. ~~[~~A list of (X1,X2): UE can process X1 NCJT CSI and X2 sTRP CSI measurement hypothesis simultaneously across all CCs~~]~~ 14. Supported codebook modes for NCJT CSI | ~~FFS~~ |  |  |  | ~~[~~Per band and per BC~~]~~ |  |  |  | ~~[~~Component 2 candidate value set: {~~[0~~, 2, 3,~~]~~ 4, 5, 6, 7, 8}~~]~~  ~~[~~Component 3 candidate value set: { mode 1 with X=0, mode 2, both}~~]~~  Component ~~5~~ 4 candidate values:   1. ~~[~~{2, 4, 8, 12, 16, 24, 32}~~]~~ 2. {2, 4, 8, 12, 16~~[~~, 24, 32~~]~~} 3. ~~[~~{1,2,3,4 … 64}~~]~~ 4. {2,3,4 … 64} 5. ~~[~~{4,5,6, …, 256}~~]~~ 6. {2,3,4, …, 256}   ~~[~~Component ~~6~~ 5: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}~~]~~  ~~[~~Component ~~7~~ 6: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}~~]~~  Component 7:{ mode 1, both mode 1 and mode 2}  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling | | 23. NR\_FeMIMO | 23-7-1  (Alt2) | Basic Features of CSI Enhancement for Multi-TRP | 1. Support of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N=1 2. Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode ~~[~~selection~~]~~ of mode 1 with X=0 ~~[~~and/or~~]~~ mode 2 4. A list of ~~[~~supported combinations, up to 16, across all CCs simultaneously, where each combination is~~]~~ 5. ~~[Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]~~ 6. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis 7. ~~[Maximum total number of CMRs for single-TRP measurement] [per CC/across all CCs]~~ 8. Maximum total number of CMRs for NCJT measurement ~~[per CC/across all CCs]~~ 9. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]~~ 10. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses ~~[per CC/across all CCs]~~ 11. ~~[Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]~~ 12. ~~[A list of (Y1,Y2):~~ UE can process Y~~1~~ NCJT CSI ~~and Y2 sTRP CSI~~ measurement hypothesis simultaneously in a CC~~]~~ 13. ~~[A list of (X1,X2):~~ UE can process X~~1~~ NCJT CSI ~~and X2 sTRP CSI~~ measurement hypothesis simultaneously across all CCs~~]~~ 14. Supported codebook modes for NCJT CSI | ~~FFS~~ |  |  |  | ~~[~~Per band and per BC~~]~~ |  |  |  | ~~[~~Component 2 candidate value set: {~~[0~~, 2, 3,~~]~~ 4, 5, 6, 7, 8}~~]~~  ~~[~~Component 3 candidate value set: { mode 1 with X=0, mode 2, both}~~]~~  Component ~~5~~ 4 candidate values:   1. ~~[{2, 4, 8, 12, 16, 24, 32}]~~ 2. {2, 4, 8, 12, 16~~[~~, 24, 32~~]~~} 3. ~~[{1,2,3,4 … 64}]~~ 4. {2,3,4 … 64} 5. ~~[{4,5,6, …, 256}]~~ 6. {2,3,4, …, 256}   ~~[~~Component ~~6~~ 5: ~~The list can have maximum of 16 pairs.~~  - Y~~1~~: {1 to 4}  ~~- Y2: {1 to 8}]~~  ~~[~~Component ~~7~~ 6: ~~The list can have maximum of 16 pairs.~~  - X~~1~~: {1 to 16}  ~~- X2: {1 to 32}]~~  Component 7:{ mode 1, both mode 1 and mode 2}  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling | | 23. NR\_FeMIMO | 23-7-1b  (Alt2) | Active CSI-RS resources and ports in the presence of multi-TRP CSI | 1. List of codebook combinations 2. List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-7-1 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {NCJT+Type 1 SP (for sTRP)}  {Codebook 2, Codebook 3} = {(NULL, NULL}), (Type II, NULL), (eType II R=1, NULL), (eType II R=2, NULL), …, (FeType II PS M=1, NULL), (FeType II PS M=2 R=1, NULL), …}  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {2, 4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1: A CMR pair configured for NCJT will be counted as two activated resources, a CMR configured for sTRP will be counted as one activated resource for a triplet.  Note2: This capability is relevant only when UE is configured with NCJT CSI in at least one CSI report setting in at least one CC in the band and/or band combination. | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-7-1a | Additional CSI report mode 1 selection | Maximum value of numberOfSingleTRP-CSI-Mode1 |  |  |  |  |  |  |  |  | Component 1 candidate value set: { X=1, X=2} | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] | |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-7-1a | Additional CSI report mode 1 ~~selection~~ | Maximum value of numberOfSingleTRP-CSI-Mode1 | 23-7-1 |  |  |  |  | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1a | Additional CSI report mode 1 selection | Maximum value of numberOfSingleTRP-CSI-Mode1 | **23-7-1** |  |  |  | Per band |  |  |  | Component 1 candidate value set: {X=1, X=2} | **Optional with capability signalling** | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-1a | Additional CSI report mode 1 selection | Maximum value of numberOfSingleTRP-CSI-Mode1 | 23-7-1 |  |  |  | Per Band |  |  |  | Component 1 candidate value set: { X=1, X=2} | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-7-2 | Support of max # of Tx ports [per source/across two CMRs] [in a resource set for Multi-TRP CSI] [and max # resources] | [A list of supported combinations, each combination is {max # of Tx ports per source in a resource set for Multi-TRP CSI, max # resources in a resource set for Multi-TRP CSI}]  [Note: same number of ports among CMRs] |  |  |  |  |  |  |  |  | [{4, 8, 12, 16, 24, 32}] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ~~23. NR\_FeMIMO~~ | ~~23-7-2~~ | ~~Support of max # of Tx ports per source and max # of resources in a resource set for Multi-TRP CSI~~ | ~~One or more list(s) of supported combinations, each combination is {max # of Tx ports per resource in a resource set for Multi-TRP CSI, max # resources in a resource set for Multi-TRP CSI}~~  ~~Note: same number of ports among CMRs~~ |  |  |  |  | ~~Per band per BC~~ |  |  |  | ~~Maximum number of lists: 16~~  ~~Max # of Tx ports per source: {[4, 8, 12, 16, 24,] 32}~~  ~~Max # resources: {2, 3, 4, 5, 6, 7, 8}~~ | ~~Optional with capability signalling~~ | |
| vivo [3] | The following agreements has been reached at the RAN1’s meetings. According to the agreement, we believe that N=1 and Ks =2 can be a basic feature due to the calculation of NCJT measurement hypothesis and N=2 and Ks>2 can be an optional feature. However, in current FG23-7-1, there is a component to indicate the maximum number of NZP CSI-RS resources in one CSI-RS resource set but did not have a component to indicate the maximum number of NZP CSI-RS resource pairs in one CSI-RS resource set. Therefore, we suggest that a unified design should be considered for the number of NZP CSI-RS resources and the number of NZP CSI-RS resource pairs.   |  | | --- | | **Agreement**  For CSI measurement associated to a reporting setting CSI-ReportConfig for NCJT, the UE can be configured with Ks ≥ 2 NZP CSI-RS resources in a CSI-RS resource set for CMR and N ≥ 1 NZP CSI-RS resource pairs whereas each pair is used for a NCJT measurement hypothesis   * Configure UE with two CMR groups with Ks=K1+K2 CMRs. CMR pairs are determined from two CMR groups by following method(s).   + K1 and K2 are the number of CMRs in two groups respectively. FFS K1=K2 or different K1/K2.   + Note that CMRs in each CMR group can be used for both NCJT and Single-TRP measurement hypotheses   + N CMR pairs are higher-layer configured by selecting from all possible pairs     - signalling mechanism can be discussed further, e.g. using a bitmap     - FFS: Whether MAC-CE or RRC+MAC CE indication is needed     - FFS: how to support NCJT measurement hypotheses in FR2 * Support N=1 and Ks =2, FFS other maximal values of N>1 and Ks>2 * Note: for CPU/resource/port occupation, NCJT hypothesis is considered separately from single TRP hypothesis   **Agreement**  With regarding to the maximal values of *Nmax* for *N, Ks,max* for *Ks*:   * Support of *Nmax*=2 is a UE optional feature * Support of *Ks,max*=*X* is a UE optional feature   + *X* can be up to 8 and other candidate values can be discussed as part of UE features * FFS: Default value of *Nmax*, *Ks,max* * FFS: Which combinations of *N*<=*Nmax*, *Ks*<=*Ks,max* are supported |   FG 23-7-2 seems redundant of what we have in FG 23-7-1 in latest agreement in R1-2200780, e.g.,  A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]   * + 1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]     2. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis     3. [Maximum total number of CMRs for ~~calculated~~ single-TRP measurement ~~hypotheses~~] [per CC/across all CCs]     4. Maximum total number of CMRs for ~~calculated~~ NCJT measurement ~~hypotheses~~ [per CC/across all CCs]     5. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]     6. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs]     7. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]   Therefore, we can also consider this FG and FG 23-7-1 together.  We also suggest to consider the number of NZP CSI-RS resources and the number of NZP CSI-RS resource pairs together. As the feature of the number of NZP CSI-RS resource pairs is a separate FG as given in FG 23-7-4, we prefer to keep FG 23-7-3 as a separate FG.  **Proposal 7-1:** **We suggest to consider FG 23-7-2 and FG 23-7-1 together and suggest following updates in FG23-7-1 and FG23-7-3.** |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] | * **23-7-2:**   + - Confirm the FG, but only for >16 TX ports.     - Propose to rename to “**Support of more than 16 Tx ports in one resource**”. Based on the following agreement, up to 16 Tx ports per resource (i.e. 32 across a Resource Pair) should be supported as part of basic capability   **Agreement**(RAN1#103-e)   * The support of larger than 32 ports across two CMRs is optional for a UE supporting Rel. 17 mTRP CSI   It should contain triplets in the same format as 23-7-1 but only for 24 and 32 antenna ports. |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | Considering Component 4 in FG 23-7-1, FG 23-7-2 is not needed.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | ~~23-7-2~~ | ~~Support of max # of Tx ports [per source/across two CMRs] [in a resource set for Multi-TRP CSI] [and max # resources]~~ | ~~[A list of supported combinations, each combination is {max # of Tx ports per source in a resource set for Multi-TRP CSI, max # resources in a resource set for Multi-TRP CSI}]~~  ~~[Note: same number of ports among CMRs]~~ | ~~[{4, 8, 12, 16, 24, 32}]~~ |  | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | Regarding 23-7-2, it can be reported as tuple, i.e., {the max # of ports per a resource, the max # of resources in a resource set}. The main objective of this feature group would be to indicate, as optional feature, the support of >16 ports per a CMR, i.e., >32 ports across two CMRs in a CMR pair. However, it may be required to indicate that 23-7-2 applies only when a UE is configured to a CSI report corresponding to NCJT measurement hypothesis, i.e., one or more CMR pairs.  **Proposal 25:** *Support 23-7-2 to be reported as tuples, i.e., {the max # of ports per a resource, the max # of resources in a resource set}.*   * *Support candidate values of the maximum # ports as 24 and 32, i.e., the tuples {24, Ks} and {32, Ks}, as UE optional feature.* * *To reflect that FG 23-7-2 applies only for CSI-RS resources for NCJT measurement, add a note as follows:*    + *Note: this capability reporting applies for the case a UE is configured with a CSI report corresponding to one or more CMR pairs.* |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | * FG 23-7-2 may not be needed assuming that the complexity issue for NCJT CSI is handled through one of Alt1 or Alt2 discussed above:  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ~~23. NR\_FeMIMO~~ | ~~23-7-2~~ | ~~Support of max # of Tx ports [per source/across two CMRs] [in a resource set for Multi-TRP CSI] [and max # resources]~~ | ~~[A list of supported combinations, each combination is {max # of Tx ports per source in a resource set for Multi-TRP CSI, max # resources in a resource set for Multi-TRP CSI}]~~  ~~[Note: same number of ports among CMRs]~~ |  |  |  |  |  |  |  |  | ~~[{4, 8, 12, 16, 24, 32}]~~ | ~~Optional with capability signalling~~ | |
| Ericsson [19] | For maximum number of CSI-RS ports per NZP CSI-RS resource, the value of 32 should be supported.   1. For maximum number of CSI-RS ports per NZP CSI-RS resource, support 32 as a candidate value. |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-7-3 | More than two resources in a resource set for Multi-TRP CSI | FFS exact candidate values, Ks,max is up to 8 |  |  |  |  |  |  |  |  | [candidate values are {2, 3, 4, 5, 6, 7, 8}] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ~~23. NR\_FeMIMO~~ | ~~23-7-3~~ | ~~More than two resources in a resource set for Multi-TRP CSI~~ | ~~FFS exact candidate values, Ks,max is up to 8~~ |  |  |  |  |  |  |  |  | ~~[candidate values are {2, 3, 4, 5, 6, 7, 8}]~~ | ~~Optional with capability signalling~~ | |
| vivo [3] | The following agreements has been reached at the RAN1’s meetings. According to the agreement, we believe that N=1 and Ks =2 can be a basic feature due to the calculation of NCJT measurement hypothesis and N=2 and Ks>2 can be an optional feature. However, in current FG23-7-1, there is a component to indicate the maximum number of NZP CSI-RS resources in one CSI-RS resource set but did not have a component to indicate the maximum number of NZP CSI-RS resource pairs in one CSI-RS resource set. Therefore, we suggest that a unified design should be considered for the number of NZP CSI-RS resources and the number of NZP CSI-RS resource pairs.   |  | | --- | | **Agreement**  For CSI measurement associated to a reporting setting CSI-ReportConfig for NCJT, the UE can be configured with Ks ≥ 2 NZP CSI-RS resources in a CSI-RS resource set for CMR and N ≥ 1 NZP CSI-RS resource pairs whereas each pair is used for a NCJT measurement hypothesis   * Configure UE with two CMR groups with Ks=K1+K2 CMRs. CMR pairs are determined from two CMR groups by following method(s).   + K1 and K2 are the number of CMRs in two groups respectively. FFS K1=K2 or different K1/K2.   + Note that CMRs in each CMR group can be used for both NCJT and Single-TRP measurement hypotheses   + N CMR pairs are higher-layer configured by selecting from all possible pairs     - signalling mechanism can be discussed further, e.g. using a bitmap     - FFS: Whether MAC-CE or RRC+MAC CE indication is needed     - FFS: how to support NCJT measurement hypotheses in FR2 * Support N=1 and Ks =2, FFS other maximal values of N>1 and Ks>2 * Note: for CPU/resource/port occupation, NCJT hypothesis is considered separately from single TRP hypothesis   **Agreement**  With regarding to the maximal values of *Nmax* for *N, Ks,max* for *Ks*:   * Support of *Nmax*=2 is a UE optional feature * Support of *Ks,max*=*X* is a UE optional feature   + *X* can be up to 8 and other candidate values can be discussed as part of UE features * FFS: Default value of *Nmax*, *Ks,max* * FFS: Which combinations of *N*<=*Nmax*, *Ks*<=*Ks,max* are supported |   FG 23-7-2 seems redundant of what we have in FG 23-7-1 in latest agreement in R1-2200780, e.g.,  A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]   * + 1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]     2. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis     3. [Maximum total number of CMRs for ~~calculated~~ single-TRP measurement ~~hypotheses~~] [per CC/across all CCs]     4. Maximum total number of CMRs for ~~calculated~~ NCJT measurement ~~hypotheses~~ [per CC/across all CCs]     5. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]     6. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs]     7. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement]   Therefore, we can also consider this FG and FG 23-7-1 together.  We also suggest to consider the number of NZP CSI-RS resources and the number of NZP CSI-RS resource pairs together. As the feature of the number of NZP CSI-RS resource pairs is a separate FG as given in FG 23-7-4, we prefer to keep FG 23-7-3 as a separate FG.  **Proposal 7-1:** **We suggest to consider FG 23-7-2 and FG 23-7-1 together and suggest following updates in FG23-7-1 and FG23-7-3.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-3 | More than two resources in a resource set for Multi-TRP CSI | FFS exact candidate values, Ks,max is up to 8 |  |  |  |  |  |  |  |  | [candidate values are {~~2,~~ 3, 4, 5, 6, 7, 8}] | Optional with capability signalling | |
| ZTE [4] | * FG 23-7-3 should be removed as it is similar as component 2 of FG 23-7-1  |  |  |  | | --- | --- | --- | | ~~23-7-3~~ | ~~More than two resources in a resource set for Multi-TRP CSI~~ | ~~FFS exact candidate values, K~~~~s,max~~ ~~is up to 8~~ | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] | * + **23-7-3:**     - This FG has been incorporated in 23-7-1 component 2, so it can be removed |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] | For FG23-7-3, since component 2 of FG23-7-1 has already included ‘8’ in the candidate value, so we suggest to remove FG23-7-3.  ***Proposal 14: Suggest to delete FG23-7-3.*** |
| LG Electronics [10] | This FG is included in 23-7-1 as component 2, so this FG is not needed.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Intel Corporation [11] | |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-7-3 | More than two resources in a resource set for Multi-TRP CSI | ~~FFS exact candidate values, Ks,max is up to 8~~  More than two resources in a resource set for Multi-TRP CSI | ~~[~~candidate values are {~~2,~~ 3, 4, 5, 6, 7, 8}~~]~~ |  | |
| Apple [12] | * FG23-7-3 can be removed since it is already included in FG23-7-1  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| CMCC [13] | Firstly, there are two ways to handle the component of maximum number of NZP CSI-RS resources in a resource set for Multi-TRP CSI. One way is to separate it as another FG (FG 23-7-3) and determine the candidate value Ks,max in this FG. However, taking this way means that we also need to decide a default value for Ks,max in case that the optional FG is not reported. The other way is to put this component in as FG 23-7-1 as a basic feature. In our view, it is much simpler and straighter to keep the component of maximum number of NZP CSI-RS resources in a resource set for Multi-TRP CSI as a part of FG 23-7-1.  ***Proposal 8: Delete FG 23-7-3.***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | ~~23. NR\_FeMIMO~~ | ~~23-7-3~~ | ~~More than two resources in a resource set for Multi-TRP CSI~~ | ~~FFS exact candidate values, K~~~~s,max~~ ~~is up to 8~~ |  |  | ~~[candidate values are {2, 3, 4, 5, 6, 7, 8}]~~ | |
| Xiaomi [14] |  |
| Samsung [15] | Regarding 23-7-3 it can be merged with 23-7-2.  **Proposal 26:** *Merge 23-7-3 with 23-7-2.* |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | * FG 23-7-3 is not needed because it is same as the agreed component 2 of FG 23-7-1.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ~~23. NR\_FeMIMO~~ | ~~23-7-3~~ | ~~More than two resources in a resource set for Multi-TRP CSI~~ | ~~FFS exact candidate values, K~~~~s,max~~ ~~is up to 8~~ |  |  |  |  |  |  |  |  | ~~[candidate values are {2, 3, 4, 5, 6, 7, 8}]~~ | ~~Optional with capability signalling~~ | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-7-4 | Support of Nmax=2 for Multi-TRP CSI | Support of maximum number of CMR pairs Nmax=2 configured in NZP-CSI-RS-ResourceSet for a given CSI report setting | 23-7-1 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | **Proposal 27:** *Support 23-7-4, i.e., the maximum number of CMR pairs* (*Nmax*), *as UE optional feature*   * *Support Nmax=2 as UE optional feature* |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-7-5 | CMR sharing | Support a NZP CSI-RS resource referred by both a CMR pair configured for NCJT measurement hypothesis and a CMR configured for Single-TRP measurement hypothesis | 23-7-1 |  |  |  | Per band |  | FR2 only |  | Note: ‘NCJT’ and ‘single-TRP’ are not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-5 | CMR sharing | Support a NZP CSI-RS resource referred by both a CMR pair configured for Rel-17 Multi-TRP CSI enhancement ~~NCJT measurement hypothesis~~ and a single CMR configured for CSI determination ~~Single-TRP measurement hypothesis~~ | 23-7-1 |  |  |  | Per band |  | FR2 only |  | ~~Note: ‘NCJT’ and ‘single-TRP’ are not used in RAN1 specifications and will be aligned with 38.214~~ | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] | Regarding 23-7-5, we support it for FR2.  **Proposal 28:** *Support 23-7-5, i.e., whether two CMRs from a CMR pair can be used for Single-TRP measurement hypotheses, as UE optional feature for FR2.* |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. [Support of/The maximum number of configured available slots offsets for] determining aperiodic SRS location based on available slot  [2. Maximum actual slots offset] | 2-52 |  |  |  | Per band |  |  |  | Candidate 1 component values: {1, 2, [3,] 4}  [Candidate 2 component values: FFS] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | **For 23-8-1**, “the maximum number of configured available slots offsets” is preferred for component 1 since it can reflect the UE capability more clear. And for the second component, we don’t see any motivation to report the maximum actual slots offset since the maximum available slots offsets is 7 is already agreed in RRC parameter discussion. So we have following proposal:  ***Proposal 4-1: For 23-8-1, support “The maximum number of configured available slots offsets” for component 1.***  ***Proposal 4-2: For 23-8-1, component 2 is unnecessary.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. ~~[Support of/~~The maximum number of configured available slots offsets for~~]~~ determining aperiodic SRS location based on available slot  ~~[2. Maximum actual slots offset]~~ | 2-52 |  |  |  | Per band |  |  |  | Candidate 1 component values: {1, 2, [3,] 4}  ~~[Candidate 2 component values: FFS]~~ | Optional with capability signalling | |
| vivo [3] | The updated higher layer parameters for Rel-17 NR is endorsed in R1-2112976, where the value range for AvailableSlotOffset is already agreed as "A list with up to 4 values per SRS resource set. (t0, t1, t2, t3), where each entry takes value from {0, 1, 2, …, 7}." It is obvious that the maximum actual slots offset is greater than or equal to 7, it is not clear what is the intention of the capability of maximum actual slots offset.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **23. NR\_FeMIMO** | **23-8-1** | **SRS triggering offset enhancement** | **1. ~~[~~Support of~~/The maximum number of configured available slots offsets for]~~ determining aperiodic SRS location based on available slot**  **~~[2. Maximum actual slots offset]~~** | **2-52** |  |  |  | **Per band** |  |  |  | **~~Candidate 1 component values: {1, 2, [3,] 4}~~**    **~~[Candidate 2 component values: FFS]~~** | **Optional with capability signalling** | |
| ZTE [4] | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-8-1 | SRS triggering offset enhancement | 1. ~~[Support of/~~The maximum number of configured available slots offsets for~~]~~ determining aperiodic SRS location based on available slot  ~~[2. Maximum actual slots offset]~~ | 2-52 |  |  |  | Per band | |
| OPPO [5] | For the UE feature group 23-8-1, there is no discussion on the actual slot offset during RAN1 discussions. There is also no description on the actual slot offset for UE behavior in the spec. Thus, we suggest the remove Component 2.  ***Proposal 12: Support the updated FG 23-8-1 as blow***   |  |  |  |  | | --- | --- | --- | --- | | 23-8-1 | SRS triggering offset enhancement | 1. ~~[Support of/~~The maximum number of configured available slots offsets for~~]~~ determining aperiodic SRS location based on available slot  ~~[2. Maximum actual slots offset]~~ | Candidate 1 component values: {1, 2, ~~[3,]~~ 4}  ~~[Candidate 2 component values: FFS]~~ | |
| CATT [6] | According to the agreements in previous meetings, up to 4 “*t*” values can be configured per SRS resource set, and each “*t*” value takes one of {0, 1, 2, …, 7}. Since configuring different “*t*” values for different SRS resource sets is supported by a UE supports Rel-17 flexible aperiodic SRS triggering, it is natural for the UE to support configuring multiple “*t*” values for a SRS resource set. Therefore reporting the maximum number of configured “*t*” values is not needed.  Component 2 can be removed since the number of counted slots is not a key to UE’s complexity.  ***Proposal-16: On FG 23-8-1, the following change is adopted:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. ~~[~~Support of ~~/The maximum number of configured available slots offsets for]~~ determining aperiodic SRS location based on available slot  ~~[2. Maximum actual slots offset]~~ | 2-52 |  |  |  | Per band |  |  |  | ~~Candidate 1 component values: {1, 2, [3,] 4}~~  ~~[Candidate 2 component values: FFS]~~ | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-8-1, we have the following two comments:   * For component 1, we are fine with either “Support of” or “The maximum number of configured available slots offsets for” at the beginning of the text, while we think the latter one could be clearer. Also, we are fine with removing 3 from candidate 1 component values. * For component 2, we are not sure which agreement in WI implies to define this component. We think this issue needs to be discussed in WI at first.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. The maximum number of configured available slots offsets for determining aperiodic SRS location based on available slot | 2-52 |  |  |  | Per band |  |  |  | Candidate 1 component values: {1, 2, 4}  [Candidate 2 component values: FFS] | Optional with capability signalling | |
