**3GPP TSG RAN WG1 #113 R1-2304940**

**Incheon, Korea, May 22nd – May 26th, 2023**

**Agenda Item: 9.16.1**

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

**Title: Summary of UE features for NR MIMO evolution**

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

# Introduction

This document presents the summary of email discussion [113-R18-UE\_features-02] during RAN1 #113. According to the Chairman’s Notes:

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| [113-R18-UE\_features-02] Email discussion on UE features for MIMO, positioning, NCR, NR-NTN, IoT-NTN, BWP without restriction – Ralf (AT&T)   * To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc |

The following was discussed and/or agreed during RAN1 #113 within the scope of [113-R18-UE\_features-02]. All proposals are based on the latest RAN1 UE features list for Rel-18 in [1].

# Summary of Contributions Submitted to RAN1 #113

The following is the moderator’s summary of contributions submitted to RAN1 #113 in this agenda item.

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| Company | Summary |
| ZTE [2] | **Enhancements on unified TCI framework extension for multi-TRP**   * Regarding AP-CSI-RS in S-DCI based mTRP, we prefer to have separate UE features of ‘per CSI-RS resource set’ or ‘per CSI-RS resource’. Considering that, either way, the legacy TCI configuration for AP-CSI-RS is supported, we think that at least ‘per CSI-RS resource set’ can be assumed as a basic UE feature. * Regarding two default beams for S-DCI based MTRP, we prefer to reuse the following UE capability signalling.  |  |  |  |  | | --- | --- | --- | --- | | 16-2a-6 | Default QCL enhancement for multi-DCI based multi-TRP | Support of default QCL assumption per CORESETPoolIndex | 16-2a and 16-2c | | 16-2b-0 | Two default beams for single-DCI based multi-TRP | Support of default QCL assumption with two TCI states | 16-2c |  * Regarding threshold value, we do not identify a clear reason why we need some further update for legacy signalling, and then, if having different one, we may need to handle different default beam behaviour when collided. Therefore, we prefer to reuse the legacy UE capability signalling of ‘*timeDurationForQCL*’. * Regarding PDSCH-CJT, support of 1 or 2 indicated joint TCI state(s) for PDSCH-CJT corresponds to separate UE capability, but support of 1 indicated joint TCI state should be assumed as a basic feature.   + Then, regarding QCL type (like QCL-Type-A, QCL Type-B or ‘average Delay and delay spread’) for second TCI state, we are open to have separate UE feature for supporting the above three candidates.   **TA enhancement for multi-DCI**   * Regarding cross TRP RACH triggering, we think it should be the basic UE feature rather than UE optional. From UE side, supporting cross TRP RACH triggering will not introduce additional UE complexity over the legacy with respect to the potential enhancement on QCL properties and PL-RS determination. From NW side, since PDCCH ordered RACH triggering depends on network implementation, it is up to gNB to decide whether the transmitted PDCCH order is to trigger RACH procedure towards the same TRP or a different TRP. * Regarding Rx timing difference between two DL reference timings is assumed to be larger than CP length, given that it has already confirmed by RAN4 (R1-2210817) that Multiple Receive Time Difference (MRTD) can be larger than CP (i.e., 33/34.6 µs in FR11 and 8/8.5 µs in FR2), this feature can be UE optional.   **CSI enhancement for high/medium UE velocities and CJT**  Type-II codebook refinement for CJT mTRP   * Regarding subset of linkages, we prefer to have a general UE feature requirement instead of identifying the subset case by case.   + Besides for supported value of NL, the maximum number of selected SD bases across the selected CSI-RS resource(s) can be considered as UE capabilities. * Regarding CJT mode-1, the following can be considered. Then, we support CJT mode-2 as a basic UE feature.   + Basic feature:   + Optional feature: * Regarding the maximum number of 2*NN*1*N*2, we may have an individual UE feature group for indicating the maximum number. Based on that, we do not need to have a separate UE feature group of ‘NTRP’ in such CJT cases. * Finally, we have separate UE feature(s) for supporting TRP dynamic selection (i.e., selection of N out of NTRP CSI-RS resources) or {LN} selection.   Type-II codebook refinement for high/medium velocities   * Regarding UE feature/capability to support only a subset of Parameter Combinations, we think that, for L=6, the same restriction and UE optionality as legacy apply. Then, we do not have any further UE features for indicating any subset as legacy. * Regarding N4>1, we have an individual UE feature of supporting the maximum number of N4 (with candidate value of {1, 2, 4, 8}), and then the feature of N4=1 should be assumed as a basic feature. * Regarding *K* (the number of AP-CSI-RS resources for the CMR), we have an individual UE feature of supporting K=12. * Regarding CQI report, the following can be assumed as two individual UE feature groups   + FG-1: X=1 and the CQI is associated with:     - the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - the last slot of the CSI reporting window (slot *l*+*WCSI*–1) and the *N*4-th**W**2 matrix   + FG-2: X=2 and     - the 1st CQI is associated with the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - the 2nd CQI is associated with the middle slot of the CSI reporting window (slot *l*+*WCSI*/2) and the (*N*4 /2)-th**W**2 matrix * Regarding the start of CSI window is *l*=*n*+**, the maximum number of ** is supported as an individual UE feature and can be supported with candidate values of {0, 1, 2}.   TRS-based TDCP report   * Regarding phase report and value of Y, we prefer to have to separate UE features, i.e., one FG of indicating whether the UE supports phase report, and another FG of indicating the maximum number of Y (with candidate value of [1, 2, 3, 4, 7]).   + As mentioned in the agreement, Y=1 with delay ≤ Dbasic symbols, only wideband quantized normalized amplitude is reported as a basic feature. * Regarding maximum value of supported D, we may have two individual FGs of: FG-1 {4 symbols, 1 slot, 2 slots, 3 slots, 4 slots, 5 slots}; FG-2 additional D value of {6 slots or 10 slots}   + For Dbasic, we prefer to have sufficient budget for guaranteeing the performance, i.e., Dbasic = 2 or 4.   **DMRS enhancement for UL/DL MU-MIMO and 8 Tx UL SU-MIMO**   * Regarding rows for Rel-18 DMRS ports combination in cases of eType1 with *maxLength* = 2, eType2 with *maxLength* = 1 and eType2 with *maxLength* = 2, we think it should be the basic UE feature instead of UE optional. Basically, given that Rel-18 DMRS enhancement aims for larger number of orthogonal DMRS ports for both downlink and uplink MU-MIMO as stated in WID. Consequently, it is proper to discuss whether to introduce MU-MIMO restriction of these rows. In addition, it is worth noting that some rows of Rel-15 DMRS are forbidden in MU-MIMO scenario rather than being treated as UE optional. * Regarding scheduling restriction of PRB number for handling orphan REs by FD-OCC length 4, it is natural to introduce UE optional feather of that as agreed in RAN1 session.   **SRS enhancement targeting TDD CJT and 8 TX operation**   * Regarding the time-domain behavior of comb offset hopping, UE should indicate the supported time-domain behavior of comb offset hopping and use one of the following candidates   + “support only comb offset hopping based on the OFDM symbol index l' of each symbol”   + “support only comb offset hopping based on the OFDM symbol index l' of the first symbol across the R repetitions”   + “support both comb offset hopping based on the OFDM symbol index l' of each symbol and the first symbol across the R repetitions” * Regarding cyclic shift hopping and comb offset hopping,   + If only separate cyclic shift hopping and comb offset hopping are supported in Rel-18, UE should indicate the supported hopping algorithms by one of the following candidates:     - “support only cyclic shift hopping”     - “support only comb offset hopping”     - “support both cyclic shift hopping and comb offset hopping”   + If combined cyclic shift hopping and comb offset hopping is supported in Rel-18, UE should indicate the supported hopping algorithms by one of the following candidates:     - “support only cyclic shift hopping”     - “support only comb offset hopping”     - “support separate cyclic shift hopping and comb offset hopping, NOT support combined cyclic shift hopping and comb offset hopping”     - “support separate and combined cyclic shift hopping and comb offset hopping” * Regarding the maximum number of simultaneous SRS resources when the usage is configured as ‘nonCodebook’, the maximum UE capability should support 8 simultaneous RS resources.   **Enhancements on UL precoding indication for multi-panel transmission**   * Regarding the maximum number of layers of each PUSCH when MDCI based STxMP PUSCH+PUSCH, it is natural to support UE optional feature as it is. Subsequently, we suggest to reuse the following FG 2-14 and FG 2-15 for CB PUSCH and NCB PUSCH, respectively.  |  |  |  |  | | --- | --- | --- | --- | | 2-14 | Codebook based PUSCH MIMO transmission | 1. Supported codebook based PUSCH MIMO with maximal number of supported layers  2. Supported max number of SRS resource per set (SRS set use is configured as for codebook). | 2-13 | | 2-15 | non-codebook based PUSCH transmission | 1. Maximal number of supported layers (non-codebook transmission scheme)  2. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook transmission).  3. Maximum number of simultaneous transmitted SRS resources at one symbol | 2-12 |  * Regarding the entry {0, 2, 3} of DMRS ports in different CDM groups for layer combination {1+2} in single DCI based STxMP SDM PUSCH, it is natural to support UE optional feature as it is. Subsequently, we suggest to refer to the following FG 16-2b-1b as much as possible, which is introduced for single DCI based SDM PDSCH in Rel-16.  |  |  |  |  | | --- | --- | --- | --- | | 16-2b-1b | Single-DCI based SDM scheme – Support of new DMRS port entry | 1. Support of new DMRS port entry {0, 2, 3} | 16-2b-1 |   **SRI/TPMI enhancement for enabling 8 TX UL transmission**   * Regarding UE antenna architecture, we think that the value of supporting “Ng and antenna architecture (i.e., N1, N2 for Ng=1)’ should be supported as in an FG-a.   + For instance, a UE can indicate the support of Ng={1, 2, 8}, and then for Ng=1, the UE support (N1, N2) = (2, 2). * Then, for additional maximum number of ranks, we can have a UE feature group of indicating maximum number of ranks if supporting the above FG-a as its pre-requisition. |
| Vivo [3] | **Unified TCI extension for MTRP**   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | Unified TCI with joint DL/UL TCI update for S-DCI based MTRP | Basic feature:  1. One MAC-CE activated full set of {1st joint TCI state, 2nd joint TCI state} for S-DCI based MTRP  2. TCI state indication for update and activation  a) MAC CE based TCI state indication for full set of active {1st joint TCI state, 2nd joint TCI state}  **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17  Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP  **Agreement**  On unified TCI framework extension for S-DCI based MTRP operation, support the followings:   * For a serving cell configured with joint DL/UL TCI mode, a full-set or any sub-set of {first joint TCI state, second joint TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE) | |  | Unified TCI with joint DL/UL TCI update for S-DCI based MTRP with more than one MAC-CE activated joint TCI state | 1. More than one TCI codepoint with full set or subset of {1st joint TCI state, 2nd joint TCI state} for S-DCI based MTRP  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  **Agreement**  On unified TCI framework extension for S-DCI based MTRP operation, support the followings:   * For a serving cell configured with joint DL/UL TCI mode, a full-set or any sub-set of {first joint TCI state, second joint TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE)   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, in one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL/UL TCI state(s) for one or both of the two TRPs in a CC/BWP or a set of CCs/BWPs in a CC list | |  | Application of TCI state for AP CSI-RS | 1. {‘per CSI-RS resource set’, ‘per CSI-RS resource’}  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, an RRC configuration can be provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTrigger State* for each CSI-RS resource set or for each CSI-RS resource in each aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the CSI-RS resource if the aperiodic CSI-RS resource set for CSI/BM is configured to follow unified TCI state   * Above applies at least if the offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in the aperiodic CSI-RS resource set is equal to or larger than a threshold (if the threshold is needed) * FFS: If the UE is configured for CSI-RS resource set, for an aperiodic CSI-RS resource set configured with two Resource Groups for NCJT CSI and configured to follow unified TCI state, if above RRC configuration is not provided to the aperiodic CSI-RS resource set, the UE shall apply the first indicated joint/DL TCI state to the CSI-RS resource(s) in Group 1 and the second indicated joint/DL TCI state to the CSI-RS resource(s) in Group 2. * ‘per CSI-RS resource set’ or ‘per CSI-RS resource’ is up to UE capability | |  | Joint TCI state application to PDSCH-CJT | 1. Supported number of indicated joint TCI states for PDSCH-CJT, {1-basic, 2-optional}  **Agreement**  On unified TCI framework extension, up to 2 joint TCI states can be indicated by MAC-CE/DCI and applied to CJT-based PDSCH reception (PDSCH-CJT) in a BWP/CC configured with joint DL/UL TCI mode   * Support of 1 or 2 indicated joint TCI states for PDSCH-CJT is up to UE capability * FFS: QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT * Note: On how to inform UE to apply which indicated joint TCI state(s) to target channel(s)/signal(s) in the BWP/CC, it is discussed individually in AI 9.1.1.1 | |  | Unified TCI with joint DL/UL TCI update for M-DCI based MTRP | Basic feature:  1. One MAC-CE activated joint TCI state per CORESETPoolIndex for M-DCI based MTRP  2. TCI state indication for update and activation per CORESETPoolIndex  **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17  Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP | |  | Unified TCI with joint DL/UL TCI update for M-DCI based MTRP with more than one MAC-CE activated joint TCI state | 1. More than one TCI