| Spreadtrum Communications [9] | For component 1, we prefer to remove the bracket, and keep the content in the bracket, for the reason that not only it actually reflects the function of flexible SRS triggering, but also it could provide enough flexibility for gNB and also consider UE’s complexity.  ***Proposal 15: For component 1 of FG23-8-1, we prefer to remove the bracket.***  Regarding component 2, the motivation is not clear to us, and more clarification is needed. |
| LG Electronics [10] | * + - Component 2: This component is not needed as legacy.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. [Support of/The maximum number of configured available slots offsets for] determining aperiodic SRS location based on available slot | 2-52 |  |  |  | Per band |  |  |  | Candidate 1 component values: {1, 2, [3,] 4} | Optional with capability signalling | |
| Intel Corporation [11] | In FG 23-8-1, there was some discussion that whether let the UE reports the maximum number of available slots that can be configured to the UE. We think this is good way and the candidate value of this component could be {1, 2, 4}. If the FG is not reported, it means the UE doesn’t support the available slot operation for aperiodic SRS. In previous meeting, some company proposed to have two components for this FG. In our understanding, one component is sufficient. The component description of FG 23-8-1 could be changed to “The max number of configured available slots offsets for determining aperiodic SRS location”.   |  |  |  |  | | --- | --- | --- | --- | | 23-8-1 | SRS triggering offset enhancement | The max number of configured available slots offsets for determining aperiodic SRS location  ~~1. [Support of /The maximum number of configured available slots offsets for] determining aperiodic SRS location based on available slot~~  ~~[2. Maximum actual slots offset]~~ | {1, 2, 4} | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] | Component 1, we think all values can be applicable.  For component 2, We don’t support to add this to UE capability, because we don’t have the corresponding RAN1 agreements to support this as an UE optional feature.  ***Proposal 19: The proposed FG23-8-1 for SRS triggering offset enhancement is***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | ~~1.~~ [Support of/The maximum number of configured available slots offsets for] determining aperiodic SRS location based on available slot  ~~[2. Maximum actual slots offset]~~ |  |  |  |  |  |  |  |  | Candidate 1 component values: {1, 2~~, [~~3,~~]~~ 4} | Optional with capability signalling | |
| Samsung [15] |  |
| MediaTek Inc. [16] | As the available slots are dynamic depending on slot format and thus the actual slots offset is undetermined, we prefer to have a component for the maximum actual slots offset UE can support. This would be in line with legacy ul-SchedulingOffset which allows UE to report capability k2 value with a range 12< k2≤ 32 (default maximum k2=12).We believe the maximum slot offset for aperiodic trigger offset should also follow the same the capability reporting, limiting the extent of a scheduled UL event that UE needs to maintain over time. We are open to discussion for candidate values for this feature.  **Proposal 32: We agree with addition of component 2 in 23-8-1, i.e., Maximum actual slots offset. We propose to remove the square brackets for this component.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1The maximum number of configured available slots offsets for determining aperiodic SRS location based on available slot  2. ~~[~~Maximum actual slots offset~~]~~ |  |  |  |  |  |  |  |  | Candidate 1 component values: {none, 1, 2, [3,] 4}  Candidate 2 component values: {32, FFS other values} |  | |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | The description of the feature could be clarified as “Support of the maximum number of configured available slots offsets for determining aperiodic SRS location based on available slot. The description of the second component is no clear whether it means the maximum configured value of available slot offset “t” or the maximum span of physical slot for the available slot.  ***Proposal 9-1: Remove the square bracket and update the description of FG 23-8-1 as “*Support of the maximum number of configured available slots offsets for determining aperiodic SRS location based on available slot”**   * **Candidate values of {1, 2, 4}.**   ***Proposal 9-2: Further clarity the description of the second component “Maximum actual slots offset” whether it means the maximum configured value of available slot ‘t’ or the maximum span of physical slots from the reference slot.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. ~~[~~Support of ~~/~~ The maximum number of configured available slots offsets for~~]~~ determining aperiodic SRS location based on available slot  [2. Maximum actual slots offset] | 2-52 |  |  |  | Per band |  |  |  | Candidate 1 component values: {1, 2, ~~[3,]~~ 4}  [Candidate 2 component values: FFS] | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-2 | Triggering SRS only in DCI 0\_1/0\_2 | Support of triggering SRS in DCI 0\_1/0\_2 without data and without CSI | 2-52 |  |  |  | [Per UE or per band] |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] | The granularity type of ‘per UE’ is not reasonable as it implies a UE should mandatory support it across all bands if UE report this ‘per UE’ feature. Thus, we believe ‘per band’ granularity is more reasonable.  **Proposal 8-1: Support ‘per band’ granularity in FG 23-8-2**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-2 | Triggering SRS only in DCI 0\_1/0\_2 | Support of triggering SRS in DCI 0\_1/0\_2 without data and without CSI | 2-52 |  |  |  | [Per ~~UE or~~ band] |  |  |  |  | Optional with capability signalling | |
| ZTE [4] | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-8-2 | Triggering SRS only in DCI 0\_1/0\_2 | Support of triggering SRS in DCI 0\_1/0\_2 without data and without CSI | 2-52 |  |  |  | ~~[~~Per UE ~~or per band]~~ | |
| OPPO [5] |  |
| CATT [6] | **23-8-2 Triggering SRS only in DCI 0\_1/0\_2**  To support triggering SRS in DCI 0\_1/0\_2 without data and without CSI requires would not increase UE’s complexity for a UE supports DCI forma 0\_1/0\_2, therefore triggering SRS only in DCI 0\_1/0\_2 can be a feature per UE.  ***Proposal-17: Feature group 23-8-2 is a per UE feature*** |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-8-2, we are fine with either per UE or per band. |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 9-3: Support per-band reporting granularity for FG 23-8-2.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-2 | Triggering SRS only in DCI 0\_1/0\_2 | Support of triggering SRS in DCI 0\_1/0\_2 without data and without CSI | 2-52 |  |  |  | per band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the antenna switching impact to downlink receiving in a band  3. Report whether the antenna is switched together with UL Tx in another band | 2-55 |  |  |  | [Per BC] |  |  |  | Component 1 candidate values: FFS  Component 2 candidate values: FFS  Component 3 candidate values: FFS  FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | **For 23-8-3,** since Rel-15 and Rel-16 UE feature for antenna switching already support <=4R antenna switching capability reporting, only thing we need to introduce for Rel-17 is >4R antenna switching i.e., 6R and 8R capability. And UE can report Rel-17 and Rel-15/16 capability together to support downgrading. So the candidate value of component 1 should be: one or more elements from set {t2r6, t1r6, t4r8, t2r8, t1r8}. And for component 2&3, the candidate value should keep same with Rel-15 and Rel-16 antenna switching UE feature no matter xTyR with x = y or x < y, i.e., {1 to 32}.  ***Proposal 4-3: Support following candidate value for component 1 of 23-8-3: one or more elements from set {t2r6, t1r6, t4r8, t2r8, t1r8}.***  ***Proposal 4-4: Candidate value for component 2&3 of 23-8-3 should keep same with Rel-15 and Rel-16, i.e., {1 to 32}.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the antenna switching impact to downlink receiving in a band  3. Report whether the antenna is switched together with UL Tx in another band | 2-55 |  |  |  | [Per BC] |  |  |  | Component 1 candidate values:  ~~FFS~~  one or more elements from set {t2r6, t1r6, t4r8, t2r8, t1r8}  Component 2 candidate values: ~~FFS~~  {1 to 32}  Component 3 candidate values: ~~FFS~~  {1 to 32}  ~~FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y~~ | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the antenna switching impact to downlink receiving in a band  3. Report whether the antenna is switched together with UL Tx in another band | 2-55 |  |  |  | ~~[~~Per BC~~]~~ | |
| OPPO [5] | For the UE feature group 23-8-3, the report type should be per band per BC (e.g., per FS) since the related UE capability is reported per band per BC in TS 38.331 (i.e., the RRC signaling structure in TS 38.331 is *BandCombination* -> *BandParameters* -> *srs-TxSwitch*). The UE should also to support the downgraded antenna switching configurations. Thus, we have the follow proposal:  ***Proposal 13: Support the updated FG 23-8-3 as blow***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the antenna switching impact to downlink receiving in a band  3. Report whether the antenna is switched together with UL Tx in another band | ~~[Per BC]~~  Per FS | Component 1 candidate values: ~~FFS~~  {r1-t1r2-t1r4-t1r6,  t1r1-t1r2-t1r4-t1r8,  t1r1-t1r2-t2r2-t2r4-t2r6,  t1r1-t1r2-t2r2-t2r4-t2r8,  t1r1-t2r2-t4r4-t4r8  }  Component 2 candidate values: ~~FFS~~ {1 to 32}  Component 3 candidate values: ~~FFS~~ {1 to 32}  FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y | |
| CATT [6] | **23-8-3 SRS Antenna switching for >4Rx**  On UE features for up to 8 Rx SRS antenna switching, one open issue is candidate values for component 1 of FG 23-8-3. In Rel-16, whether a UE supports down downgrading configuration of SRS Tx port switching pattern is an optional UE feature, and if a UE supports down downgrading configuration, UE can report the supported downgrading configurations by an additional UE feature. In Rel-17, the maximum number of Rx antennas has been increased to 8, and various circuitry and transceiver designs for *x*T*y*R are possible. Two UEs support *x*T*y*R may be have different circuitry and transceiver designs and support different downgrading configurations. The flexibility of reporting multiple SRS Tx port switching patterns by UE should be allowed. One solution is that UE reports one or more options in {t1r1, t1r2, t1r4, t1r6, t1r8, t2r2, t2r4, t2r6, t2r8, t4r4, t4r8} by component 1 of FG 23-8-3. According to current specs, for a given time domain behaviour for *x*T*y*R, *y*/*x* *x*-port SRS resources would be configured. Therefore it is natural for a UE supports *x*T*y*R to support configuring with *n/m m*-port SRS resources, wherein *mx*, *ny*/*x*. We suggest to defining downgraded patterns for each SRS Tx port switching pattern respectively as in Table 1, and clarify that a UE reports *x*T*y*R is mandatory to support the corresponding downgraded patterns of *x*T*y*R.  Table 1 Downgraded configurations for SRS Tx port switching patterns   |  |  | | --- | --- | | *x*T*y*R | Downgraded patterns | | t1r2 | t1r1 | | t1r4 | t1r1，t1r2 | | t1r6 | t1r1，t1r2，t1r4 | | t1r8 | t1r1，t1r2，t1r4，t1r6 | | t2r2 | t1r1 | | t2r4 | t1r1，t1r2, t2r2 | | t2r6 | t1r1，t1r2, t2r2, t2r4 | | t2r8 | t1r1，t1r2, t1r4，t2r2, t2r4，t2r6 | | t4r4 | t1r1，t2r2 | | t4r8 | t1r1，t1r2, t2r2, t2r4，t4r4 |   Since it is natural for a UE supports *x*T*y*R to support the corresponding downgraded patterns as in Table 1, allowing UE report arbitrary combination of options in set {t1r1, t1r2, t1r4, t1r6, t1r8, t2r2, t2r4, t2r6, t2r8, t4r4, t4r8} is not needed.We can introduce a rule that if UE reports multiple options in the set, any option should not be a downgraded pattern of another option.  ***Proposal-18: For component 1 of FG 23-8-3, UE reports at least one of options in set {t1r1, t1r2, t1r4, t1r6, t1r8, t2r2, t2r4, t2r6, t2r8, t4r4, t4r8}.***   * ***If multiple options are reported, one option should not be a downgraded pattern of another option.*** * ***The downgraded patterns for each xTyR pattern are as bellow, respectively:***  |  |  | | --- | --- | | *x*T*y*R | Downgraded patterns | | t1r2 | t1r1 | | t1r4 | t1r1，t1r2 | | t1r6 | t1r1，t1r2，t1r4 | | t1r8 | t1r1，t1r2，t1r4，t1r6 | | t2r2 | t1r1 | | t2r4 | t1r1，t1r2, t2r2 | | t2r6 | t1r1，t1r2, t2r2, t2r4 | | t2r8 | t1r1，t1r2, t1r4，t2r2, t2r4，t2r6 | | t4r4 | t1r1，t2r2 | | t4r8 | t1r1，t1r2, t2r2, t2r4，t4r4 | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-8-3, our view is as follows:   * As we described multiple times during the last e-meeting, we believe downgraded configurations for each combination of xTyR should be configurable. Component 1 candidate values should capture them explicitly. We observe the following alternatives on this issue:   + Alt-0: Define FG23-8-3 for reporting only the mandatory configurations     - Only a mandatory configuration can be reported. Any downgrading configuration is not supported for antenna architecture with Rx more than 4.     - Component 1 can indicate either of {*t1r6, t2r6, t1r8, t2r8, t4r8*}   + Alt-1: Define FG23-8-3 for reporting the mandatory configuration, and all the downgrading configurations corresponding to the reported mandatory configuration     - Either “only mandatory configuration” or “mandatory configuration + all the corresponding downgrading configurations” can be reported. Support of only a part of downgrading configurations is not considered.     - Component 1 can indicate either of {*t1r6, t1r1-t1r2-t1r4-t1r6, t2r6, t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6, t1r8, t1r1-t1r2-t1r4-t1r6-t1r8, t2r8, t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6-t1r8-t2r8, t4r8, t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6t1r8-t2r8-t4r8*}   + Alt-2: Define FG23-8-3 for reporting the mandatory configuration and all the downgrading configurations with the exception for 6Rx support for UE with 8Rx     - On top of the candidate report available for Alt-1, for UE that implements 8 Rx antenna architecture, support of downgrading configurations other than the ones with 6 Rx can be reported. This restriction is added because of concern that UE supports 8Rx may not always supports 6Rx.     - Component 1 can indication either of {*t1r6, t1r1-t1r2-t1r4-t1r6, t2r6, t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6, t1r8, t1r1-t1r2-t1r4-t1r6-t1r8, t1r1-t1r2-t1r4-t1r8, t2r8, t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6-t1r8-t2r8, t1r1-t1r2-t2r2-t1r4-t2r4-t1r8-t2r8, t4r8, t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6-t1r8-t2r8-t4r8, t1r1-t1r2-t2r2-t1r4-t2r4-t1r8-t2r8-t4r8*}   + Alt-3: Define FG23-8-3 for reporting one or multiple configurations for antenna switching, regardless of mandatory or downgrading ones     - Any combination of configurations can be reported, while a note can also be added to avoid considering non-practical combinations (e.g., *t2r6* and *t1r8*) for smaller reporting overhead. For example, in case of reporting of multiple configurations, one should be mandatory configuration and the others should be downgrading configuration(s) of the mandatory configuration.     - Component 1 can indicate one or more of {*t1r1, t1r2, t2r2, t1r4, t2r4, t4r4, t1r6, t2r6, t1r8, t2r8, t4r8*}   + Alt-4: Define separate FGs (e.g., FG23-8-3 and a new FG) for reporting mandatory configuration and downgrading configurations, respectively     - A mandatory configuration can be reported per FG23-8-3. A supported combination of downgrading configurations can be reported per the new FG.     - Component 1 in FG23-8-3 can indicate either of {*t1r6, t2r6, t1r8, t2r8, t4r8*}     - A component in the new FG can indicate one or more of {*t1r1, t1r2, t2r2, t1r4, t2r4, t4r4, t1r6, t1r8, t2r8*}. No report of the new FG implies no support of any downgrading configuration for antenna architecture with the number of Rx more than 4   Since we would like to unlock downgrading configurations, we prefer to go with the alternatives other than Alt-0 above. Among the alternatives with downgrading configuration, our best preference is Alt-1 since the least signaling overhead is assumed. On other hand, we can understand that just to define the choice like “support all, or not support at all” may result in the difficulty for UE vendors to support downgrading configurations, which is not our preference either. If the issue is only about the support of 6 Rx when the UE supports the antenna architecture with 8 Rx, we would suggest to go with Alt-2. Otherwise, we think it would be good to take either Alt-3 or Alt-4. Between Alt.3-4, we think Alt-4 could be slightly better since “no support of downgrading configuration” can be achieved without signaling overhead. Although we reflect our best preference (i.e. Alt-1) in the following table, we are open to discuss further on this issue from options between Alt.1-4.   * For Component 2 and 3, we are ok with supporting each integer from 1 to 32 as candidate values, which is the same candidate value set as what FG2-55 defines for the corresponding components. Meanwhile, it may be a bit strange that the value for “Report whether …” is an integer. The component descriptions could be updated to improve the readability by reusing the existing text in 38.306. * Since the prerequisite FG is per-BC, we think FG23-8-3 should also be per-BC capability. * For a FFS “FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y”, we are not sure what needs to be considered further for component 2 and 3 when UE reports x=y.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report the entry number of the first-listed band with UL in the band combination that affects this DL  3. Report the entry number of the first-listed band with UL in the band combination that switches together with this UL | 2-55 |  |  |  | Per BC |  |  |  | Component 1 candidate values:   * *'t1r6’ for 1T6R* * *'t2r6’ for 2T6R* * *'t1r8’ for 1T8R* * *'t2r8’ for 2T8R* * *'t4r8’ for 4T8R* * *'t1r1-t1r2-t1r4-t1r6’ for 1T=1R/1T2R/1T4R/1T6R* * *'t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R* * *'t1r1-t1r2-t1r4-t1r6-t1r8’ for 1T=1R/1T2R/1T4R/1T6R/1T8R* * *'t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6-t1r8-t2r8' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R/1T8R/2T8R* * *'t1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6t1r8-t2r8-t4r8' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R1T8R/2T8R/4T8R*   Component 2 candidate values: {1 to 32}  Component 3 candidate values: {1 to 32}  NOTE: The first-listed band with UL includes a band associated with *FeatureSetUplinkId* set to 0 corresponding to the support of *SRS-SwitchiingTimeNR* | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | FG 23-8-3 defines UE capability for antenna switching with up to 8 Rx. It should be noted that in Rel-16 UE capability, the downgraded antenna switching configuration can also be reported by the UE. For example, the UE of 1T4R can also support 1T2R and 1T1R. Following the same principles, the UE capable of antenna switching with > 4R should also be able to report the supported downgraded configuration.  In the discussion in previous meetings, companies have diverse view on which downgraded configuration should be supported by the UE. Therefore, it could be a good way for progress that the candidate value of the first component is defined as a bitmap, i.e., {t1r1, t1r2, t1r4, t1r6, t1r8, t2r2, t2r4, t2r6, t2r8, t4r4, t4r8}, and the UE could report one or several configurations based on its capability.   |  |  |  |  | | --- | --- | --- | --- | | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. A band whose DL receiving is impacted by antenna switching ~~Report whether the antenna switching impact to downlink receiving in a band~~  3. A band whose UL Tx is switched together with antenna switching ~~Report whether the antenna is switched together with UL Tx in another band~~ | Component 1 candidate values: ~~FFS~~  {t1r1, t1r2, t1r4, t1r6, t1r8, t2r2, t2r4, t2r6, t2r8, t4r4, t4r8}  Component 2 candidate values: {1 to 32}  Component 3 candidate values: {1 to 32}  Note: Component 2 and component 3 is not reported if component 1 is reported as xTyR with x=y. | |
| Apple [12] | * FG23-8-3: For SRS antenna switching, we propose the candidate value for the components. The reporting type should be per FS  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the antenna switching impact to downlink receiving in a band  3. Report whether the antenna is switched together with UL Tx in another band | 2-55 |  |  |  | per FS |  |  |  | Component 1: candidate values are bitmap {“1T1R”, “1T2R”, “1T4R”, “1T6R”, “1T8R”, “2T2R”, “2T4R”, “2T6R”, “2T8R”, “4T4R”, “4T8R”}  Component 2: Candidate value set: {yes, no}  Component 3: Candidate value set: {yes, no}  FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] | For component 1, this combo of UE supported configurations does not have to support all candidate values and all downgraded options, we suggest to have the following candidate values   * t1r1-t2r2-t4r4- t4r8 * t1r1-t1r2-t2r2-t2r4- t2r6 * t1r1-t1r2-t2r2-t2r4 –t1r4-t1r6-t2r6-t2r8 * t1r1- t1r2- t1r4-t1r6 * t1r1-t1r2-t1r4-t2r2-t2r4-t2r8 * t1r1-t1r2-t1r4-t1r8 * t1r6 * t1r8 * t2r6 * t2r8 * t4r8   ***Proposal 20: For component 1 of FG23-8-3, our proposed candidate values for 6/8Rx are as below,***   * ***t1r1-t2r2-t4r4- t4r8*** * ***t1r1-t1r2-t2r2-t2r4- t2r6*** * ***t1r1-t1r2-t2r2-t2r4 –t1r4-t1r6-t2r6-t2r8*** * ***t1r1- t1r2- t1r4-t1r6*** * ***t1r1-t1r2-t1r4-t2r2-t2r4-t2r8*** * ***t1r1-t1r2-t1r4-t1r8*** * ***t1r6*** * ***t1r8*** * ***t2r6*** * ***t2r8*** * ***t4r8*** |
| Samsung [15] |  |
| MediaTek Inc. [16] | For antenna switching ≤ 4R in R15/R16, the candidate values for UE to report includes both non-downgraded (e.g., t2r4) and downgraded (e.g., t1r1-t1r2-t2r2-t2r4) options. It is reasonable that R17 also provides similar options for UE to choose from since whether UE can support downgraded options (and which combinations) or not depends on UE’s implementation. However, as number of Rx is up to 8, the combination considering all possible downgraded options can be large, enumerating all possible cases is not a good approach and difficult to get consensus. RAN1 should look for a more efficient way.  One possible approach is to let UE reports one or more elements from set {t1r1, t2r2, t1r2, t4r4, t2r4, t1r4, t2r6, t1r6, t4r8, t2r8, t1r8}. Although this provides full flexibility, an issue raised in the previous discussion. For example, combination [t2r4, t1r8] is unusual in which none of element is downgraded from the other one. This inconsistency can be resolved by imposing some rule. For example, the reported elements required to be equal to or downgraded from the most capable one.  **Proposal 33: As for FG 23-8-3 component 1 candidate values, we propose the UE to report *one or more* elements from set {t1r1, t2r2, t1r2, t4r4, t2r4, t1r4, t2r6, t1r6, t4r8, t2r8, t1r8}. The detailed asn.1 data structure can be decided by RAN2.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the uplink TX switching impact to downlink receiving in a band  3. Report whether the UL Tx is switched together with UL Tx in another band |  |  |  |  |  |  |  |  | Component 1 candidate values: one or more elements from set {t1r1, t2r2, t1r2, t4r4, t2r4, t1r4, t2r6, t1r6, t4r8, t2r8, t1r8}  Note: The reported element tXrY satisfies X≤Xmax and Y≤Ymax where tXmaxrYmax is the most capable one in the report set | **Optional with capability signalling** | |
| Lenovo [17] | Firstly, only capabilities on more than 4RX can be contained in Rel-17 UE feature. Secondly, downgraded configured similar with Rel-16 should be included in the candidate value.   1. For FG 23-8-3, component 1 candidate values should only include    1. 't1r1-t1r2-t1r4-t1r6’ for 1T=1R/1T2R/1T4R/1T6R    2. 't1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R    3. 't1r1-t1r2-t1r4-t1r6-t1r8’ for 1T=1R/1T2R/1T4R/1T6R/1T8R    4. 't1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6-t1r8-t2r8' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R/1T8R/2T8R    5. 't1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6t1r8-t2r8-t4r8' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R1T8R/2T8R/4T8R |
| Qualcomm Incorporated [18] | The candidate values for component 1 should have independent xTyR configuration = {1T8R, 1T6R, 2T8R, 2T6R, 4T8R}. UE should report one of {1T6R, 1T8R, 2T6R, 2T8R, 4T6R, 4T8R} similar to basic feature FG 2-55. There is no RAN1 agreement to support a downgraded (or combo) SRS switching configuration. If the UE wants to support downgraded configuration, this can be done by the combination of this FG 38-8-3 and Rel-16 (supportedSRS-TxPortSwitchv1610).  ***Proposal 9-4: The candidate values for component 1 should be independent xTyR configuration of {1T8R, 1T6R, 2T8R, 2T6R, 4T8R}.***   * ***Note: Downgraded SRS antenna switching configuration could be achieved by the combination of FG 38-8-3 and Rel-16 (supportedSRS-TxPortSwitchv1610).*** * ***Support per-band perBC reporting granularity.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report whether the antenna switching impact to downlink receiving in a band  3. Report whether the antenna is switched together with UL Tx in another band | 2-55 |  |  |  | Per band per BC |  |  |  | Component 1 candidate values: {1T8R, 1T6R, 2T8R, 2T6R, 4T8R}.  Component 2 candidate values: FFS  Component 3 candidate values: FFS  FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-4 | Maximum 2 SP and 1 periodic SRS sets for antenna switching | Support of maximum 2 SP SRS resource sets and maximum 1 periodic SRS resource set for antenna switching | 2-53 |  |  |  | [Per FS] |  |  |  | Note1:   * Applies for all supported xTyR where y<=8 * For xTyR where y>4, if UE does NOT support this feature, support maximum one SRS resource set for periodic SRS and maximum one SRS resource set for semi-persistent SRS * For xTyR where y<=4, if UE does not support this feature, follow Rel-15 on the number of resource sets for periodic and semi-persistent SRS * The two SP-SRS resource sets are not activated at the same time | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-8-4 | Maximum 2 SP and 1 periodic SRS sets for antenna switching | Support of maximum 2 SP SRS resource sets and maximum 1 periodic SRS resource set for antenna switching | 2-53 |  |  |  | ~~[~~Per FS~~]~~ | |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For FG23-8-4, we support to define this per BC as the prerequisite FG is defined per BC.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-4 | Maximum 2 SP and 1 periodic SRS sets for antenna switching | Support of maximum 2 SP SRS resource sets and maximum 1 periodic SRS resource set for antenna switching | 2-53 |  |  |  | Per FS |  |  |  | Note1:   * Applies for all supported xTyR where y<=8 * For xTyR where y>4, if UE does NOT support this feature, support maximum one SRS resource set for periodic SRS and maximum one SRS resource set for semi-persistent SRS * For xTyR where y<=4, if UE does not support this feature, follow Rel-15 on the number of resource sets for periodic and semi-persistent SRS * The two SP-SRS resource sets are not activated at the same time | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | ***Proposal 9-5: Support reporting granularity of per-FS for FG 23-8-4 to align with reporting type of the prerequisite 2-53.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-4 | Maximum 2 SP and 1 periodic SRS sets for antenna switching | Support of maximum 2 SP SRS resource sets and maximum 1 periodic SRS resource set for antenna switching | 2-53 |  |  |  | ~~[~~Per FS~~]~~ |  |  |  | Note1:   * Applies for all supported xTyR where y<=8 * For xTyR where y>4, if UE does NOT support this feature, support maximum one SRS resource set for periodic SRS and maximum one SRS resource set for semi-persistent SRS * For xTyR where y<=4, if UE does not support this feature, follow Rel-15 on the number of resource sets for periodic and semi-persistent SRS * The two SP-SRS resource sets are not activated at the same time | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-5 | Increased repetition for SRS | Support of increased repetition patterns (8, 10, 12, 14 symbols) for SRS resource | 10-11, 2-52 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
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| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-6 | Partial frequency sounding of SRS | Support of partial frequency sounding for SRS | 2-52 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-7 | Start RB location hopping for partial frequency SRS | Support of start RB location hopping in partial frequency SRS transmission across different SRS frequency hopping periods for periodic/semi-persistent/aperiodoc SRS | 23-8-6 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
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| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-7 | Start RB location hopping for partial frequency SRS | Support of start RB location hopping in partial frequency SRS transmission across different SRS frequency hopping periods for periodic/semi-persistent/aperiodic SRS | 23-8-6 |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-7 | Start RB location hopping for partial frequency SRS | Support of start RB location hopping in partial frequency SRS transmission across different SRS frequency hopping periods for periodic/semi-persistent/aperiodic SRS | 23-8-6 |  |  |  | Per band |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-8-8 | Comb-8 SRS | Support of comb-8 for SRS other than for positioning |  |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-9-1 | Basic Features of Further Enhanced Port-Selection Type II Codebook (FeType-II) | 1. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support Port-selection FeType-II with M=1 and R=1 2. Support rank 1,2 3. Support parameter combinations with M=1 | 2-35 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:   * Maximum 16 triplets * Max # of Tx ports in one resource: {4,8,12,16,24,32} * Max # resources: {1 to 64}   Max # total ports: {4 to 256} | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | FG 23-9-1 with M=1, FG 23-9-2 with M=2 R =1, and FG 23-9-2 with M=2 R =2 have been agreed as three independent FGs for FeType-II PS codebook due to the concerns of UE complexity. Therefore, when the UE supports mixed codebook types in any slot, FG 23-9-1, FG 23-9-2, and FG 23-9-4 need to be treated as individual codebooks, with a similar manner as Rel-16 MIMO capability design methodology when addressing values of R. Therefore the following codebook combinations are suggested for FG 23-9-5 considering the mixture of all legacy Type II codebooks and Rel-17 FeTypeII PS codebook in {codebook 2, codebook 3}   * Codebook 1 = {Type I SP, Type I MP}, * {Codebook 2, Codebook 3} ={{FeType II PS M=1, NULL},   {FeType II PS M=2 R = 1, NULL},  {FeType II PS M=2 R =2, NULL},  {Type II, FeType II PS M=1},  {Type II, FeType II PS M=2 R = 1},  {Type II, FeType II PS M=2 R = 2},  {eType II R=1, FeType II PS M=1},  {eType II R=1, FeType II PS M=2 R = 1},  {eType II R=1, FeType II PS M=2 R = 2},  {eType II R=2, FeType II PS M=1},  {eType II R=2, FeType II PS M=2 R = 1},  {eType II R=2, FeType II PS M=2 R = 2}}  ***Proposal 5.4: To support mixed codebook types in a slot in FG 23-9-5, FG 23-9-1, FG 23-9-2, and FG 23-9-4 can be treated as individual codebooks as Rel-16 UE capability design methodology, e.g. FG 23-9-1 with M=1 or FG 23-9-2 with M=2 R=1 or FG 23-9-2 with M=2 R=2 are jointly supported with all legacy Type II codebooks in {codebook 2, codebook 3}.*** |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| 23. NR\_FeMIMO | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations   List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41, 2-43 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL},{FeType II PS M=2 R=1, NULL}[, {FeType II PS M=2 R=2, NULL}], {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}}  FFS: The list of {Codebook 2, Codebook 3} may be refined depending on outcome of discussion for FG 23-9-2 Component 1 and FG 23-9-4 Component 2  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  [Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously] | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | In last meeting, it is agreed that the UE can report a list of triplets at least for supporting NCJT CSI measurement hypotheses over CMR pairs in FG 23-7-1 Component 5, which can be a good starting point to address new feature specified in Rel-17. However in practice, commercial UE will share a CSI processing engine across multiple CSI measurement hypothesis types as well as across multiple codebook types, e.g., Type I SP with single-TRP measurement hypothesis in Rel-15, eType II in Rel-16 and Type I SP with NCJT measurement hypothesis in Rel-17, etc. The remaining issue is to help the NW utilizing UE CSI processing capability efficiently for mixed measurement hypothesis types as well as codebook types, without exceeding actual UE CSI processing capability,  When the UE supports multiple codebook types independently, this UE may report conservative values assuming that multiple CSI reports associated with different codebook types are triggered simultaneously. To address this issue, FG 23-9-5 is to report a more precise list of supported codebook combinations with a list of triplets. {codebook 1} for mixed CSI measurement capability in FG 23-9-5 can be extended to support simultaneous CSI calculation with NCJT and single-TRP measurement hypotheses. {Codebook 2, codebook 3} can be used as usual to support all advanced Type II/eTypeII/FeTypeII codebooks. Note that there is no perfect mechanism when addressing with supported mixed codebook types in a slot, e.g., in FG 16-8 in Rel-16. In particular, the capability values on mixed codebook types are always “under-reported” more or less, because the UE will always quantized the hardware requirement based on the codebook with higher processing complexity. Considering reporting overhead and UE/gNB implementation due to signaling complexity, the following proposal can achieve the tradeoff:  ***Proposal 5.2: {codebook 1} in 23-9-5 can cover all CSI processing capability based on Type I SP codebook, including single-TRP measurement hypothesis and NCJT measurement hypothesis.***  In addition, some UEs may only support Type I SP with both single-TRP and NCJT measurement hypotheses. No advanced codebook types are supported. To enable the UE to indicate the CSI processing capability on Type I SP codebook with multiple CSI measurement hypotheses simultaneously, we have the following proposal:  ***Proposal 5.3: {NULL, NULL} is added as a new candidate value for {Codebook 2, Codebook 3} in FG 23-9-5.***  FG 23-9-1 with M=1, FG 23-9-2 with M=2 R =1, and FG 23-9-2 with M=2 R =2 have been agreed as three independent FGs for FeType-II PS codebook due to the concerns of UE complexity. Therefore, when the UE supports mixed codebook types in any slot, FG 23-9-1, FG 23-9-2, and FG 23-9-4 need to be treated as individual codebooks, with a similar manner as Rel-16 MIMO capability design methodology when addressing values of R. Therefore the following codebook combinations are suggested for FG 23-9-5 considering the mixture of all legacy Type II codebooks and Rel-17 FeTypeII PS codebook in {codebook 2, codebook 3}   * Codebook 1 = {Type I SP, Type I MP}, * {Codebook 2, Codebook 3} ={{FeType II PS M=1, NULL},   {FeType II PS M=2 R = 1, NULL},  {FeType II PS M=2 R =2, NULL},  {Type II, FeType II PS M=1},  {Type II, FeType II PS M=2 R = 1},  {Type II, FeType II PS M=2 R = 2},  {eType II R=1, FeType II PS M=1},  {eType II R=1, FeType II PS M=2 R = 1},  {eType II R=1, FeType II PS M=2 R = 2},  {eType II R=2, FeType II PS M=1},  {eType II R=2, FeType II PS M=2 R = 1},  {eType II R=2, FeType II PS M=2 R = 2}}  ***Proposal 5.4: To support mixed codebook types in a slot in FG 23-9-5, FG 23-9-1, FG 23-9-2, and FG 23-9-4 can be treated as individual codebooks as Rel-16 UE capability design methodology, e.g. FG 23-9-1 with M=1 or FG 23-9-2 with M=2 R=1 or FG 23-9-2 with M=2 R=2 are jointly supported with all legacy Type II codebooks in {codebook 2, codebook 3}.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations   List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-7-1, 23-9-1, 23-9-2，23-9-4, 16-3a, 16-3a-1, 2-36, 2-40, 2-41 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{NULL, NULL},  {FeType II PS M=1, NULL},  {FeType II PS M=2 R=1, NULL},  {FeType II PS M=2 R=2, NULL},  {Type II, FeType II PS M=1},  {Type II, FeType II PS M=2 R=1} ,  {Type II, FeType II PS M=2 R=2} ,  {eType II R=1, FeType II PS M=1},  {eType II R=1, FeType II PS M=2 R=1},  {eType II R=1, FeType II PS M=2 R=2}  {eType II R=2, FeType II PS M=1},  {eType II R=2, FeType II PS M=2 R=1},  {eType II R=2, FeType II PS M=2 R=2}}  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41, 16-3a and 16-3a-1, 23-7-1 and 23-9-1/2/4  Note 3: For an active CSI-RS resource associated with a CSI-RS resource set for channel measurement configured with two resource groups and N resource pairs, if it is referred X times by one of the M CSI-RS resource and/or one or two resource pairs, the CSI-RS resource and associated number of CSI-RS ports are counted X times within max number of resources and max number of total ports respectively.  Note 4: if a UE report (Codebook2, Codebook3) as (NULL, NULL), when at least one active CSI-RS resource is associated with the CSI-RS Resource Set for channel measurement configured with two Resource Groups and *N* Resource Pairs, then usage of active CSI-RS resources and ports for channel measurement for Type I SP only in any slot is allowed.  ~~Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously~~ | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations   List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41, 2-43 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL},{FeType II PS M=2 R=1, NULL}~~[~~, {FeType II PS M=2 R=2, NULL}~~]~~, {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}}  ~~FFS: The list of {Codebook 2, Codebook 3} may be refined depending on outcome of discussion for FG 23-9-2 Component 1 and FG 23-9-4 Component 2~~  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  ~~[Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously]~~ | |
| OPPO [5] |  |
| CATT [6] | When M=1, the maximum number of resources is 1 to 64, the maximum number of total ports is 4 to 256, and there are maximum 16 triplets. According to the agreemt of RAN1#107b-e meeting, the maximum number of triplets has been reduced by 8 for FG 23-9-2 and FG 23-9-4. It is not necessary to restrict the maximum number of resouces and the maximum number of total ports.  When M=2, compared with R=1, R=2 can achieve better performance due to its finer PMI granuliarity. Hence, the codbook combinations {Codebook 2, Codebook 3} = {FeType II PS M=2 R=2, NULL} could be supported. The prerequistite feature groups of FG 23-9-5 is FG 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41 and 2-43. The maxium numbers of triplets, maximum number of transmit ports, maximum number of resource and maximum number of total ports are same for all of these feature. Therefore, if the list of triplets forcodebook combination is empty, the list of triplets from the codebook combination indicated previously can be reused. According to above discussion, we provide the following proposal.  ***Proposal-19: For CSI enhancement on FDD CSI, the UE feature is revised as follows:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations  2. List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination. | 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41, 2-43 | per band and per BC | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL},{FeType II PS M=2 R=1, NULL}~~[~~, {FeType II PS M=2 R=2, NULL}~~]~~, {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}}  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  ~~[~~Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously~~]~~ | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For 23-9-5, to align with 23-9-2 and 23-9-4, the FFS part of (codebook 2, codebook 3) can be revised as {FeType II PS R=2, NULL}.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations 2. List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41, 2-43 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL}, {FeType II PS M=2 R=1, NULL}, {FeType II PS R=2, NULL}, {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}}  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}~~]~~  Note 1：if a UE reports one or more codebook combinations in ~~[~~23-9-5~~]~~, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  [Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously] | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | * If the list of triplets for a codebook combination is empty, then the list of triplets is reused from the codebook combination indicated previously.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations 2. List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL},{FeType II PS M=2 R=1, NULL}[, {FeType II PS M=2 R=2, NULL}], {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}, {Type I SP with N Resource Pairs, NULL}, {Type I SP with N Resource Pairs, Type II}, {Type I SP with N Resource Pairs, Type II PS}, {Type I SP with N Resource Pairs, eType II R=1}, {Type I SP with N Resource Pairs, eType II PS R=1}, {Type I SP with N Resource Pairs, eType II R=2}, {Type I SP with N Resource Pairs, eType II PS R=2}, {Type I SP with N Resource Pairs, FeType II PS M=1}, {Type I SP with N Resource Pairs, FeType II PS M=2 R=1}, {Type I SP with N Resource Pairs, FeType II PS M=2 R=2}}  FFS: The list of {Codebook 2, Codebook 3} may be refined depending on outcome of discussion for FG 23-9-2 Component 1 and FG 23-9-4 Component 2  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  ~~[~~Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously~~]~~ | Per band and per BC | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] | In our view, following aspects should be considered   * 1. Since CSI-RS triplets are reported in FG23-9-4, codebook combination of FeType II PS M=2 R=2 should be added to avoid underreporting. Besides, we don’t see strong motivation in adding combination of 3 codebooks in the list as it is not typical use case. The total number of candidate codebook combinations should be considered small and only important combinations should be added into the candidate list.   2. FG23-9-2 and FG2-9-4 should be added as prerequisite because the codebook combination list includes FeTypeII PS M=2 R=1 and FeType II PS M=2 R=2.   3. The last note in yellow text is not needed.   ***Proposal:*** ***Adopt the following for Rel-17 CSI codebook concurrency UE feature (modifications in red)***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | List of codebook combinations  List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41, 2-43, 23-9-2, 23-9-4 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL},{FeType II PS M=2 R=1, NULL}, {FeType II PS M=2 R=2, NULL}, {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}}  ~~FFS: The list of {Codebook 2, Codebook 3} may be refined depending on outcome of discussion for FG 23-9-2 Component 1 and FG 23-9-4 Component 2~~  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  ~~[Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously]~~ | Optional with capability signalling |  | |
| Ericsson [19] |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-9-2 | Support of M=2 and R=1 for FeType-II | 1. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support Port-selection FeType-II with M=2 and R=1  2. Support parameter combinations with M=2 | 23-9-1 |  |  |  | per band and per BC |  |  |  | Component 1 candidate values  - Maximum 8 triplets  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256} | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] | FG 23-9-1 with M=1, FG 23-9-2 with M=2 R =1, and FG 23-9-2 with M=2 R =2 have been agreed as three independent FGs for FeType-II PS codebook due to the concerns of UE complexity. Therefore, when the UE supports mixed codebook types in any slot, FG 23-9-1, FG 23-9-2, and FG 23-9-4 need to be treated as individual codebooks, with a similar manner as Rel-16 MIMO capability design methodology when addressing values of R. Therefore the following codebook combinations are suggested for FG 23-9-5 considering the mixture of all legacy Type II codebooks and Rel-17 FeTypeII PS codebook in {codebook 2, codebook 3}   * Codebook 1 = {Type I SP, Type I MP}, * {Codebook 2, Codebook 3} ={{FeType II PS M=1, NULL},   {FeType II PS M=2 R = 1, NULL},  {FeType II PS M=2 R =2, NULL},  {Type II, FeType II PS M=1},  {Type II, FeType II PS M=2 R = 1},  {Type II, FeType II PS M=2 R = 2},  {eType II R=1, FeType II PS M=1},  {eType II R=1, FeType II PS M=2 R = 1},  {eType II R=1, FeType II PS M=2 R = 2},  {eType II R=2, FeType II PS M=1},  {eType II R=2, FeType II PS M=2 R = 1},  {eType II R=2, FeType II PS M=2 R = 2}}  ***Proposal 5.4: To support mixed codebook types in a slot in FG 23-9-5, FG 23-9-1, FG 23-9-2, and FG 23-9-4 can be treated as individual codebooks as Rel-16 UE capability design methodology, e.g. FG 23-9-1 with M=1 or FG 23-9-2 with M=2 R=1 or FG 23-9-2 with M=2 R=2 are jointly supported with all legacy Type II codebooks in {codebook 2, codebook 3}.*** |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | In our view it is important to address the issue of increased number of bits required for UE capability signalling in order to indicate the support of Rel-17 Type II codebook with different parameters including M = 1, M = 2 with R = 1 and M = 2 with R = 2. According to the current version of the UE feature list UE is required to indicate the list of triplets in order to indicate support of Rel-17 Type II codebook with M = 2 with R = 1 (FG 23-9-2) and M = 2 with R = 2 (FG 23-9-4) which leads to large number of bits in UE capability message. However, the indication of the triplets is not always necessary since the difference in PMI search complexity for the Rel-17 Type II codebook with different M and R can be acceptable to report the same triplets. Thus, we propose to introduce the following note for FG 23-9-2 and FG 23-9-4.   * If the list of triplets in component 1 of FG 23-9-2 is empty, then the list of triplets is reused from component 1 of FG 23-9-1. * If the list of triplets in component 2 of FG 23-9-2 is empty, then the list of triplets is reused from the list of triplets corresponding to FeType-II with M=2 and R=1.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-9-2 | Support of M=2 and R=1 for FeType-II | 1. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support Port-selection FeType-II with M=2 and R=1  2. Support parameter combinations with M=2 | Component 1 candidate values  - Maximum 8 triplets  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  NOTE: if the list of triplets in component 1 of FG 23-9-2 is empty, then the list of triplets is reused from component 1 of FG 23-9-1. | Per band and per BC | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] | For Port Selection Type-II codebook, we suggest merging both FG 23-9-2 and FG 23-9-4, since the complexity of supporting M=2 with R=1 and M=2 with R=2 is not significant, i.e., both correspond to PMI sub-band granularities of 2, 4 per BWP. Under a common FG 23-9-2, the first component of FG 23-9-4 can be represented as an additional component of FG 23-9-2.   1. Merge FG 23-9-2 and FG 23-9-4 into one FG, with the first component of FG 23-9-4 incorporated as an additional component of FG 23-9-2 |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-9-3 | Support of rank 3, 4 for FeType-II | Support of rank 3, 4 for FeType-II | 23-9-1 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| Company | Summary |
| Huawei, HiSilicon [2] |  |
| vivo [3] |  |
| ZTE [4] |  |
| OPPO [5] |  |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] |  |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] |  |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2 | 23-9-2 |  |  |  | per band and per BC |  |  |  | Component 2 candidate values:  • Maximum 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: [{1 to 64}]  • Max # total ports: [{4 to 256}] | Optional with capability signalling |