codepoint with a joint TCI state per CORESETPoolIndex for M-DCI based MTRP  a) MAC-CE+DCI-based TCI state indication per CORESETPoolIndex (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication per CORESETPoolIndex (use of DCI formats 1\_1/1\_2 without DL assignment)  **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * The existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one *coresetPoolIndex* value can indicate the joint/DL/UL TCI state(s) specific to the same *coresetPoolIndex* value   + FFS: The UE shall apply the indicated joint/DL/UL TCI state(s) specific to a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the same *coresetPoolIndex* value * A *coresetPoolIndex* value field is included in TCI state activation command (MAC-CE) to indicate that the mapping between the activated TCI state(s) and the TCI codepoint(s) is specific to which *coresetPoolIndex* value   **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * For a serving cell configured with joint DL/UL TCI mode, one joint TCI state can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) | |  | Unified TCI with separate DL/UL TCI update for S-DCI based MTRP | Basic feature:  1. One MAC-CE activated full set of {1st DL TCI state, 1st UL TCI state, 2nd DL TCI state, 2nd UL TCI state} for S-DCI based MTRP  2. TCI state indication for update and activation  a) MAC CE based TCI state indication for full set of active {1st DL TCI state, 1st UL TCI state, 2nd DL TCI state, 2nd UL TCI state}  **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17  Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP  **Agreement**  On unified TCI framework extension for S-DCI based MTRP operation, support the followings:   * For a serving cell configured with separate DL/UL TCI mode, a full-set or any sub-set of {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE) | |  | Unified TCI with separate DL/UL TCI update for S-DCI based MTRP with more than one MAC-CE activated separate TCI state | 1. More than one TCI codepoint with full set or subset of {1st DL TCI state, 1st UL TCI state, 2nd DL TCI state, 2nd UL TCI state} for S-DCI based MTRP  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  **Agreement**  On unified TCI framework extension for S-DCI based MTRP operation, support the followings:   * For a serving cell configured with separate DL/UL TCI mode, a full-set or any sub-set of {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE)   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, in one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL/UL TCI state(s) for one or both of the two TRPs in a CC/BWP or a set of CCs/BWPs in a CC list | |  | Unified TCI with separate DL/UL TCI update for M-DCI based MTRP | Basic feature:  1. One MAC-CE activated full set of {DL TCI state, UL TCI state} per CORESETPoolIndex for M-DCI based MTRP  2. TCI state indication for update and activation per CORESETPoolIndex  **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17  Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP | |  | Unified TCI with separate DL/UL TCI update for M-DCI based MTRP with more than one MAC-CE activated separate TCI state | 1. More than one TCI codepoint with full set or subset of {DL TCI state, UL TCI state} per CORESETPoolIndex for M-DCI based MTRP  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * The existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one *coresetPoolIndex* value can indicate the joint/DL/UL TCI state(s) specific to the same *coresetPoolIndex* value   + FFS: The UE shall apply the indicated joint/DL/UL TCI state(s) specific to a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the same *coresetPoolIndex* value * A *coresetPoolIndex* value field is included in TCI state activation command (MAC-CE) to indicate that the mapping between the activated TCI state(s) and the TCI codepoint(s) is specific to which *coresetPoolIndex* value   **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * For a serving cell configured with separate DL/UL TCI mode, a DL TCI state, an UL TCI state, or a pair of DL and UL TCI states can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) |   **Support of 2TA**   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | 2TAs for UL M-DCI based MTRP operation, intra-cell | **Agreement**  Enhancement on two TAs for UL multi-DCI for multi-TRP operation is supported in Rel-18.  Note 1: whether (1) the network signals two TACs or (2) the network signals one TAC and the UE deriving the second TA can be further studied. | |  | 2TAs for UL M-DCI based MTRP operation, inter-cell | **Agreement**  Support two TA enhancement for both intra-cell and inter-cell multi-DCI multi-TRP scenarios in Rel-18. | |  | CFRA triggered by PDCCH order for intra-cell M-DCI based MTRP | **Agreement**  For multi-DCI based Multi-TRP operation with two TA enhancement, support CFRA triggered by PDCCH order for both intra-cell and inter-cell cases. | |  | CFRA triggered by PDCCH order for inter-cell M-DCI based MTRP |  | |  | PRACH configuration associated with additional PCI | **Agreement**  For multi-DCI based inter-cell Multi-TRP operation with two TA enhancement, support PRACH configuration associated with additional configured PCIs different from the PCI of the serving cell.  FFS: details | |  | PDCCH order sent by one TRP triggers RACH procedure towards either the same TRP or a different TRP | **Agreement**  For multi-DCI based Multi-TRP operation with two TA enhancement, support the case where a PDCCH order sent by one TRP triggers RACH procedure towards either the same TRP or a different TRP at least for inter-cell Multi-DCI. |   **CSI feedback enhancement**  CSI enhancement for high/medium UE velocities  We provide our suggestions on basic and optional features for CSI enhancement for high/medium velocities based on the features agreed till RAN1#112bis-e. All the optional feature requires extra UE capability report. The ones highlighted in green are already captured in existed agreements.   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | Basic: Basic feature of CSI enhancement for high/medium UE velocities. | N4=1  R=1  Rank<=2  Basic parameter combinations  d=CSI-RS periodicity for P CSI-RS or d=m for AP CSI-RS  l = slot (n+δ) where δ ≥ 0  X=1 and the CQI is associated with only one slot | |  | Optional: support of N4>1 | Based on previous RAN1 study and evaluation results, most of the gain for CSI enhancement for high/medium UE velocities comes from CSI prediction. Further time domain compression (N4>1) provides limited gain compared with prediction, while compression causes extra UE complexity. Hence we suggest to make the support of N4>1 optional. | |  | Optional: Support of R=2 | Following legacy principle. | |  | Optional: Support of rank>2 | Following legacy principle. | |  | Optional: Support of L=6 | Following legacy principle | |  | Optional: Support of d=1 for AP CSI-RS if m>1 | If m>1, support of d=1 requires UE to perform extra interpolation to get the channel for each DD unit. Hence we support to make it optional due to its high complexity. | |  | Optional: support of *l* = (*n* – *nCSI,ref* ) for CSI reference slot | **Agreement**  On the CSI reporting and measurement for the Rel-18 Type-II codebook refinement for high/medium velocities, when UE-side prediction is assumed, support UE “predicting” channel/CSI after slot *l* where the location of slot *l* is configured (from multiple candidate values) by gNB via higher-layer signalling   * Candidates of slot *l* location include the legacy CSI reference resource location (*n* – *nCSI,ref* ) and slot (*n*+*δ*) where *δ* ≥ 0 * FFS: Possible value(s) of *δ* and possible value(s) of WCSI   Note: Per legacy behavior, the legacy CSI reference resource, i.e., (*n* – *nCSI,ref* ), is reused for locating the last CSI-RS occasion used for a CSI report  For a UE that supports UE-side prediction, the support of *l* = (*n* – *nCSI,ref* ) is UE optional. | |  | Optional: Support of X=1 and the CQI is associated with two slots. | **Agreement**  For the Rel-18 Type-II codebook refinement for high/medium velocities, regarding the time instance and/or PMI(s) in which a CQI is associated with, given the CSI reporting window *WCSI* (in slots), *as well as* the number of CQIs (=X) in one sub-band and one CSI reporting instance, support only the following:   * Basic feature: X=1 and the CQI is associated with the first/earliest slot of the CSI reporting window and the first/earliest of the *N*4 **W**2 matrices * Optional features:   + X=1 and the CQI is associated with:     - the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - the last slot of the CSI reporting window (slot *l*+*WCSI*–1) and the *N*4-th**W**2 matrix   + X=2 and     - The 1st CQI is associated with the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - The 2nd CQI is associated with the middle slot of the CSI reporting window (slot *l*+*WCSI*/2) and the (*N*4 /2)-th**W**2 matrix     - FFS: Whether/how to include CQI overhead reduction for X=2 | |  | Optional: Support of X=2 for CQI. | **Agreement**  For the Rel-18 Type-II codebook refinement for high/medium velocities, regarding the time instance and/or PMI(s) in which a CQI is associated with, given the CSI reporting window *WCSI* (in slots), *as well as* the number of CQIs (=X) in one sub-band and one CSI reporting instance, support only the following:   * Basic feature: X=1 and the CQI is associated with the first/earliest slot of the CSI reporting window and the first/earliest of the *N*4 **W**2 matrices * Optional features:   + X=1 and the CQI is associated with:     - the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - the last slot of the CSI reporting window (slot *l*+*WCSI*–1) and the *N*4-th**W**2 matrix   + X=2 and     - The 1st CQI is associated with the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - The 2nd CQI is associated with the middle slot of the CSI reporting window (slot *l*+*WCSI*/2) and the (*N*4 /2)-th**W**2 matrix     - FFS: Whether/how to include CQI overhead reduction for X=2 |   CSI enhancement for coherent JT  We provide our suggestions on basic and optional features for CSI enhancement for CJT based on the features agreed till RAN1#112bis-e. All the optional feature requires extra UE capability report. The ones highlighted in green are already captured in existed agreements.   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | Basic: Basic feature of CSI enhancement for CJT | Mode 2  R=1  Rank<=2  Basic parameter combinations  2NN1N2 <= 32  N\_L = 1  Configuring N = N\_TRP  As a component, UE reports the maximum value for Ltot it supports. | |  | Optional: support of Mode 1 | Based on RAN1 evaluation, the gain of mode 1 compared with mode 2 is marginal, and mode 1 causes extra calculation of FD offset. Hence we suggest to make the support of mode 1 optional.  Mode 1 with | |  | Optional: Support of R=2 | Following legacy principle. | |  | Optional: Support of rank>2 | Following legacy principle. | |  | Optional: Support of L=6 for N\_TRP =1 | Following legacy principle | |  | Optional: Support of N\_L>1 | As N\_L >1 requires UE to calculate multiple SD hypothesis and thus multiple SVDs after SD projection, we suggest to make it optional due to its high complexity. | |  | Optional: support of dynamic selection of N<N\_TRP | **Agreement**  On the Type-II codebook refinement for CJT mTRP, the selection of N CSI-RS resources is performed by UE and reported as a part of CSI report where N{1,..., NTRP}   * N is the number of cooperating CSI-RS resources, while NTRP is the maximum number of cooperating CSI-RS resources configured by gNB via higher-layer signaling * The selection of N out of NTRP CSI-RS resources is reported via NTRP-bit bitmap in CSI part 1   + Note: The value of N is inferred from the selection * A restricted configuration (gNB-configured via higher-layer signaling) where N=NTRP is supported   + NTRP-bit bitmap is not reported when the restriction is configured   + FFS: Whether other RRC-configured TRP selection restriction including configuring the value of N is supported * This feature is UE optional   Note: This agreement does not impact the decision on Ln being configured by gNB or selected by UE  Note: per WID and previous agreement, the candidate values for NTRP of are 1, 2, 3, and 4.  Note: only one transmission hypothesis is reported. UE is not mandated to calculate CSI for multiple transmission hypotheses. | |  | Optional: The support of 2NN1N2 >32 | Agreement  On the Type-II codebook refinement for CJT mTRP:   * The maximum value of 2NN1N2 is 128   + The support of 2NN1N2 >32 is UE optional for UEs supporting Rel-18 CJT CSI enhancement * Note: Following the legacy specification on the maximum number of NZP CSI-RS ports per CSI-RS resource, the maximum value of 2N1N2 is 32. | |  | Optional: The support of pv= {1/2, 1/2, 1/2, 1/2} | **Agreement**  On the Type-II codebook refinement for CJT mTRP, for Rel-16-based refinement, support at least the following combinations of {pv,} from where the value of {*pv,*} is gNB-configured via higher-layer (RRC) signaling:   * FFS by RAN1#112: whether other combinations can be supported   FFS (by RAN1#112bis-e): Whether/how the supported combinations of {*M*} for Rel-17-based refinement are derived from the supported combinations of {*pv ,*} for Rel-16-based refinement   |  |  |  | | --- | --- | --- | | **pv for layers 1-4** | **** | **Condition(s)** | | {1/8, 1/8, 1/16, 1/16} | ¼ | -- | | ½ | -- | | {1/4, 1/4, 1/8, 1/8} | ¼ (\*) | -- | | ½ (\*) | -- | | {1/4, 1/4, 1/4, 1/4} | ¾ (\*) | -- | | {1/2, 1/2, 1/2, 1/2} | ½ | - Only applicable when NTRP≤3 and NL=1  - Optional | | |  | Optional: Support of fractional phi\_n for mode 1. | **Agreement**  On the Type-II codebook refinement for CJT mTRP, *for mode-1*, support the use of per-CSI-RS-resource FD basis selection offset (relative to a reference CSI-RS resource) for independent FD basis selection across *N* CSI-RS resources, i.e. (example formulation) where:   * is commonly selected across *N* CSI-RS resources * is the layer-common FD basis selection offset for CSI-RS resource *n* relative to a layer-common reference CSI-RS resource with   + Therefore, (*N* – 1) FD basis selection offset values are reported   + Basic feature:   + Optional feature: * FFS: UCI design details, details on |   TDCP  We provide our suggestions on basic and optional features for CSI enhancement for TDCP based on the features agreed till RAN1#112bis-e. All the optional feature requires extra UE capability report. The ones highlighted in green are already captured in existed agreements.   