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] | FG 23-9-1 with M=1, FG 23-9-2 with M=2 R =1, and FG 23-9-2 with M=2 R =2 have been agreed as three independent FGs for FeType-II PS codebook due to the concerns of UE complexity. Therefore, when the UE supports mixed codebook types in any slot, FG 23-9-1, FG 23-9-2, and FG 23-9-4 need to be treated as individual codebooks, with a similar manner as Rel-16 MIMO capability design methodology when addressing values of R. Therefore the following codebook combinations are suggested for FG 23-9-5 considering the mixture of all legacy Type II codebooks and Rel-17 FeTypeII PS codebook in {codebook 2, codebook 3}   * Codebook 1 = {Type I SP, Type I MP}, * {Codebook 2, Codebook 3} ={{FeType II PS M=1, NULL},   {FeType II PS M=2 R = 1, NULL},  {FeType II PS M=2 R =2, NULL},  {Type II, FeType II PS M=1},  {Type II, FeType II PS M=2 R = 1},  {Type II, FeType II PS M=2 R = 2},  {eType II R=1, FeType II PS M=1},  {eType II R=1, FeType II PS M=2 R = 1},  {eType II R=1, FeType II PS M=2 R = 2},  {eType II R=2, FeType II PS M=1},  {eType II R=2, FeType II PS M=2 R = 1},  {eType II R=2, FeType II PS M=2 R = 2}}  ***Proposal 5.4: To support mixed codebook types in a slot in FG 23-9-5, FG 23-9-1, FG 23-9-2, and FG 23-9-4 can be treated as individual codebooks as Rel-16 UE capability design methodology, e.g. FG 23-9-1 with M=1 or FG 23-9-2 with M=2 R=1 or FG 23-9-2 with M=2 R=2 are jointly supported with all legacy Type II codebooks in {codebook 2, codebook 3}.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2 | 23-9-2 |  |  |  | per band and per BC |  |  |  | Component 2 candidate values:  • Maximum 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: {1 to 64}  • Max # total ports: {4 to 256} | Optional with capability signalling | |
| vivo [3] |  |
| ZTE [4] | |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2 | 23-9-2 |  |  |  | per band and per BC |  |  |  | Component 2 candidate values:  • Maximum 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: ~~[~~{1 to 64}~~]~~  • Max # total ports: ~~[~~{4 to 256}~~]~~ | |
| OPPO [5] |  |
| CATT [6] | When M=1, the maximum number of resources is 1 to 64, the maximum number of total ports is 4 to 256, and there are maximum 16 triplets. According to the agreemt of RAN1#107b-e meeting, the maximum number of triplets has been reduced by 8 for FG 23-9-2 and FG 23-9-4. It is not necessary to restrict the maximum number of resouces and the maximum number of total ports.  When M=2, compared with R=1, R=2 can achieve better performance due to its finer PMI granuliarity. Hence, the codbook combinations {Codebook 2, Codebook 3} = {FeType II PS M=2 R=2, NULL} could be supported. The prerequistite feature groups of FG 23-9-5 is FG 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41 and 2-43. The maxium numbers of triplets, maximum number of transmit ports, maximum number of resource and maximum number of total ports are same for all of these feature. Therefore, if the list of triplets forcodebook combination is empty, the list of triplets from the codebook combination indicated previously can be reused. According to above discussion, we provide the following proposal.  ***Proposal-19: For CSI enhancement on FDD CSI, the UE feature is revised as follows:***   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2. | 23-9-2 | per band and per BC | Component 1 candidate values  - Maximum 8 triplets  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources:~~[~~ {1 to 64} ~~]~~  - Max # total ports:~~[~~ {4 to 256}~~]~~ | Optional with capability signalling | |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] | For 23-9-4, there is duplicated ‘to support’ in component 2, which should be removed. We’re okay with the candidate values of max number of resource and max number of total ports in component 2.  **Proposal: Adopt the following for Rel-17 port selection CSI.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support Port-selection FeType-II with M=2 and R=2 | 23-9-2 |  |  |  | per band and per BC |  |  |  | Component 2 candidate values:  • Maximum 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: {1 to 64}  • Max # total ports: {4 to 256} | Optional with capability signalling | |
| Spreadtrum Communications [9] |  |
| LG Electronics [10] |  |
| Intel Corporation [11] | |  |  |  |  |  | | --- | --- | --- | --- | --- | | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2 | Component 2 candidate values:  • Maximum 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: [{1 to 64}]  • Max # total ports: [{4 to 256}]  NOTE: if the list of triplets in component 2 of FG 23-9-2 is empty, then the list of triplets is reused from the list of triplets corresponding to FeType-II with M=2 and R=1. | Per band and per BC | |
| Apple [12] |  |
| CMCC [13] |  |
| Xiaomi [14] |  |
| Samsung [15] |  |
| MediaTek Inc. [16] |  |
| Lenovo [17] | For Port Selection Type-II codebook, we suggest merging both FG 23-9-2 and FG 23-9-4, since the complexity of supporting M=2 with R=1 and M=2 with R=2 is not significant, i.e., both correspond to PMI sub-band granularities of 2, 4 per BWP. Under a common FG 23-9-2, the first component of FG 23-9-4 can be represented as an additional component of FG 23-9-2.   1. Merge FG 23-9-2 and FG 23-9-4 into one FG, with the first component of FG 23-9-4 incorporated as an additional component of FG 23-9-2 |
| Qualcomm Incorporated [18] |  |
| Ericsson [19] |  |

**Others**

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| --- | --- |
| Company | Summary |
| Huawei, HiSilicon [2] | In order to limit the UE implementation complexity in tracking activated TCI, similar to FG 2-4 in Rel-15 and FG 16-2a-7, the maximum number of activated TCI states should also be added in HST scenarios.  With above analysis, we propose the following:  ***Proposal 3-11: Support adding a new FG 23-6-5 for TCI tracking capability in HST as follow,***   * + ***FG 23-6-5: Component 1. The maximal total number of activated TCI states per BWP per CC including data and control, with candidate values {1, 2, 4, 8 ,16};***   + ***FG 23-6-5: Component 2. The maximal total number of activated TCI states all BWPs all CCs including data and control, with candidate values {1, 2, 4, 8 ,16, 32};***   In addition, a UE should indicate the PDSCH processing capability that highly impact the implementation complexity. We propose to add one components ‘Maximum number of PDSCHs per slot’ per CC of per band and per BC.  ***Proposal 3-12: Support adding a new FG 23-6-6 for PDSCH processing capability in HST as follow,***   * + ***FG 23-6-6: Component 1. The maximal number of PDSCHs per slot, with candidate values {1, 2, 3, 4 ,7};***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-5 | Maximum number of activated TCI states for HST/[URLLC] | 1. The maximal number of activated TCI states per BWP per CC including data and control  2. The maximal number of activated TCI states all BWPs all CCs including data and control |  |  |  |  |  |  |  |  | Candidate values for Component 1: {1,2,4,8,16}  Candidate values for Component 2: {1,2,4,8,16, 32} |  | | 23. NR\_FeMIMO | 23-6-6 | PDSCH processing capability for HST/[URLLC] | 1. The maximal number of PDSCH per slot |  |  |  |  |  |  |  |  | Candidate values for Component 1: {1,2,3,4,7} |  |   In RAN1#106bis-e, extension of aperiodic SRS set number for 1T4R, 1T2R and 2T4R was agreed, which is an optional UE feature.  Agreement  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional   According to the agreement, a new UE feature should be added for the extension. Therefore, we propose  ***Proposal 4-5: Add a new FG 23-8-9 for extension of aperiodic SRS set number for 1T4R, 1T2R and 2T4R.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-9 | Extension of aperiodic SRS set number for 1T4R, 1T2R and 2T4R | Support of 4 aperiodic SRS resource sets for 1T4R and 2 aperiodic SRS resource sets for 1T2R/2T4R | 2-53 |  |  |  | Per FS |  |  |  |  |  |   The UE is not mandated to support simultaneous reception with different QCL-TypeD for Rel-16 NCJT operation. Therefore UE FG 16-2c *simultaneousReceptionDiffTypeD-r16* is used to indicate whether UE supports simultaneous reception with different QCL-TypeD reference signal, as 38.306.  However it is unclear whether *simultaneousReceptionDiffTypeD-r16* can be applied CSI-IM resources, since one may argue that CSI-IM is not reference signal. Therefore if *simultaneousReceptionDiffTypeD-r16* reports “not support” (i.e. such an IE is not reported by UE), NW may be able to configuretwo CMRs with different QCL-TypeD with a TDM manner, e.g., over different symbols in a slot.  Then according to following agreement in RAN1 #104bis-e:  **Agreement**  The UE may assume that QCL-Type D of CMRs associated with a NCJT measurement hypothesis are applied to the corresponding CSI-IM resource.  The UE still have to apply two different QCL-Type D of CMRs associated with a NCJT measurement hypothesis over the corresponding CSI-IM resource simultaneously. Therefore the UE needs to support two receive beams simultaneously which is contradictive to the spirit of FG 16-2c to report “not support”.  So we have the following proposal:  **Proposal 5.1: Add a new FG 23-7-6 to i*ndicate whether UE supports simultaneous reception with different QCL-TypeD for CSI-IM resource associated with NCJT measurement hypothesis.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-6 | Simultaneous reception of CSI-IM with different Type-D | Supports simultaneous reception with different QCL Type-D over CSI-IM resources for Multi-TRP CSI | 23-7-1 |  |  |  | Per UE |  | FR2 only |  |  | Optional with capability signalling | |
| vivo [3] | Following was agreed in previous RAN1 meeting.  Agreement:  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional   Therefore, we propose to add the following new FG.  **Proposal 8-2: Add the following new FG to support capability enhancement on number of max SRS sets for 1T4R and 1T2R/2T4R.**   |  |  |  | | --- | --- | --- | | 23-8-9 | Extension of aperiodic antenna switching SRS configurations for 1T4R, 1T2R and 2T4R | Support of 4 aperiodic SRS resource sets for 1T4R and 2 aperiodic resource sets for 1T2R/2T4R. | |
| ZTE [4] | In addition, given that inter-span PDCCH repetition was agreed as a UE optional feature in RAN1#106bis-e meeting, we think one new FG should be introduced.   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23-2-3 | Inter-span PDCCH repetition | Support of inter-span PDCCH repetition |  |  |  |  |  |  |  |  |  |   In RAN1#106bis-e, a new UE optional feature is supported based on the following agreement.  **Agreement**  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional   Hence a new FG is needed for such extension of aperiodic antenna switching SRS of 1T4R and 1T2R/2T4R. We have the following proposal.  ***Proposal 12:*** *Add the following new FG*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-8-9 | Extension of aperiodic SRS configuration for 1T4R, 1T2R and 2T4R | Support of 4 aperiodic SRS resource sets for 1T4R and 2 aperiodic resource sets for 1T2R/2T4R. | 2-53 |  |  |  | Per FS |   Further, one remaining issue in an editor’s note of the Dec. RAN1 specification is whether RPFS is applicable to the case that frequency hopping is not enabled. We think one way to resolve this issue is to introduce a UE capability for the non-FH case. This new UE feature should use 23-8-6 as the prerequisite. If this capability is not reported, the UE cannot support to be configured with partial frequency sounding for non-FH case. Therefore, we have the following proposal.  ***Proposal 13:*** *Add the following new FG with 23-8-6 as the prerequisite.*   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 23-8-6a | Applicability of partial frequency sounding for non-FH case | Support of partial frequency sounding for the case that FH is not enabled. | 23-8-6 |  |  |  | Per band | |
| OPPO [5] | In RAN1#106 e-meeting, combination of scheme 1 PDCCH scheduling S-TRP PDSCH was agreed for URLLC use-case as below. This feature is optional to UE, and is only used for URLLC use-case. For HST, there is no use case that only PDCCH is configured with SFN, and SFN PDCCH+SFN PDSCH is a more common configuration. In this case, for a UE doesn’t have URLLC use case, but has HST use case, it can only support combination of SFN PDCCH+SFN PDSCH. Hence, separate FG for Scheme A PDCCH scheduling S-TRP PDSCH is proposed to be consistent with the agreement.  ***Agreement***  *Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH*   * *This is optional UE feature* * *Note: The support of such combination scheme is for URLLC use-case only.*   ***Proposal 11: Support Scheme A PDCCH scheduling S-TRP PDSCH as a separate FG.*** |
| CATT [6] |  |
| Nokia, Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [7] |  |
| Spreadtrum Communications [9] | **New FG:**  In RAN1#106bis-e meeting, a separate capability on number of max aperiodic SRS sets for 1T4R and 1T2R/2T4R was agreed.  Agreement:  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional   In addition, we also notice that the latest 38.214 has captured this capability as ‘extension of aperiodic antenna switching SRS configuration’. In detail, if UE supports the ‘extension of aperiodic antenna switching SRS configuration’, up to 4 aperiodic SRS resource set can be configured for 1T4R, and up to 2 aperiodic SRS resource set can be configured for 1T2R/2T4R.  Therefore, we propose to add one new FG to reflect the above agreement and align with the latest specification.  ***Proposal 16: Suggest to introduce one new FG to reflect the extension of aperiodic SRS resource set.*** |
| LG Electronics [10] | * + - Regarding the following agreement, a FFS point should be clarified for the maintenance. In our perspective, a new UE capability for X=2 should be introduced. This is because the value of X can impact the UE implementation. For example, for two CMRs for NCJT CSI calculation, when X=2, it is necessary to occupy the memory for a longer time than when X=1. Furthermore, the value of X also can impact CSI accuracy and latency. So, it is preferred to report UE’s capability about the value of X.   **Agreement @106b-e**  For CSI measurement associated with a *CSI-ReportingConfig* for NCJT, support two CMRs within the same CMR pair configured for NCJT measurement hypothesis to be restricted within X continuous slot(s) without DL/UL switch between two CMRs   * X=1, 2   + whereas X=1 implying the same slot and X=2 implying two adjacent slots * FFS other restrictions for FR2   FFS whether UE capability is needed for X=2   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-6 | Support of adjacent slots for a CMR pair | 1. Support of two CMRs within the same CMR pair configured for NCJT measurement hypothesis to be restricted within two continuous slots without DL/UL switch between two CMRs | 23-7-1 |  |  |  |  |  |  |  |  | Optional with capability signalling | |
| Intel Corporation [11] | In RAN1 #106b-e meeting, the below agreement was reached. Since this feature is UE optional, a new FG 23-8-9 should be introduced accordingly.   |  | | --- | | **Agreement**  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional |  |  |  |  |  | | --- | --- | --- | --- | | 23-8-9 | Increased number of aperiodic SRS resource sets for xTyR with y<=4 | 1. Support 4 aperiodic SRS resource sets for 1T4R 2. Support 2 aperiodic SRS resource sets for 1T2R 3. Support 2 aperiodic SRS resource sets for 2T4R |  |   We note that Rel-17 HST would support BFR enhancements for SFN PDCCH. In particular, BLER calculation for hypothetical PCCCH transmission are based on two reference signals, comparing to single reference signal supported in Rel-16. It is therefore proposed to introduce new FG 23-6-5 for this functionality as part of Rel-17 UE capabilities.  In RAN1#106e meeting, it was also agreed to support PDCCH monitoring with for overlapping CORESETs configured with different QCL-Type D. Therefore, it is proposed to capture the corresponding functionality as part of new FG 23-6-6.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | 23-6-5 | BFR for SFN PDCCH | Support of BFR using CORESETs configured with two TCI states | 23-6-1, 23-6-2 | Per band |  | Optional with capability signalling | | 23-6-6 | PDCCH monitoring of with different QCL-TypeD | Support of PDCCH monitoring of PDCCH candidates in overlapping monitoring occasions with different QCL-TypeD | 23-6-1, 23-6-2 | Per band | FR2 only | Optional with capability signalling | | 23-6-7 | PDSCH reception without TCI state | Support of PDSCH reception without TCI state field |  | Per band |  | Optional with capability signalling | |
| Apple [12] | FG 23-3-x (SRS for NCB based mTRP PUSCH) Based on the following conclusion, we propose an additional FG on SRS for mTRP PUSCH transmission.  **Conclusion**  For NCB based mTRP PUSCH repetition, no changes to the Rel-15/16 defined minimal gap between associated NZP-CSI-RS and aperiodic SRS.   * Note: Whether to introduce a UE capability on UE support simultaneous precoding calculation for different associated NZP-CSI-RS within a CC can be further discussed in UE capability discussions.   **Proposal 1.5-1: Introduce a FG for on SRS transmission for non-codebook based mTRP PUSCH with the following element:**   * **Maximum number of overlapped associated CSI-RS and SRS pairs in a CC** * **Maximum number of overlapped associated CSI-RS and SRS pairs across CCs within a band**  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1h | SRS for NCB based mTRP PUSCH | 1. Maximum number of overlapped associated CSI-RS and SRS pairs in a CC  2. Maximum number of overlapped associated CSI-RS and SRS pairs across CCs within a band |  |  |  |  |  |  |  |  | 1. Candidate value {1, 2, 4, 8}  2. Candidate value {1, 2, 4, 8} |  |  FG 23-6-x (HST enhancement)  * We also proposed to have the following three new FGs   + FG 23-6-5: Support of implicit configuration of RS(s) with two TCI states for beam failure detection   + FG 23-6-6: Support of SFN scheme A PDCCH scheduling Single-TRP PDSCH. This is to implement the following agreement  |  | | --- | | **Agreement**  Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH   * This is optional UE feature * Note: The support of such combination scheme is for URLLC use-case only. |  * + FG 23-6-7: QCL-TypeD collision handling with CORESET with 2 TCI states. This is to implement the following agreement  |  | | --- | | **Agreement**  When a CORESET is activated with two TCI states which overlaps with another CORESET, support extension of Rel-15 prioritization rule for PDCCH monitoring of PDCCH candidates in overlapping monitoring occasions with different QCL-TypeD   * FFS: Prioritization rule considers CORESETs indicated with 1 and/or 2 TCI states * Supports identifying two QCL-TypeD properties for multiple overlapping CORESETs   + UE capability is introduced |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-5 | Support implicit/explicit configuration of RS(s) with two TCI states for beam failure detection | Support RS(s) with two TCI states configured, either implicitly or explicitly, for beam failure detection enhancement for HST |  | Y | N/A |  | Per band | N | N |  |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-6-6 | Support of SFN scheme A PDCCH scheduling Single-TRP PDSCH | Support of SFN scheme A PDCCH scheduling Single-TRP PDSCH |  | Y | N/A |  | Per band | N | N |  |  | Optional with capability signalling | | 23. NR\_FeMIMO | 23-6-7 | QCL-TypeD collision handling with CORESET with 2 TCI states | Support of identifying two QCL-TypeD properties for multiple overlapping CORESETs When a CORESET is activated with two TCI states which overlaps with another CORESET. |  | Y | N/A |  | Per band | N | N |  |  | Optional with capability signalling |  FG 23-7-x (mTRP CSI enhancement)  * We propose to introduce FG23-7-6 for the support of CSI-IMR  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-6 | Support of CSI-IM for CSI enhancement for Multi-TRP | Support CSI-IM for CSI enhancement for Multi-TRP | 23-7-1 | Y | N/A |  | Per UE | N | Y |  |  | Optional with capability signalling |  1.8 FG 23-8-x (SRS enhancement)  * We also propose to add new FG23-8-9 for the following agreement  |  | | --- | | **Agreement**  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-9 | Extension of aperiodic antenna switching SRS configurations for <=4Rx | Support of N=4 for 1T4R and N=2 for 1T2R/2T4R. N is the number of aperiodic SRS resource sets for antenna switching |  |  |  |  | Per FS |  |  |  |  | Optional with capability signaling | |
| CMCC [13] |  |
| Xiaomi [14] | In FG 23-2-2, two QCL Type D is covered only for non-SFN PDCCH scheme. But according to the agreement in RAN1-107 e-meeting [11], UE feature on support of two QCL Type D for SFN PDCCH scheme should also be introduced.  ***RAN1-107 e-meeting-Agreement***  *When a CORESET is activated with two TCI states which overlaps with another CORESET, support PDCCH monitoring of PDCCH candidates in overlapping monitoring occasions with QCL-TypeD properties identified according to prioritization rule*   * *Reuse Rel-15 prioritization to identify the first CORESET, i.e., SS type > serving cell index > SS set ID*   + *If the CORESET has two TCI states with QCL-typeD, both QCL-typeD are identified****.***   + *If the CORESET has one TCI state with QCL-typeD, the second QCL-typeD is not identified*   ***Proposal 18: new FG on support of two QCL Type D for SFN PDCCH scheme in FG23-6-5.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-5 | Two QCL TypeD for CORESET monitoring in PDCCH with SFN scheme | Support of determining two QCL-TypeD for overlapping in time CORESETs in the same CC or for intra-band CA when UE is configured with SFN PDCCH | 23-6-1, 23-6-2 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling | |
| Samsung [15] | Moreover, in RAN1#107b-e there was a discussion on how to incorporate UE capability reporting on the supported mixed codebook types pertinent to NCJT CSI reporting. In order to keep the structure of the legacy UE capability reporting for mixed codebook types in FG 16-8 while limiting the new capability reporting to CSI reporting for NCJT, we support a separate mixed codebook types capability reporting for NCJT as FG 23-7-1b.  **Proposal 29:** *Support FG 23-7-1b for mixed codebook reporting for NCJT with reporting structure {Codebook 1, Codebook 2, Codebook 3}*   * *NCJT + Type 1 SP (for sTRP) as a candidate value for Codebook 1.* * *Support a candidate value {Codebook 2, Codebook 3}={Null, Null}.* |
| MediaTek Inc. [16] | **Proposal 20: Add FG 23-3-1-1a “CSI-RS processing framework for SRS” with the following components:**   * **Maximum number of periodic SRS resources associated with CSI-RS per BWP: {2, 4, 6, 8}** * **Maximum number of aperiodic SRS resources associated with CSI-RS per BWP: {2, 4, 6, 8}** * **Maximum number of semi-persistent SRS resources associated with CSI-RS per BWP: {0, 2, 4, 6, 8}** * **UE can process Y SRS resources associated with CSI-RS resources simultaneously in a CC, including P/SP/A SRS: {2, 4, 6, 8, 10, 12, 14, 16}**  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-3-1-1a | CSI-RS processing framework for SRS | 1. Maximum number of periodic SRS resources associated with CSI-RS per BWP  2. Maximum number of aperiodic SRS resources associated with CSI-RS per BWP  3. Maximum number of semi-persistent SRS resources associated with CSI-RS per BWP  4. UE can process Y SRS resources associated with CSI-RS resources simultaneously in a CC. Includes P/SP/A SRS. | **23-3-1a** |  |  |  | Per Band |  |  |  | Component 1: {2, 4, 6, 8}  Component 2: {2, 4, 6, 8}  Component 3: {0, 2, 4, 6, 8}  Component 4: {2, 4, 6, 8, 10, 12, 14, 16} | **Optional with capability signalling** |   Add the new optional FG 23-3-4 to capture the following agreement reached in RAN1 #106 bis-e:  **Agreement**  When 3 BDs are counted for two linked candidates   * The third BD is counted in the later span for inter-span PDCCH repetition when *r16monitoringcapablity* is configured. * Note: Inter-span repetition is UE optional   **Proposal 17: Add optional UE feature, FG 23-2-4 to indicate support for inter-span PDCCH repetition**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-2-4 | Inter-span PDCCH repetition | Support of Inter-span repetition for PDCCH | **23-2-1** |  |  |  |  |  |  |  | {Supported, Not supported} | **Optional with capability signalling** |   We propose to add a new FG, 23-6-5 to capture the following agreement reach in RAN1 #106 bis-e  **Agreement**  Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH   * This is optional UE feature * Note: The support of such combination scheme is for URLLC use-case only.   **Proposal 26: Add the optional UE feature FG 23-6-5 to indicate support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-5 | Support of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH combination | Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH |  |  |  |  |  |  |  |  | {Supported, Not supported} | **Optional with capability signalling** |   In the RAN1#106bis-e meeting, we have the following agreement:   |  | | --- | | Agreement  **For CSI measurement associated with a *CSI-ReportingConfig* for NCJT, support two CMRs within the same CMR pair configured for NCJT measurement hypothesis to be restricted within X continuous slot(s) without DL/UL switch between two CMRs**   * **X=1, 2**   + **whereas X=1 implying the same slot and X=2 implying two adjacent slots** * **FFS other restrictions for FR2** * **FFS whether UE capability is needed for X=2** |   We propose to add a new optional UE FG to indicate support of two resources in a resource pair configured within two adjacent slots, with candidate values {Supported, Not supported}. The reasons are two-fold: First, maintaining phase coherency across two slots increases UE implementation complexity. Second, awake for an additional slot consumes extra power.  **Proposal 30: Add FG to indicate support of maximum slot offset X=2 for two** **resources in a resource pair.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-4 | Slot offset of CMRs in a CMR pair | Support of two CMRs in a CMR pair transmitted in two contiguous slots | **23-7-1** |  |  |  | Per band |  |  |  | {Support, Not support} | **Optional with capability signalling** |   We propose to add a new optional UE FG to indicate support for Codebook type I Mode 2 in Multi-TRP CSI, with candidate values {Supported, Not supported}.  **Proposal 31: Add a new FG to indicate support for Codebook type I Mode 2 in Multi-TRP CSI.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-7-5 | Codebook type I Mode 2 in Multi-TRP CSI | Support for Codebook type I Mode 2 in Multi-TRP CSI | **23-7-1** |  |  |  | Per band |  |  |  | {Support, Not support} | **Optional with capability signalling** | |
| Lenovo [17] | It was agreed in RAN1#106bis-e [4] that when 3 BDs are counted for two linked candidates, the third BD is counted in the later span for inter-span PDCCH repetition when *r16monitoringcapablity* is configured. Inter-span repetition is UE optional. In addition to available FG 23-2-1 for intra-slot PDCCH repetition, we propose adding a new FG 23-2-4 or FG 23-2-1b “Intra-span PDCCH repetition” based on *r16monitoringcapablity* for supporting intra-span PDCCH repetition based on two linked SS sets associated with corresponding CORESETs with non-SFN scheme TDM and FDM (except FR2) including PDCCH repetition for Type 3 CSS.   1. Add new FG 23-2-4 or FG 23-2-1b for supporting intra-span PDCCH repetition based on two linked SS sets associated with corresponding CORESETs with non-SFN scheme TDM and FDM (except FR2) including PDCCH repetition for Type 3 CSS   It was agreed in RAN1#107-e [5] that handling UE complexity/memory requirements for linked PDCCH candidates would be addressed via UE capability, where UE indicates a limit (X) associated with the total number of linked candidates of which the first candidate is received and the second one has not been received at any given span. The limit X is indicated as a total count assuming count 1 for AL=1; 2 for AL=2; 4 for AL=4 or 8 or 16. The limit X is indicated per CC and also across all CCs, which is applicable at least for the inter-span case (FFS: intra-span case). To capture this agreed UE capability for newly introduced FG 23-2-4, two new components “total number of linked candidates per CC with receiving the first candidate but not receiving the second candidate at any given span” and “total number of linked candidates across all CCs with receiving the first candidate but not receiving the second candidate at any given span” should be introduced.   1. For newly introduced FG 23-2-4 or FG 23-2-1b, introduce two new components “limit of total number of linked candidates per CC with receiving the first candidate but not receiving the second candidate at any given span” and “limit of total number of linked candidates across all CCs with receiving the first candidate but not receiving the second candidate at any given span” |
| Qualcomm Incorporated [18] | There is missing FG for the UE capability of supporting of two QCL TypeD prosperities for multiple overlapping CORESETs when a CORESET is activated with two TCI as per RAN1-agreement below   |  | | --- | | **Agreement**  When a CORESET is activated with two TCI states which overlaps with another CORESET, support extension of Rel-15 prioritization rule for PDCCH monitoring of PDCCH candidates in overlapping monitoring occasions with different QCL-TypeD   * FFS: Prioritization rule considers CORESETs indicated with 1 and/or 2 TCI states * Supports identifying two QCL-TypeD properties for multiple overlapping CORESETs   + UE capability is introduced * FFS other details * FFS: Strive to have same / similar solution as discussed under AI 8.1.2.1 |   ***Proposal 8-8: Add FG 23-6-4b for the indication of Two QCL TypeD properties determination for overlapping CORESETs.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-6-4b | Two QCL TypeD properties for SFN PDCCH | Supports identifying two QCL-TypeD properties for multiple overlapping CORESETs when a CORESET is activated with two TCI states. |  |  |  |  | Per Band |  | FR2 only |  |  | Optional with capability signalling |   In RAN1 meeting #106bis-e, it was agreed to extend the number of aperiodic SRS sets for legacy xTyR configuration as separate UE feature. A separate UE feature 23-8-9 should be added to reflect the RAN1 agreement.   |  | | --- | | **Agreement**  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional. |   ***Proposal 9-6: Add FG 23-8-9 supporting the extension of maximum number of sets for aperiodic SRS antenna switching configuration for <= 4Rx***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 23. NR\_FeMIMO | 23-8-9 | extension of maximum number of SRS sets for antenna switching | Support the extension of number of sets (N) for aperiodic SRS antenna switching to N = 4 for 1T4R, N = 2 for 1T2R/2T4R. | FG 2-55 |  |  |  | Per band per BC |  |  |  |  | Optional with capability signalling | |
| Ericsson [19] | This agreement from RAN1 is not captured in the current list of FG. We propose to use per band indication.  **Agreement**  For extension of aperiodic antenna switching SRS configurations for <=4Rx, support N=4 for 1T4R and N=2 for 1T2R/2T4R.   * The above extension is UE optional  1. Add a new UE feature group FG 23-8-9 to capture the UE optional agreement on aperiodic SRS for 2 and 4 RX UEs. Use per band signalling. |