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | Basic: Basic feature of CSI enhancement for TDCP | Y=1 with delay≤ Dbasic symbols, only wideband quantized normalized amplitude is reported | |  | Optional: Support of delay>Dbasic | **Agreement**  For aiding gNB determination of codebook switching and SRS periodicity with the Rel-18 TRS -based TDCP reporting, support reporting quantized wideband normalized amplitude/phase of the time-domain correlation profile with Y≥1 delay(s) as follows:   * Basic feature: Y=1 with delay≤ Dbasic symbols, only wideband quantized normalized amplitude is reported   + FFS: Candidate values for delay * Optional feature: Y=1 with delay>Dbasic symbols and Y≥1, wideband quantized normalized amplitude and phase for each delay are reported   + For Y>1, the phase can be configured to be absent for all the Y delays   + TBD: Whether the value of Y is configurable or following the delays from the configured TRS resource   + TBD: Candidate value(s) for Y>1 * FFS: Value of Dbasic | |  | Optional: Support of Y>=1 with phases | **Agreement**  For aiding gNB determination of codebook switching and SRS periodicity with the Rel-18 TRS -based TDCP reporting, support reporting quantized wideband normalized amplitude/phase of the time-domain correlation profile with Y≥1 delay(s) as follows:   * Basic feature: Y=1 with delay≤ Dbasic symbols, only wideband quantized normalized amplitude is reported   + FFS: Candidate values for delay * Optional feature: Y=1 with delay>Dbasic symbols and Y≥1, wideband quantized normalized amplitude and phase for each delay are reported   + For Y>1, the phase can be configured to be absent for all the Y delays   + TBD: Whether the value of Y is configurable or following the delays from the configured TRS resource   + TBD: Candidate value(s) for Y>1 * FFS: Value of Dbasic |   **DMRS enhancement**   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | R18 DMRS eType1 for PDSCH/PUSCH | **Agreement**  For enhanced FD-OCC length for DMRS of PDSCH/PUSCH for Rel.18 eType 1 DMRS, support   * Opt.1-2: Length 4 FD-OCC is applied to 4 REs of DMRS within a PRB or across consecutive PRBs within an CDM group | |  | R18 DMRS eType2 for PDSCH/PUSCH | **Agreement**  For enhanced FD-OCC length for DMRS of PDSCH/PUSCH, support the following FD-OCC length:   * For Rel.18 DMRS type 1, down select from the following in RAN1#110bis-e:   + Opt.1-1: Length 6 FD-OCC is applied to 6 REs of DMRS within a PRB within an CDM group.   + Opt.1-2: Length 4 FD-OCC is applied to 4 REs of DMRS within a PRB or across consecutive PRBs within an CDM group * For Rel.18 DMRS type 2:   + Length 4 FD-OCC is applied to 4 REs of DMRS within a PRB within an CDM group | |  | PDSCH scheduling without restriction for DMRS eType1 | **Agreement**  For FD-OCC length 4 in Rel.18 eType 1 DMRS for PDSCH, support the following:   * Introduce UE capability to report whether UE can be scheduled PDSCH without the scheduling restriction for FD-OCC length 4 in Rel.18 eType 1 DMRS.   + If this capability is not supported by the UE, UE expects that gNB shall apply the scheduling restriction for PDSCH for FD-OCC length 4 in Rel.18 eType 1 DMRS. * The scheduling restriction above means satisfying all of the following at least for other than M-TRP PDSCH transmission with FDM 2a or FDM 2b scheme.   + 1) The number of consecutively scheduled PRBs for PDSCH is even.   + 2) The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) is even.   + 3) FFS: Restriction on scheduling of different UEs in case of MU-MIMO.   + FFS: Scheduling restriction for M-TRP PDSCH transmission with FDM 2a or FDM 2b scheme. * Note1: Up to UE how to implement DMRS channel estimation. * Note2: No further RAN1 specification enhancement is introduced to handle the orphan REs (e.g. if the total number of REs of DMRS in a CDM group is not multiples of 4, how to handle the remainder of REs) for UE that is scheduled PDSCH without the scheduling restriction. * Note 3: Other scheduling restrictions, if identified in future meetings, are not precluded. |   **SRS enhancement**   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | Cyclic shift hopping for SRS with usage ‘antennaSwitching’ for CJT scenario | **Agreement**  For SRS interference randomization, support:   * Opt. 3: Both cyclic shift hopping and comb offset hopping.   + At least the two features can be separately configured   + FFS: Combined cyclic shift hopping and comb offset hopping for a UE   + FFS: Separate or combined with SRS sequence group hopping / sequence hopping   + FFS: Associated UE capability | |  | Comb offset hopping for SRS with usage ‘antennaSwitching’ for CJT scenario | **Agreement**  For SRS interference randomization, support:   * Opt. 3: Both cyclic shift hopping and comb offset hopping.   + At least the two features can be separately configured   + FFS: Combined cyclic shift hopping and comb offset hopping for a UE   + FFS: Separate or combined with SRS sequence group hopping / sequence hopping   FFS: Associated UE capability | |  | Time-domain hopping granularity for comb offset hopping | **Agreement**  For a SRS resource configured with comb offset hopping, if the repetition factor R > 1, within a slot, the time-domain hopping behavior depends on the OFDM symbol index l' of each symbol or the first symbol across the R repetitions based on RRC configuration, and FFS configuration details.   * UE can indicate whether it supports one or both the options. Details to be discussed in UE feature. | |  | Comb offset hopping with group / sequence hopping | **Agreement**  Whether SRS comb offset hopping can be combined with one of group / sequence hopping on a SRS resource depends on UE feature/capability design.   * FFS: Whether SRS cyclic shift hopping can be combined with one of group / sequence hopping on a SRS resource depends on UE feature/capability design. * FFS: UE feature/capability design details. | |  | The maximum number of simultaneous SRS resources for non-codebook | **Agreement**  For SRS resource set(s) with usage ‘nonCodebook’ support 8 1-port SRS resources in one or multiple OFDM symbols.   * Note: The maximum number of simultaneous SRS resources is determined via UE-capability signalling. | |  | Time domain mapping of 8-port SRS resource with usage ‘codebook’ | **Agreement**  For one single SRS resource in a SRS resource set with usage ‘codebook’ for 8Tx PUSCH, when the SRS resource is configured with n ports (n <= 8) and m OFDM symbols (m >= 1), at least support the n ports mapped onto each of the m OFDM symbols using legacy schemes (repetition, frequency hopping, partial sounding, or a combination thereof).   * n can be 8 * m takes the legacy values, i.e., 1,2,4,8,10,12,14.   **Agreement**  For single SRS resource in a SRS resource set with usage ‘codebook’ for 8Tx PUSCH or ‘antennaSwitching’ (i.e., for 8T8R antenna switching), when the SRS resource is configured with 8 ports and m OFDM symbols (m > 1), support the case of 8 ports mapped onto the m OFDM symbols   * Option 1: Different SRS ports are mapped onto different OFDM symbols (i.e., TDM) * FFS: m can be legacy values, i.e., 2,4,[8,10,12,14]. | |  | Time domain mapping of 8-port SRS resource with usage ‘antennaSwitching’ | **Agreement**  For an 8-port SRS resource in a SRS resource set ‘antennaSwitching’ (i.e., for 8T8R antenna switching), when the SRS resource is configured with m OFDM symbols (m >= 1), at least support the 8 ports mapped onto each of the m OFDM symbols using legacy schemes (repetition, frequency hopping, partial sounding, or a combination thereof).   * m takes the legacy values, i.e., 1,2,4,8,10,12,14.   **Agreement**  For single SRS resource in a SRS resource set with usage ‘codebook’ for 8Tx PUSCH or ‘antennaSwitching’ (i.e., for 8T8R antenna switching), when the SRS resource is configured with 8 ports and m OFDM symbols (m > 1), support the case of 8 ports mapped onto the m OFDM symbols   * Option 1: Different SRS ports are mapped onto different OFDM symbols (i.e., TDM) * FFS: m can be legacy values, i.e., 2,4,[8,10,12,14]. |   **Support of STXMP**   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | |  | S-DCI based SDM PUSCH | **Agreement**  For single-DCI based STxMP PUSCH SDM scheme, support the layer combinations of {1+1, 1+2, 2+1 and 2+2} | |  | Dynamic switching SDM - STRP | **Agreement**  Support dynamic switching between SDM scheme of single-DCI based STxMP PUSCH and sTRP transmission | |  | S-DCI based SFN PUSCH | **Agreement**  Support SFN-based transmission scheme for STxMP PUSCH transmission in single-DCI based mTRP system in Rel-18 | |  | M-DCI based SDM PUSCH | **Agreement**  Support STxMP PUSCH+PUSCH transmission in multi-DCI based system in Rel-18.   * Two independent PUSCHs associated with different TRPs can be transmitted by a UE simultaneously in same active BWP. * The total number of layers of these two PUSCHs is up to 4.   **Agreement**  Multi-DCI based STxMP PUSCH+PUSCH transmission at least supports the following PUSCH combinations:   * DG-PUSCH + DG-PUSCH * CG-PUSCH + DG-PUSCH | |  | S-DCI based SFN PUCCH | **Agreement**  Support the SFN scheme for single-DCI based STxMP PUCCH transmission |   **Support of UL 8TX transmission**   |  |  |  | | --- | --- | --- | | xx | Feature | Detail | | x-x | 8Tx PUSCH  1, full coherent {N1, N2} = {2, 2}, {4, 1}  2, partial coherent, Ng=2  3, partial coherent, Ng=4  4, non-coherent | **Agreement**  8TX PUSCH is supported in Rel-18  **Agreement**  For 8TX PUSCH, at least support   * Ng=1, 2, 4   Note: The above does not restrict the Ng for the non-coherent case | |  | Codebook-based PUSCH MIMO transmission, max layers | **Agreement**  Support up to X layers for codebook and non-codebook UL transmission for 8TX UE where X=4, 8 is determined based on separate UE capability   * For uplink transmission with rank<=4, single CW is supported * For uplink transmission with rank>4, whether single or dual CW is used will be decided in RAN1 meeting #110b-e | |  | Non-codebook based 8Tx PUSCH, max layers | **Agreement**  Support up to X layers for codebook and non-codebook UL transmission for 8TX UE where X=4, 8 is determined based on separate UE capability   * For uplink transmission with rank<=4, single CW is supported * For uplink transmission with rank>4, whether single or dual CW is used will be decided in RAN1 meeting #110b-e | |  | Full power modes | **Agreement**  Framework for full power PUSCH transmission by an 8TX UE   * To support full power transmission with Mode0, Rel-16 Mode0 (fullPower ) is re-used.   + FFS if any change is required in the specifications. * **Working Assumption** To support full power transmission with Mode1, Rel-16 Mode1 (fullPowerMode1) is re-used.   + FFS if more than one of the 8TX full coherent precoders is used ~~per rank~~. * **Working Assumption** To support full power transmission with Mode2, Rel-16 Mode2 (fullPowerMode2) is re-used.   + FFS definition of precoder groups (G0, G1, …)   + FFS enhancements for SRS configuration | |
| Apple [4] | Note that, since RAN1#113 is the first meeting to discuss UE features for Rel-18 NR MIMO evolution and we still have 2 meetings left before RAN1 Rel-18 funtional freeze, UE features in this contribution focus on the high level FG definition and components definition with some placeholder pending further RAN1 discussion. At high level, the FGs are organized in the following way to handle different objectives/agendas in NR Rel-18 MIMO evolution.   * FG40-1x covers the extension of unified TCI framework for multi-TRP. * FG40-2x covers the two TAs for multi-DCI multi-TRP. * FG40-3x covers the CSI enhancement.   + FG40-3-1x covers Type-II codebook refinement for multi-TRP CJT (Coherent Joint Transmission)   + FG40-3-2x covers Type-II codebook refinement exploiting channel time domain properties   + FG40-3-3x covers TDCP (Time Domain Channel Properties) report * FG40-4x covers the increased number of DMRS ports.   + FG40-4-1x covers the increased number of DMRS ports for DL with CP-OFDM   + FG40-4-2x covers the increased number of DMRS ports for UL with CP-OFDM * FG40-5x covers the SRS enhancement   + FG40-5-1x covers the SRS comb offset/cyclic shift hopping   + FG40-5-2x covers the TDM SRS ports   + FG40-5-3x covers the 8 SRS ports * FG40-6x covers the STxMP (Simultaneous Transmission across Multiple Panels) enhancement   + FG40-6-1x covers the single-DCI SDM STxMP PUSCH   + FG40-6-2x covers the single-DCI SFN STxMP PUSCH   + FG40-6-3x covers the multi-DCI STxMP PUSCH   + FG40-6-4x covers the single-DCI SFN STxMP PUCCH * FG40-7x covers 8Tx UL  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1 | Unified TCI with joint DL/UL TCI framework extension for single-DCI intra-cell multi-TRP operation | 1. The maximum number of configured joint TCI state per BWP per CC in a band. 2. Two MAC-CE activated joint TCI-states per CC in a band. 3. MAC-CE based TCI-state indication for two active TCI-states. 4. The maximum number of MAC-CE activated joint TCI-states across all CC(s) in a band. 5. The maximum number of MAC-CE activated joint TCI states per CC in a band |  |  |  |  |  |  |  |  | Component 1 candidate values {8, 12, 16, 24, 32, 48, 64, 128}  Component 4 candidate value {2, 4, 8, 16, 32}  Component 5 candidate value {2, 4, 8, 10, 12, 14, 16} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1a | Unified TCI with joint DL/UL TCI update for multi-DCI intra-cell and inter-cell multi-TRP operation | 1. Support unified TCI with joint DL/UL TCI update for multi-DCI intra-cell and inter-cell multi-TRP operation 2. The maximum number of configured joint TCI state per BWP per CC in a band. 3. One MAC-CE activates one joint TCI-states per CC in a band for a TRP assocaited with a ‘CORESETpoolIndex’ value. 4. The maximum number of MAC-CE activated joint TCI-states across all CC(s) per ‘CORESETpoolIndex’ value. 5. The maximum number of MAC-CE activated joint TCI states per CC in a band per ‘CORESETpoolIndex’ value |  |  |  |  |  |  |  |  | Component 1 candidate values {Intra-cell, intra-cell and inter-cell}  Component 2 candidate values {8, 12, 16, 24, 32, 48, 64, 128}  Component 4 candidate value {1, 2, 4, 8, 16}  Component 5 candidate value {1, 2, 4, 8 } | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-2 | Unified TCI with separate DL/UL TCI framework extension for single-DCI intra-cell multi-TRP operation | 1. The maximum number of configured separate DL TCI state per BWP per CC in a band. 2. The maximum number of configured separate UL TCI state per BWP per CC in a band. 3. Two MAC-CE activated DL TCI-states per CC in a band. 4. Two MAC-CE activated UL TCI-states per CC in a band. 5. MAC-CE based TCI-state indication. 