# Discussion/Approval Items during RAN1 #108-e — First Checkpoint

After review of contributions submitted to RAN1 #108-e in this agenda item, the following topics were identified by the moderator for discussion/approval during RAN1 #108-e.

**General comments**

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| --- | --- |
| Company | Comments/Questions/Suggestions |
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# Issue 1: FG 23-1-1

This FG is not discussed by email until further progress is made via GTW sessions.

# Issue 2: FG 23-1-2

This FG is not discussed by email until further progress is made via GTW sessions.

# Issue 3: FG 23-1-3

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-1-3 | MPE mitigation | 1. Support of enhanced ~~[~~PHR~~]~~ reporting which includes pairs of (P-MPR, SSBRI/CRI)  2. Maximum number of reported P-MPR and SSBRI/CRI pairs per CC  3. Maximum number of candidate RS(s) configured in a RRC pool for MPE mitigation |  |  |  |  | Per band |  |  |  | Component 2 candidate value: ~~of~~ {1,2,3, 4}  Component 3 candidate value: ~~FFS~~ {4,8,16,32,64} | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Regarding the first component, we think that it is better to add Pcmax and PHR together with current P-MPR and SSBRI/CRI (i.e. enhanced PHR reporting which includes pairs of {Pcmax, PHR, P-MPR, SSBRI/CRI}) based on the RAN2 LS. This can be discussed further in 8.1.1. |
| MediaTek | On the 2nd component, we see the number of pairs should be per report instead of per CC  On the 3rd component, we still prefer to change “RRC pool” to “CSI-RS/SSB resource set” to align RAN1 agreement. We are fine with the candidate value set. |
| ZTE | Support in principle. As for FR2 operation, we are wondering that motivation of candidate value ‘4’ and ‘8’. In our views, it should be removed. |

# Issue 4: FG 23-1-4

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-1-4 | MPUE support for UL | 1. Supported UE capability value ~~[~~sets~~]~~ and corresponding max number of SRS ports for each UE capability value ~~[~~set~~]~~  2. Supported maximum periodicity for periodic/semi-persistent report |  |  |  |  | per band |  |  |  | Component 1 candidate values: ~~[~~Up to ~~[~~4~~]~~ value ~~[~~sets~~]~~ each with one value of {~~[~~0,~~]~~1,2,4}~~]~~  Component 2 candidate values: {40, 80, 160, 320} slots  ~~Note: the reported list contains only unique value [sets]~~  ~~This FG is a working assumption~~ | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Fine with the updates on component 1. The necessity of component 2 is not clear to us, and needs further discussion. |
| MediaTek | Fine in principle. Suggest to keep candidate value 0 in component in brackets since RAN1 has not agreed to report DL-only panel yet. |
| ZTE | First of all, for semi-persistent or periodic reporting, in order to accommodate UE panel switching, UE can further indicate recommended periodicities, as a new component, then gNB configures a periodicity based on the reported periodicities. So we support the new component of ‘supported maximum periodicity for periodic/semi-persistent report’.  Then, we support to remove the note of ‘the report list contains only unique value [set]’ which should be discussed in MB session.  Finally, we are open to considering the addition of ‘0’ as a candidate value for component-1, but our first preference is to add one new FG of ‘support of DL-only report’. |

# Issue 5: FG 23-2-1

This FG is not discussed by email until further progress is made via GTW sessions.

# Issue 6: FG 23-2-1a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | ~~[~~23-2-1~~]~~ |  |  |  | Per band |  |  |  | ~~[Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET]~~ | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support, we can compromise with companies to remove the “Note”. |
| vivo | We want to clarify what relationship between this feature and component 4(FFS) in FG 23-2-1 is.   1. When the max number of overlaps is reported with value 0, should UE not report the capability of ‘Monitoring of individual candidates’? 2. When the max number of overlaps is reported with value >0, must UE report the capability of that ‘Monitoring of individual candidates’ is enabled?   If answers both are YES, can the FG 23-2-1a be deleted?  Note: Component 4(FFS): Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |

# Issue 7: FG 23-2-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition ~~[with non-SFN TDM and/or FDM sheme]~~ | 23-2-1 |  |  |  | Per band |  |  | FR2 only |  | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | We think this feature was introduced due to FDM based PDCCH repetition rather than TDM scheme.  If two QCL-TypeD of CORESETS overlaps in time domain and TDM based PDCCH repetition is configured, gNB would not care two beams can be received by UE, and the priority of beam reception should reuse the rule as Rel-15. |

# Issue 8: FG 23-2-3

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| ~~23. NR\_FeMIMO~~ | ~~23-2-3~~ | ~~PDCCH repetition for Type3 CSS~~ | ~~Support of PDCCH repetition for Type3 CSS~~ |  |  |  |  |  |  |  |  |  | ~~Optional with capability signalling~~ |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | OK with removing this FG and including it in basic FG, i.e., 23-2-1. |
| ZTE | Support to delete this FG, it is more proper to capture this in FG 23-2-1. |
| vivo | We prefer to reserve FG 23-2-3.  Type3 CSS mainly serve a group of UEs. In FR2, some UEs may be located in same beam from TRP1 but may not in different beam from TRP2 due to the orientation of panels of every UE is different. Therefore, it is hard to gNB to select a group of UEs with same QCL-TypeD1 for PDCCH repetition1 and same QCL-TypeD2 for PDCCH repetition2. We think Type3 CSS for PDCCH repetition may be infrequent in real deployment of mm-wave.  So, it is not necessary for UE to support PDDCH repetition for Type3 CSS. |

# Issue 9: FG 23-3-1

This FG is not discussed by email until further progress is made via GTW sessions.

# Issue 10: FG 23-3-1a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1a | Cyclic mapping | Support of cyclic mapping when the number of repetitions is larger than 2 ~~for single DCI based M-TRP PUSCH repetition Type A~~ | 23-3-1 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| ZTE | Support. |
| vivo | Fine to remove “for single DCI based M-TRP PUSCH repetition Type A”, but better to capture component value: {for repetition Type A, for repetition Type B, both} |

# Issue 11: FG 23-3-1b

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1b | Second TPC field | Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2 | 23-3-1 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | Support. |

# Issue 12: FG 23-3-1c

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | 1. Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.)  2. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission) | 23-3-1 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | We are open for further discussion on compenent 2. |
| ZTE | Do NOT support component 2, it is not in line with any existing agreements/conclusions. If it is needed, this issue should be discussed in AI 8.1.2.1 at first. |
| vivo | Support. |

# Issue 13: FG 23-3-1e

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1e | A-CSI report | Support of A-CSI report on two PUSCH repetitions | 23-3-1 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | Support. |

# Issue 14: FG 23-3-1f

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1f | SP-CSI report | Support of SP-CSI report on two PUSCH repetitions | 23-3-1 |  |  |  | Per Band |  |  |  |  | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | Support. |

# Issue 15: FG 23-3-1g

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1g | CG PUSCH transmission | 1. Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.)  2. Supported type of configured grant for multi-TRP PUSCH repetition | 23-3-1 |  |  |  | Per Band |  |  |  | Component 2: {Type1, Type2, both} | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | Support. |

# Issue 16: FG 23-3-1-1

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-1-1 ~~[~~-~~CB]~~ codebook based | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[~~for ~~CB]~~ codebook based  - sequential mapping for repetitions equal to or larger than 2  - cyclic mapping for 2 repetitions  2. Maximum number of supported layers  3. Supported maximum number of SRS resources per set (SRS set use is configured as for non-codebook transmission)  4. Maximum number of simultaneous transmitted SRS resources at one symbol  5. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission  ~~FFS: Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~ |  |  |  |  |  |  |  |  | ~~[Candidate component values: {CB, non-CB, both}]~~  Component 2 candidate values: {1,2,4}  Component 3 candidate values: {1,2,3,4}  Component 4 candidate values: {1,2,3,4} | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1-2 – non-codebook based | Multi-TRP PUSCH repetition (type B) | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) for non-codebook based  - sequential mapping for repetitions equal to or larger than 2  - cyclic mapping for 2 repetitions  2. Maximum number of supported layers  3. Supported maximum number of SRS resources per set (SRS set use is configured as for non-codebook transmission)  4. Maximum number of simultaneous transmitted SRS resources at one symbol  5. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission | 23-3-1, 2-15 |  |  |  | Per FSPC |  |  |  | Component 2 candidate values: {1,2,4}  Component 3 candidate values: {1,2,3,4}  Component 4 candidate values: {1,2,3,4} | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | This can be discussed after 23-3-1 is stable. |
| ZTE | Come back to this part when FG 23-3-1 family is stable. |
| vivo | Full power mode2 should be a separate component with  Propose following updates for the “Components” column:  1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type B) ~~[~~for ~~CB]~~ codebook based  - sequential mapping for repetitions ~~equal to or~~ larger than 2  - cyclic mapping for 2 repetitions  2. Maximum number of supported layers  3. Supported maximum number of SRS resources per set (SRS set use is configured as for ~~non-~~codebook transmission)  4. The maximum number of SRS resources in one SRS resource set with usage set to 'codebook' for fullpowerMode2: {1, 2, 4}  ~~4. Maximum number of simultaneous transmitted SRS resources at one symbol~~  ~~5~~ 4. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission  According to the existing component candidate values, propose following updates for the component values:  Component 2 candidate values: {1,2,4}  Component 3 candidate values: {1,2~~,3,4~~}  Component 4 candidate values: {~~1,2,3,4~~Support, not support} |

# Issue 17: FG 23-3-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  - sequential mapping for repetitions equal to or larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~  ~~[2. Support of up to two PUCCH spatial relation per PUCCH resource]~~  2. Supported PUCCH formats for this scheme  3. Maximum number of power control sets configured for multi-PUCCH in FR1 | ~~FFS~~ |  |  |  | Per FS |  |  |  | Component 2: A bit map of size 5 for PUCCH format 0-4. At least one value of the bitmap should be set to 1. | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-2d | Updating two Spatial relation or two sets of power control parameters for PUCCH group | Support of updating two Spatial Relation Info’s / two sets of power control parameters for a group of PUCCH resources in a CC by MAC-CE | 16-1b-3 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-2-1e | Multi-TRP PUCCH intra-slot repetition | Support of multi-TRP PUCCH intra-slot repetition | 23-3-2 |  |  |  | Per FS |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | For 23-3-2 component 1, we think sequential mapping for repetitions equal to 2 is not needed. We had agreement that when repetition number is 2, it is cyclic mapping regardless of configured mapping pattern.  Thus, we suggest following update. “- sequential mapping for repetitions ~~equal to or~~ larger than 2”  And FG23-3-2-1e can be removed. It seems duplicate with 23-3-3. |
| LG | 23-3-2: Removed component 2 is needed and we should describe it separately for FR 1 and FR 2 because two PC sets are configured instead of two spatial relation in FR 1. |
| ZTE | For component 1 in FG 23-3-2, based on the parallel discussion in AI 8.1.2.1, we can be fine to remove the part “equal to or”.  For component 2 in FG 23-3-2, it should be removed, because we fail to see any discrepancy among PUCCH formats.  For component 3 in FG 23-3-2, it should be FFS, which is now be discussed in AI 8.1.2.1 and without any conclusion so far.  For FG 23-3-2d, it should be removed or added to FG 23-3-2 as one component, because it is mandatory to MTRP PUCCH repetition. If not, how to perform MTRP PUCCH repetition scheme without this feature?  For FG 23-3-2-1e, it should be the separated from FG 23-3-2, as the follow FG 23-3-3. |
| vivo | Remove “equal to or”. |

# Issue 18: FG 23-3-2b

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-2b | Cyclic mapping for multi-TRP PUCCH repetition | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | ~~FFS~~  23-3-2 |  |  |  | Per band |  |  |  | ~~FFS:~~ Component candidate values: {4,8} | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | Propose adding a component as follows:  2. Supported maximum number of PUCCH repetitions larger than 2  And separate cyclic mapping for inter-slot and intra-slot. Therefore, proposed component values are:  Component 1: {for scheme 1, for scheme 3, for both}  Component 2 candidate values: {4,8} |

# Issue 19: FG 23-3-2c

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-2c | Second TPC field for multi-TRP PUCCH repetition | Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2 | ~~FFS~~  23-3-2 |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| LG | Support |
| ZTE | Support. |
| vivo | Support |

# Issue 20: FG 23-3-3

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-3-3 | Multi-TRP PUCCH repetition-intra-slot | 1. Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions equal to or larger than 2  ~~[~~- cyclic mapping for 2 repetitions~~]~~  2. Supported PUCCH formats for this scheme  3. Maximum number of power control sets configured for multi-PUCCH in FR1 | ~~FFS~~  23-3-2  25-3 |  |  |  | Per FS |  |  |  | Component 2: A bit map of size 5 for PUCCH format 0-4. At least one value of the bitmap should be set to 1. | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | For component1, Similar as for 23-3-2, we think sequential mapping for repetitions equal to 2 is not needed. We had agreement that when repetition number is 2, it is cyclic mapping regardless of configured mapping pattern.  Thus, we suggest following update. “- sequential mapping for repetitions ~~equal to or~~ larger than 2” |
| LG | 23-3-2 should be discussed first and then 23-3-3 can be further discussed. |
| ZTE | Come back to this part when FG 23-3-2 family is stable. |
| vivo | Remove “equal to or” |

# Issue 21: FG 23-4

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  ~~[~~2. The maximum number of configured additional PCIs is X1 (case 1) when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI~~]~~  ~~[~~3. The maximum number of configured additional PCIs is X2 (Case 2) when the configurations of SSB time domain positions and periodicity of the additional PCIs is ~~not according to Case 1~~ different with SSB time domain positions and periodicity of the serving cell PCI~~]~~ | 16-2a |  |  |  | Per band |  |  |  | ~~[~~Component 2 candidate values: {0,1,2,3,7}~~]~~  ~~[~~Component 3 candidate values: {0,1,2,3,7}~~]~~    Note: UE indicates a non-zero value for at least one of component 2 or component 3  ~~[~~Note: case1 and case2 cannot be enabled simultaneously~~]~~ | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | For component 3, we prefer the wording that is aligned with the agreement, i.e., ‘not according to Case 1’.  For candidate value of component 2, we suggest deleting the value 0 as Case 1 is important for our NW and it should be default case to be supported for inter-cell MTRP.  Regarding the note, it is more like restriction on RRC configuration signaling, instead of UE feature. Hence, it can be removed. |
| LG | Remove value 0 for component 2. If UE support non-zero value for component 3 then UE is capable of supporting non-zero value for component 2 as well. |
| ZTE | Support in principle, we suggest to revise component 3 as the follow to keep alignment with the yellow highlighted part in the previous agreement.  ~~[~~3. The maximum number of configured additional PCIs is X2 (Case 2) when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1~~]~~   |  | | --- | | ***Agreement***  *Support two independent X values (X1, X2) are reported as a UE capability for two different assumptions on additional SSB time domain position and periodicity with respect to serving cell SSB.*   * *X1 (Case 1)= The maximum number of configured additional PCIs when each configuration~~s~~ of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI* * *X2 (Case 2)= The maximum number of configured additional PCIs when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1* * *Note: By definition, Case 1 and Case 2 cannot be enabled simultaneously* * *Supported values for X1 and X2 include~~s~~ at least 0,1,2,3 and 7. FFS on other values*   *This UE capability has FR1 and FR2 differentiation (FFS : Whether this UE capability is per UE or per band)* | |

# Issue 22: FG 23-5-1

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in a single L1-RSRP reporting instance based on measurement on two CMR resource sets  ~~[2. Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs]~~  ~~[3. Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs]~~ |  |  |  |  |  |  |  |  | Component 1 candidate values: {1,2,3,4}  ~~Component 2 candidate values: FFS~~  ~~Component 3 candidate values: FFS~~  ~~FFS: If FG 23-5-1a is not introduced, the relationship of this FG with FG 16-1g/16-1g-1 needs to be further clarified~~ | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support the above update. |
| LG | Support. |
| MediaTek | Support |
| ZTE | Support |
| Nokia, NSB | Do not support, we think components 2 and 3 should be confirmed. |

# Issue 23: FG 23-5-1a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-5-1a | Resources ~~[~~for beam management , PL measurement, BFD, RLM, and new beam identification~~]~~ | 1. Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs  2. Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs  ~~Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations~~  ~~If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted~~ |  |  |  |  |  |  |  |  | Component 1 candidate values: ~~FFS~~ {1, 2, 3, 4}  Component 1 candidate values: {8, 16, 32, 64} | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | We think the similar UE feature in Rel-16 is sufficient. |
| LG | Fine in principle. Regarding candidate values, we can refer those of 16-1g and add increased value from legacy to consider the number of increased beam measurement related resources in Rel-17, e.g., increased BFD-RSs from increased number of BFD-RS sets, inter-cell beam measurement. |
| MediaTek | According to the title of this FG, the resources include not only those for group-based reporting associated with two CMR set, but also for all other possible Rel-15/16/17 features. Thus, the two components should be similar to the components of 16-1g as follows:   * + - 1. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification       2. The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification |
| ZTE | We prefer to use the FG-16-1g/-1 rather than a new one. So, we can not support the above. |

# Issue 24: FG 23-5-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-5-2 | MTRP BFR ~~enhancement~~ based on two BFD-RS sets | 1. ~~Support of the~~ Maximum number of supported BFD-RS resources per set  ~~2. [Support of Rel-17 M-TRP BFR based on two BFD-RS sets]~~  ~~[~~3. Support PUCCH-SR resource for MTRP BFRQ~~]~~  4. Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP  5. Support of TRP-specific BFR for inter-cell mTRP operation  6. The maximum number of CCs configured with BFR (including spCell/SCell/MTRP BFR in Rel-15/16/17) |  |  |  |  |  |  |  |  | ~~[~~Component 1 candidate values: {1, 2~~,…~~}~~]~~  Component 4 candidate values: {2,3,4}  Component 6 candidate values: {1, 2, 3, 4, 5, 6, 7, 8, 9} | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support update of components.  For component 3, it is noted that Rel-16 does not introduce related UE feature for PUCCH-SR for BFR, hence, it is assumed that one PUCCH-SR for BFR could be baseline. |
| LG | For component 3, same view with DOCOMO. If the intention is to clarify the basic components, the wording needs to be revised such that ‘support of at least one PUCCH-SR resource for MTRP BFRQ’ so that FG 23-5-2a can indicate whether to support one more PUCCH-SR resource for MTRP BFRQ (i.e. two PUCCH-SR resources for BFRQ).  Component 5 and 6 need further discussion, so prefer not to agree on adding them. |
| MediaTek | Component 3: Support one PUCCH-SR resource for MTRP BFRQ per cell group  Component 5: RAN1 never agrees on this. We suggest to remove this component. |
| ZTE | Firstly we are open to consider component 5/6 as a new component.  Then, we can support the above update for component 1~3. |

# Issue 25: FG 23-5-2a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ per cell group  ~~[~~2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)~~]~~ |  |  |  |  |  |  |  |  | Component 1 candidate values: {~~[~~0,1~~]~~, 2} | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support update of the two components.  For candidate values for component 1, as one PUCCH-SR for BFR is baseline, there is no need to support candidate values of 0 and 1. Only value of 2 is needed |
| LG | Same view with DOCOMO. Candidate values of {0,1} should be removed since all UE must support at least one PUCCH-SR for BFRQ as Rel-16 BFR. All we need to define is to indicate whether to support two PUCCH-SR resources or not. |
| MediaTek | For the candidate value of component 1, only 2 is needed. Suggest to remove 0 and 1. In one alternative, the component 1 can be changed as follows:   * ~~Max number of~~Support two PUCCH-SR resources for MTRP BFRQ per cell group |
| ZTE | Not support. In our views, component-2 should be removed, and candidate [0,1] of component 1 should be removed. Meanwhile, the motivation for ‘per cell group’ is unclear. |

# Issue 26: FG 23-6-1

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. Support of SFN scheme A for PDCCH scheduling ~~[single TRP/]~~ SFN Scheme A PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ |  |  |  |  | ~~[~~Per band ~~or per FS or per FSPC]~~ |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-1-1 | SFN scheme A (scheme 1) for PDCCH only | Support of SFN scheme A for PDCCH scheduling single TRP PDSCH |  |  |  |  | Per band |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | OK. We understand 3 combinations are reported by 23-6-1, 23-6-1-1, 23-6-1b. We assume 23-6-1 should be a basic FG for SFN Scheme A.  We agree with “per band”. |
| LG | Support |
| ZTE | Support these two FGs in principle.  For FG 23-6-1-1, its pre-requisite is FG 23-6-1 should be added. |

# Issue 27: FG 23-6-1a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | 23-6-2 or ~~[~~23-6-2~~[~~b~~]]~~ |  |  |  | ~~[~~Per band ~~or per FS or per FSPC]~~ |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support.  We agree with “per band”. |
| LG | The prerequisite should be FG 23-6-1 or FG 23-6-1b |
| ZTE | Support in principle, its pre-requisite should be FG 23-6-1 and FG 23-6-1b. |

# Issue 28: FG 23-6-1b

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH ~~[~~only scheduled by ~~[~~single TRP/ ~~Scheme A]~~ PDCCH~~] [and default QCL assumption with one or two TCI states for PDSCH]~~ |  |  |  |  | ~~[~~Per band ~~or per FS or per FSPC]~~ |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support.  We agree with “per band”. |
| LG | Support |
| ZTE | Revise component 1 as the follow, because both of combination schemes of “SFN scheme A PDCCH + SFN scheme A PDSCH” and “STRP PDCCH + SFN scheme A PDSCH” was supported. Although FG 23-6-1 captures the combination “SFN scheme A PDCCH + SFN scheme A PDSCH”, it is better to explicitly point out this combination here due to this FG aims to specify SFN scheme A PDSCH.  1. Support of SFN scheme A for PDSCH ~~[~~scheduled by ~~[~~single TRP/ Scheme A~~]~~ PDCCH~~] [and default QCL assumption with one or two TCI states for PDSCH]~~ |

# Issue 29: FG 23-6-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. Support of SFN scheme B for PDCCH scheduling SFN Scheme B PDSCH ~~[and default QCL assumption with one or two TCI states for PDCCH]~~ | ~~[~~23-6-1~~]~~ |  |  |  | ~~[~~Per band ~~or per FS or per FSPC]~~ |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support.  We agree with “per band”. |
| LG | We prefer to remove the prerequisite. The other modifications are fine to us. |
| ZTE | Support in principle, but the pre-requisite “FG 23-6-1” should be removed. |

# Issue 30: FG 23-6-2a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | 23-6-2 or ~~[~~23-6-2~~[~~b~~]]~~ |  |  |  | ~~[~~Per band ~~or per FS or FSPC]~~ |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support.  We agree with “per band”. |
| LG | Support |
| ZTE | Support. |