6. The maximum number of MAC-CE activated DL TCI states across all CC(s) in a band 7. The maximum number of MAC-CE activated UL TCI states across all CC(s) in a band 8. The maximum number of MAC-CE activated DL TCI states per CC in a band 9. The maximum number of MAC-CE activated UL TCI states per CC in a band |  |  |  |  |  |  |  |  | Component 1 candidate values {8, 12, 16, 24, 32, 48, 64, 128}  Component 2 candidate values {8, 12, 16, 24, 32, 48, 64, 128}  Component 6 candidate value {2, 4, 8, 16, 32}    Component 7 candidate value {2, 4, 8, 16, 32}  Component 8 candidate value {2, 4, 8, 10, 12, 14, 16}  Component 9 candidate value {2, 4, 8, 10, 12, 14, 16} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-2a | Unified TCI with separate DL/UL TCI update for multi-DCI intra-cell and inter-cell multi-TRP operation | 1. Support unified TCI with separate DL/UL TCI update for multi-DCI intra-cell and inter-cell multi-TRP operation 2. The maximum number of configured separate DL TCI state per BWP per CC in a band. 3. The maximum number of configured separate UL TCI state per BWP per CC in a band. 4. One MAC-CE activated DL TCI-state per CC in a band for a TRP assocaited with a ‘CORESETpoolIndex’ value. 5. One MAC-CE activated UL TCI-state per CC in a band for a TRP assocaited with a ‘CORESETpoolIndex’ value. 6. The maximum number of MAC-CE activated DL TCI states across all CC(s) in a band per ‘CORESETpoolIndex’ value 7. The maximum number of MAC-CE activated UL TCI states across all CC(s) in a band per ‘CORESETpoolIndex’ value 8. The maximum number of MAC-CE activated DL TCI states per CC in a band per ‘CORESETpoolIndex’ value 9. The maximum number of MAC-CE activated UL TCI states per CC in a band per ‘CORESETpoolIndex’ value |  |  |  |  |  |  |  |  | Component 1 candidate values {Intra-cell, intra-cell and inter-cell}  Component 2 candidate values {8, 12, 16, 24, 32, 48, 64, 128}  Component 3 candidate values {8, 12, 16, 24, 32, 48, 64, 128}  Component 6 candidate value {1, 2, 4, 8, 16}    Component 7 candidate value {1, 2, 4, 8, 16}  Component 8 candidate value {1, 2, 4, 8}  Component 9 candidate value {1, 2, 4, 8} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-3 | Unfied TCI update for CJT (Coherent Joint Transmission) PDSCH transmission scheme. | 1. Support of unified TCI with joint TCI update for CJT (Coherent Joint Transmission) PDSCH transmission scheme 2. Maximum number of DL TCI states that can be indicated by MAC-CE/DCI and applied to CJT PDSCH reception in a BWP/CC configured with joint DL/UL TCI mode. |  |  |  |  |  |  |  |  | Component 1 candidate value: {Joint UL/DL, Separate UL/DL, both}  Component 2 candidate value: {1, 2 } | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-4 | Common multi-CC joint UL/DL TCI state ID update and activation for multi-TRP operation | 1. Common multi-CC TCI state ID update and activation with joint TCI upate. 2. The multi-TRP mode for CCs in a common list. 3. Maximum number of configured CC lists per cell group for common multi-CC TCI state ID activation/update. |  |  |  |  |  |  |  |  | Component 2 candidate value: {single-DCI multi-TRP only, multi-DCI multi-TRP only}  Component 3 candidate value: {1, 2, ,3, 4 } | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-5 | Aperiodic CSI-RS resource QCL configuration with unified TCI framework extension for Single-DCI based Multi-TRP | 1. Supported configuration of mode, on unified TCI framework extension for Single-DCI based Multi-TRP, RRC configuration in CSI-AssociatedReportConfigInfo of CSI-AperiodicTriggerState in each aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the CSI-RS resource if the aperiodic CSI-RS resource set for CSI/BM is configured to follow unified TCI state. |  |  |  |  |  |  |  |  | Component 1 candidate value: {per CSI-RS resource set, per CSI-RS resource, both } | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-6 | Unified TCI framework for Single-DCI Multi-TRP, spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to a PUSCH transmission is different from the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission | 1. For unified TCI framework for Single-DCI Multi-TRP, support of spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to a PUSCH transmission that is different from the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-7 | Unified TCI framework for Single-DCI Multi-TRP, DCI format 1\_1/1\_2 configured without the [TCI selection field] | 1. For unified TCI framework for Single-DCI Multi-TRP, support of DCI format 1\_1/1\_2 configured without the [TCI selection field] |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | | | | | | | | | | | | | | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2 | 2 TA for multi-DCI multi-TRP | 1. Support of 2 TA/TAG within a serving cell for multi-DCI multi-TRP 2. Rx timing difference between the two DL reference timings is no larger than CP length 3. The UL/joint TCI states of UL signals/channels associated to one CORESET Pool Index correspond to one TAG |  |  |  |  |  |  |  |  | Component 1 candidate value: {intra-cell multi-TRP, inter-cell multi-TRP, both} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-1 | Maximum number of n-TimingAdvanceOffset value per serving cell | 1. Maximum number of n-TimingAdvanceOffset value supported per serving cell |  |  |  |  |  |  |  |  | Component 1 candidate value: {1, 2 } | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-2 | Maximum Rx timing difference between the two DL reference timings larger than CP | 1. Support of maximum Rx timing difference between the two DL reference timings larger than CP |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-3 | Activated UL/joint TCI states[of UL signals/channels associated to one coresetPoolIndex correspond to both TAGs | 1. Support of activated UL/joint TCI states[of UL signals/channels associated to one coresetPoolIndex correspond to both TAGs |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-4 | For intra-cell multi-DCI based Multi-TRP operation with two TA, a PDCCH order sent by TRP X triggers RACH procedure towards a different TRP Y | 1. For intra-cell multi-DCI based Multi-TRP operation with two TA, support of a PDCCH order sent by TRP X triggers RACH procedure towards a different TRP Y |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-5 | The maximum number of TAGs all CCs | 1. Maximum number of TAGs that can be supported across all intra-frequency and inter-frequency CCs |  |  |  |  |  |  |  |  | Component 1 candidate value: { 2, 3, 4[, 5, 6, 7, 8]}  Note: the UE only supports the configuration where all UL CCs of the same frequency band are configured with up to 2 Timing Advance Group ID. | Optional with capability signalling | |  | | | | | | | | | | | | | | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a | Rel-16 eType-II regular codebook refinement for multi-TRP CJT (Coherent Joint Transmission) | 1. Support of Rel-16 eType-II regular codebook refinement for multi-TRP CJT with PMI subband R=1. 