# Issue 31: FG 23-6-2b

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH ~~[~~only ~~and default QCL assumption with two TCI states for PDSCH] [~~scheduled by ~~[~~single TRP~~/Scheme B]~~ PDCCH~~]~~ | ~~[~~23-6-1~~]~~ |  |  |  | ~~[~~Per band ~~or per FS or per FSPC]~~ |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support.  We agree with “per band”. |
| LG | We prefer to remove the prerequisite. The other modifications are fine to us. |
| ZTE | Revise component 1 as the follow, because both of combination schemes of “SFN scheme B PDCCH + SFN scheme B PDSCH” and “STRP PDCCH + SFN scheme B PDSCH” was supported. Although FG 23-6-2 captures the combination “SFN scheme B PDCCH + SFN scheme B PDSCH”, it is better to explicitly point out this combination here due to this FG aims to specify SFN scheme B PDSCH.  1. Support of SFN scheme B for PDSCH ~~[and default QCL assumption with two TCI states for PDSCH] [~~scheduled by ~~[~~single TRP/Scheme B~~]~~ PDCCH~~]~~ |

# Issue 32: FG 23-6-3

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| --- | --- |
| Company | Comments/Questions/Suggestions |
|  |  |

# Issue 33: FG 23-6-4

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-6-4 | Default DL beam setup for SFN | 1. Support of PDSCH reception using default beam for Rel-17 enhanced SFN scheme when PDSCH is scheduled with offset less than threshold  2. Support PDSCH reception using default beam for Rel-17 enhanced SFN scheme when TCI field is not present in DCI when PDSCH is scheduled with offset equal or larger than the threshold  3. Support aperiodic CSI-RS reception using default beam for Rel-17 enhanced SFN scheme when scheduling offset is less than threshold | ~~[~~23-6-1, 23-6-2~~]~~ |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Pre-requisite feature should be “23-6-1, or 23-6-2”. It is not necessary for UE supporting FG 23-6-4 to support both of FG 23-6-1 and 23-6-2.  There is missing FG to report default TCI state for “no TCI state field” in FR1, which is already specified. We suggest to add the following change to component 2, and add “FR2 only for component 1 and 3 only”.  2. Support PDSCH reception using default beam for Rel-17 enhanced SFN scheme when TCI field is not present in DCI when PDSCH is scheduled with offset equal or larger than the threshold, if applicable |
| ZTE | Support. |

# Issue 34: FG 23-6-4a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-6-4a | Default UL beam setup for SFN | 1. Support of single-TRP PUCCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  2. Support of single-TRP PUSCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  3. Support of single-TRP SRS resource transmission using default beam when enhanced SFN PDCCH transmission scheme is configured | ~~[~~23-6-1, 23-6-2~~]~~ |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Pre-requisite feature should be “23-6-1, or 23-6-2”. It is not necessary for UE supporting FG 23-6-4 to support both of FG 23-6-1 and 23-6-2. |
| ZTE | Support. |

# Issue 35: FG 23-7-1

This FG is not discussed by email until further progress is made via GTW sessions.

# Issue 36: FG 23-7-1a

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-7-1a | Additional CSI report mode 1 ~~selection~~ | Maximum value of numberOfSingleTRP-CSI-Mode1 | 23-7-1 |  |  |  | Per Band |  |  |  | Component 1 candidate value set: { X=1, X=2} | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Maybe it is better to revise ‘selection’ to ‘configuration’. |
| LG | Support |
| ZTE | Support |
| vivo | Support. |

# Issue 37: FG 23-7-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Remove FG 23-7-2 from the Rel. 17 NR UE features list**

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| ~~23. NR\_FeMIMO~~ | ~~23-7-2~~ | ~~Support of max # of Tx ports [per source/across two CMRs] [in a resource set for Multi-TRP CSI] [and max # resources]~~ | ~~[A list of supported combinations, each combination is {max # of Tx ports per source in a resource set for Multi-TRP CSI, max # resources in a resource set for Multi-TRP CSI}]~~  ~~[Note: same number of ports among CMRs]~~ |  |  |  |  |  |  |  |  | ~~[{4, 8, 12, 16, 24, 32}]~~ | ~~Optional with capability signalling~~ |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support. |
| ZTE | Support |
| vivo | Support. |

# Issue 38: FG 23-7-3

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Remove FG 23-7-3 from the Rel. 17 NR UE features list**

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| ~~23. NR\_FeMIMO~~ | ~~23-7-3~~ | ~~More than two resources in a resource set for Multi-TRP CSI~~ | ~~FFS exact candidate values, K~~~~s,max~~ ~~is up to 8~~ |  |  |  |  |  |  |  |  | ~~[candidate values are {2, 3, 4, 5, 6, 7, 8}]~~ | ~~Optional with capability signalling~~ |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Support |
| ZTE | Support |
| vivo | Don’t support. As N=1 has been included in the basic feature FG 23-7-1 while N=2 has been included in a separate FG 23-7-4, we think the same structure should apply for Ks,max as well. We have following agreement to have Ks=2 as basic feature.  **Agreement**  For CSI measurement associated to a reporting setting CSI-ReportConfig for NCJT, the UE can be configured with Ks ≥ 2 NZP CSI-RS resources in a CSI-RS resource set for CMR and N ≥ 1 NZP CSI-RS resource pairs whereas each pair is used for a NCJT measurement hypothesis   * Configure UE with two CMR groups with Ks=K1+K2 CMRs. CMR pairs are determined from two CMR groups by following method(s).   + K1 and K2 are the number of CMRs in two groups respectively. FFS K1=K2 or different K1/K2.   + Note that CMRs in each CMR group can be used for both NCJT and Single-TRP measurement hypotheses   + N CMR pairs are higher-layer configured by selecting from all possible pairs     - signalling mechanism can be discussed further, e.g. using a bitmap     - FFS: Whether MAC-CE or RRC+MAC CE indication is needed     - FFS: how to support NCJT measurement hypotheses in FR2 * Support N=1 and Ks =2, FFS other maximal values of N>1 and Ks>2 * Note: for CPU/resource/port occupation, NCJT hypothesis is considered separately from single TRP hypothesis   **Agreement**  With regarding to the maximal values of *Nmax* for *N, Ks,max* for *Ks*:   * Support of *Nmax*=2 is a UE optional feature * Support of *Ks,max*=*X* is a UE optional feature   + *X* can be up to 8 and other candidate values can be discussed as part of UE features * FFS: Default value of *Nmax*, *Ks,max*   FFS: Which combinations of *N*<=*Nmax*, *Ks*<=*Ks,max* are supported |
| Nokia, NSB | OK to remove it |

# Issue 39: FG 23-7-4

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 40: FG 23-7-5

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-7-5 | CMR sharing | Support a NZP CSI-RS resource referred by both a CMR pair configured for configured for Rel-17 Multi-TRP CSI enhancement ~~NCJT measurement hypothesis~~ and a single CMR configured for CSI determination ~~Single-TRP measurement hypothesis~~ | 23-7-1 |  |  |  | Per band |  | FR2 only |  | ~~Note: ‘NCJT’ and ‘single-TRP’ are not used in RAN1 specifications and will be aligned with 38.214~~ | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | The update of the wording is not clear enough, in addition, suggest adding ‘in a CSI reporting setting’ in the end. |
| LG | For editorial correction, ‘configured for’ is repeated. |
| ZTE | Support |
| vivo | We prefer the original wording and remove the note: Note: ‘NCJT’ and ‘single-TRP’ are not used in RAN1 specifications and will be aligned with 38.214  Because there are many terminologies in Rel15/16 UE feature lists not used in RAN1 specifications and not aligned with 38.214, such as “Multi-DCI based multi-TRP”, “single-DCI based SDM scheme”, etc. |

# Issue 41: FG 23-8-1

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-8-1 | SRS triggering offset enhancement | 1. ~~[Support of/~~The maximum number of configured available slots offsets for~~]~~ determining aperiodic SRS location based on available slot  ~~[2. Maximum actual slots offset]~~ | 2-52 |  |  |  | Per band |  |  |  | Candidate 1 component values: {1, 2, ~~[3,]~~ 4}  ~~[Candidate 2 component values: FFS]~~ | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| DOCOMO | Support the proposal. |
| LG | OK |
| ZTE | Support the proposed change. |
| vivo | Fine with the revision |

# Issue 42: FG 23-8-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-8-2 | Triggering SRS only in DCI 0\_1/0\_2 | Support of triggering SRS in DCI 0\_1/0\_2 without data and without CSI | 2-52 |  |  |  | ~~[Per UE or~~ per band~~]~~ |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| DOCOMO | Ok with the proposal. |
| ZTE | Ok with the proposed change. |
| vivo | Fine with the revision |

# Issue 43: FG 23-8-3

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. NR\_FeMIMO | 23-8-3 | SRS Antenna switching for >4Rx | 1. Support of SRS antenna switching xTyR with y>4  2. Report the entry number of the first-listed band with UL in the band combination that affects this DL ~~whether the antenna switching impact to downlink receiving in a band~~  3. Report the entry number of the first-listed band with UL in the band combination that switches together with this UL ~~whether the antenna is switched together with UL Tx in another band~~ | 2-55 |  |  |  | Per band ~~[~~per BC~~]~~ |  |  |  | Component 1 candidate values: ~~FFS~~ {t1r1, t1r2, t1r4, t1r6, t1r8, t2r2, t2r4, t2r6, t2r8, t4r4, t4r8}   * 't1r6’ for 1T6R * 't2r6’ for 2T6R * 't1r8’ for 1T8R * 't2r8’ for 2T8R * 't4r8’ for 4T8R * 't1r1-t1r2-t1r4-t1r6’ for 1T=1R/1T2R/1T4R/1T6R * 't1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R * 't1r1-t1r2-t1r4-t1r6-t1r8’ for 1T=1R/1T2R/1T4R/1T6R/1T8R * 't1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6-t1r8-t2r8' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R/1T8R/2T8R * 't1r1-t1r2-t2r2-t1r4-t2r4-t1r6-t2r6t1r8-t2r8-t4r8' for 1T=1R/1T2R/2T=2R/1T4R/2T4R/1T6R/2T6R1T8R/2T8R/4T8R   Component 2 candidate values: ~~FFS~~ {1 to 32}  Component 3 candidate values: ~~FFS~~ {1 to 32}  Note: Component 2 and component 3 is not reported if component 1 is reported as xTyR with x=y.  ~~FFS for component 2&3: impact when UE reports component 1 as xTyR with x=y~~ | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| DOCOMO | We prefer “per BC”, not “per band per BC”, following FG2-55.  For component 1 candidate value, we may not get the intention of the proposal well. Is it correct understanding that 6th to 10th bullets capturing downgrading configurations can be indicated in component 1? If so, we support it. |
| LG | Generally fine. For candidate values of component 1, ‘t4r4’ for 4T=4R is missing for last bullet. |
| ZTE | We are generally OK. |
| vivo | Are candidate values for component 1 those listed in bullet points not those in the bracket { }? |

# Issue 44: FG 23-8-4

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-8-4 | Maximum 2 SP and 1 periodic SRS sets for antenna switching | Support of maximum 2 SP SRS resource sets and maximum 1 periodic SRS resource set for antenna switching | 2-53 |  |  |  | ~~[~~Per FS~~]~~ |  |  |  | Note1:   * Applies for all supported xTyR where y<=8 * For xTyR where y>4, if UE does NOT support this feature, support maximum one SRS resource set for periodic SRS and maximum one SRS resource set for semi-persistent SRS * For xTyR where y<=4, if UE does not support this feature, follow Rel-15 on the number of resource sets for periodic and semi-persistent SRS * The two SP-SRS resource sets are not activated at the same time | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| DOCOMO | Ok with the proposal. |
| ZTE | Ok with the proposed change. |
| vivo | Fine with the revision |

# Issue 45: FG 23-8-5

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 46: FG 23-8-6

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 47: FG 23-8-7

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 48: FG 23-8-8

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 49: FG 23-9-1

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 50: FG 23-9-5

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-9-5 | Active CSI-RS resources and ports for mixed codebook types in any slot | 1. List of codebook combinations   List of {max number of ports per resource, max number of resources, max number of total ports} for each codebook combination | 23-9-1, 16-3a, 16-3b, 16-3a-1, 16-3b-1, 2-36, 2-40, 2-41, 2-43, 23-9-2, 23-9-4 |  |  |  | Per band and per BC |  |  |  | Component 1 candidate values:  Codebook 1 = {Type I SP, Type I MP}  {Codebook 2, Codebook 3} = {{FeType II PS M=1, NULL},{FeType II PS M=2 R=1, NULL}~~[~~, {FeType II PS M=2 R=2, NULL}~~]~~, {Type II, FeType II PS M=1}, {Type II, FeType II PS M=2 R=1} ,{eType II R=1, FeType II PS M=1},{eType II R=1, FeType II PS M=2 R=1}}  ~~FFS: The list of {Codebook 2, Codebook 3} may be refined depending on outcome of discussion for FG 23-9-2 Component 1 and FG 23-9-4 Component 2~~  Component 2 candidate values:  - Maximum 16 triplets for each codebook combination  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}  Note 1：if a UE reports one or more codebook combinations in 23-9-5, then usage of active CSI-RS resources and ports for multiple codebooks in any slot is allowed only within those combinations  Note 2: For coexisting of mixed codebooks in any slot, gNB need to honor 16-8, 23-9-5 and per-codebook capability 2-36/40/41/43, 16-3a/b and 16-3a-1/16-3b-1, and 23-9-1/23-9-2/23-9-4  ~~[Note: If the list of triplets for a codebook combination is empty then the list of triplets is reused from the codebook combination indicated previously]~~ | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | To align with current wording of 23-9-4, the update is “{FeType II PS R=2, NULL}” |
| ZTE | Okay with the proposed change. |

# Issue 51: FG 23-9-2

After review of contributions submitted to RAN1 #108-e in this agenda item, nothing is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 52: FG 23-9-3

After review of contributions submitted to RAN1 #108-e in this agenda item, noting is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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| Company | Comments/Questions/Suggestions |
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# Issue 53: FG 23-9-4

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 23. NR\_FeMIMO | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2 | 23-9-2 |  |  |  | per band and per BC |  |  |  | Component 2 candidate values:  • Maximum 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: ~~[~~{1 to 64}~~]~~  • Max # total ports: ~~[~~{4 to 256}~~]~~ | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | For component 2, there is duplicated ‘to support’ in component 2, which should be removed. We’re fine with the candidate values. |
| ZTE | Ok with the proposed change. |
| vivo | Agree with NTT DCOCOMO. |

# Issue 54: New FG “Extension of aperiodic SRS configuration for 1T4R, 1T2R and 2T4R”

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG**

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| 23. NR\_FeMIMO | 23-8-9 | Extension of aperiodic SRS configuration for 1T4R, 1T2R and 2T4R | Support of 4 aperiodic SRS resource sets for 1T4R and 2 aperiodic resource sets for 1T2R/2T4R. | 2-53 | Yes | N/A | Extension of aperiodic SRS configuration for 1T4R, 1T2R and 2T4R is not supported | Per FS | N/A | Applicable only to FR1 | N/A |  | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | Generally fine, but one question: why is it applicable only to FR1? We think it can be applied to FR2 as well. |
| ZTE | Okay with this new FG. |
| vivo | Fine with this FG |

# Discussion/Approval Items during RAN1 #108-e — Second Checkpoint

Based on the comments/questions/suggestions received by the first checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 3 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Discussion/Approval Items during RAN1 #108-e — Third Checkpoint

Based on the comments/questions/suggestions received by the second checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 4 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #108-e by email. There are no tables for comments.

***[All comments must be directly made on the RAN1 email reflector]***

Companies can continue to update their comments in the previous Sections, however, these are no longer monitored by the moderator. Any such comments will be for archival purposes only and will not influence the outcome of this email discussion. Any objection to any of the proposals in this Section must be voiced directly on the RAN1 email reflector.

**Possible Agreement: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Conclusion

After further discussion on the RAN1 email reflector the following was agreed as part of this email discussion:

# References

1. R1-2200780, Updated RAN1 UE features list for Rel-17 NR after RAN1 #108-e, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2200936, Rel-17 UE features for further NR MIMO enhancements, Huawei/HiSilicon
3. R1-2201120, Discussion on remaining issues of FeMIMO features, vivo
4. R1-2201199, UE features for feMIMO, ZTE
5. R1-2201230, UE features for further enhancements on NR-MIMO, OPPO
6. R1-2201344, On UE features for Rel-17 feMIMO, CATT
7. R1-2201408, On UE features for further enhancements on NR-MIMO, Nokia/Nokia Shanghai Bell
8. R1-2201501, Discussion on Rel.17 FeMIMO UE features, NTT DOCOMO, INC.
9. R1-2201562, Discussion on UE features for FeMIMO, Spreadtrum Communications
10. R1-2201574, Discussion on Rel-17 UE feature for NR FeMIMO, LG Electronics
11. R1-2201723, On UE features for feMIMO, Intel Corporation
12. R1-2201791, Views on Rel-17 FeMIMO UE features, Apple
13. R1-2201882, Discussion on UE features for FeMIMO, CMCC
14. R1-2201952, Discussion on UE features for FeMIMO, Xiaomi
15. R1-2202038, Views on UE features for Rel-17 NR FeMIMO, Samsung
16. R1-2202058, UE Features for further enhancements on NR MIMO, MediaTek Inc.
17. R1-2202092, Discussion on UE features for FeMIMO, Lenovo
18. R1-2202165, Discussion on FeMIMO UE features, Qualcomm Incorporated
19. R1-2202282, Discussion on UE features for FeMIMO, Ericsson