2. Support of parameter combinations with L=2,4 3. Support of rank 1,2 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 multi-TRP CJT 6. Maximum total number of NZP CSI-RS resource associated with multi-TRP CJT 7. Maximum total number of Tx ports of NZP CSI-RS resources associated with multi-TRP CJT 8. Number of TRP/TRP groups, i.e., NZP CSI-RS resources 9. Supported frequency basis selection mode 10. Maximum number of ports across all TRPs in the same CSI report setting for multi-TRP CJT. 11. Maximum number of lists for spatial basis selection, i.e., NL |  |  |  |  |  |  |  |  | Component 4 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {2,3,4}  Component 5 candidate values: {mode 2, both mode 1 and mode 2}  Component 6 candidate values: {32, 64, 96, 128}  Component 7 candidate values: {1, 2, 4}  Note: Frequency basis selection mode 1 is the common frequency basis selection with frequency basis offset reporting, mode 2 is only the common frequency basis selection. | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-1 | Rel-16 eType-II regular codebook refinement for multi-TRP CJT, R=2 | 1. Support of Rel-16 eType-II regular codebook refinement for multi-TRP CJT with PMI subbands R=2. 2. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 3. Maximum number of Tx ports in one NZP CSI-RS resource associated with multi-TRP CJT 4. Maximum total number of NZP CSI-RS resource associated with multi-TRP CJT 5. Maximum total number of Tx ports of NZP CSI-RS resources associated with multi-TRP CJT 6. Number of TRP/TRP groups, i.e., NZP CSI-RS resources 7. Supported frequency basis selection mode |  |  |  |  |  |  |  |  | Component 2 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {2,3,4}  Component 3 candidate values: {mode 2, both mode 1 and mode 2} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-2 | Rel-16 eType-II regular codebook refinement for multi-TRP CJT, support of parameter combination with L=6 | 1. Support of Rel-16 eType-II regular codebook refinement for multi-TRP CJT with parameter combination with L=6. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-3 | Rel-16 eType-II regular codebook refinement for multi-TRP CJT, rank 3,4 | 1. Support of Rel-16 eType-II regular codebook refinement for multi-TRP CJT with rank 3,4 |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-4 | Active CSI-RS resources and ports in the presence of multi-TRP NCJ eType-II regular | 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 |  |  |  |  |  |  |  |  | FFS | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b | Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT (Coherent Joint Transmission) | 1. Support of Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT with PMI subband R=1. 2. Support of parameter combinations with M=1 3. Support of rank 1,2 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 multi-TRP CJT 6. Maximum total number of NZP CSI-RS resource associated with multi-TRP CJT 7. Maximum total number of Tx ports of NZP CSI-RS resources associated with multi-TRP CJT 8. Number of TRP/TRP groups, i.e., NZP CSI-RS resources 9. Supported frequency basis selection mode 10. Maximum number of ports across all TRPs in the same CSI report setting for multi-TRP CJT. 11. Maximum number of lists for spatial basis selection, i.e., NL |  |  |  |  |  |  |  |  | Component 4 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {1, 2,3,4 … 64}  c) {4, …, 256}  d) {2,3,4}  Component 5 candidate values: {mode 2, both mode 1 and mode 2}  Component 6 candidate values: {32, 64, 96, 128}  Component 7 candidate values: {1, 2, 4} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-1 | Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT, R=2 | 1. Support of Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT with PMI subband R=2. 2. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 3. Maximum number of Tx ports in one NZP CSI-RS resource associated with multi-TRP CJT 4. Maximum total number of NZP CSI-RS resource associated with multi-TRP CJT 5. Maximum total number of Tx ports of NZP CSI-RS resources associated with multi-TRP CJT 6. Number of TRP/TRP groups, i.e., NZP CSI-RS resources 7. Supported frequency basis selection mode |  |  |  |  |  |  |  |  | Component 2 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {2,3,4}  Component 3 candidate values: {mode 2, both mode 1 and mode 2} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-2 | Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT, M=2 and R=1 | 1. Support of Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT with M=2 and PMI subband R=1. 2. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 3. Maximum number of Tx ports in one NZP CSI-RS resource associated with multi-TRP CJT 4. Maximum total number of NZP CSI-RS resource associated with multi-TRP CJT 5. Maximum total number of Tx ports of NZP CSI-RS resources associated with multi-TRP CJT 6. Number of TRP/TRP groups, i.e., NZP CSI-RS resources 7. Supported frequency basis selection mode |  |  |  |  |  |  |  |  | Component 2 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {2,3,4}  Component 3 candidate values: {mode 2, both mode 1 and mode 2} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-3 | Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT, rank 3,4 | 1. Support of Rel-17 FeType-II port selection codebook refinement for multi-TRP CJT with rank 3,4. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-4 | Active CSI-RS resources and ports in the presence of multi-TRP NCJ FeType-II port selection | 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 |  |  |  |  |  |  |  |  | FFS | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1c | Slection of N CSI-RS resource by UE for Type II codebokk refinement for multi-TRP CJT | 1. Support of slection of N CSI-RS resource by UE for Type II codebokk refinement for multi-TRP CJT including Rel-16 eType-II regular codebook and Rel-17 FeType-II portseletion codebook refinement. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1d | [Place Holder]  W2 qualitzation group for Type II codebokk refinement for multi-TRP CJT | 1. Supported W2 qualitzation group for Type II codebokk refinement for multi-TRP CJT including Rel-16 eType-II regular codebook and Rel-17 FeType-II portseletion codebook refinement. |  |  |  |  |  |  |  |  | Component 1 candidate values: {mode 1, mode 1 and mode 2}  Mode 1: One group comprises one polarization across all N CSI-RS resources for each layer  Mode 2: One group comprises one polarization for one CSI-RS resource with a common phase reference across N CSI-RS resources for each layer. | Optional with capability signalling | | NR\_MIMO\_evo\_DL\_UL | 40-3-1e | Fractional frequency basis selection offset for mode 1 frequency baiss selection for multi-TRP CJT | 1. Support of fractional frequency basis selection offset, i.e.,  for mode 1 frequency baiss selection for multi-TRP CJT including Rel-16 eType-II regular codebook and Rel-17 FeType-II portseletion codebook refinement |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | NR\_MIMO\_evo\_DL\_UL | 40-3-1f | Unequal number of spatial basis selection for multi-TRP CJT | 1. Support of unequal number of spatial basis selection for multi-TRP CJT including Rel-16 eType-II regular codebook and Rel-17 FeType-II portseletion codebook refinement |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a | Rel-16 eType-II regular codebook refinement exploiting channel time domain properties | 1. Support of Rel-16 eType-II regular codebook refinement exploiting channel time domain properties with PMI subband R=1. 2. Support of parameter combinations with L=2,4 3. Support of rank 1,2 4. Support X=1 CQI associated with the first/earliest slot of the CSI reporting window and the first PMI prediction 5. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 6. Maximum number of Tx ports in one NZP CSI-RS resource 7. Maximum total number of NZP CSI-RS resource 8. Maximum total number of Tx ports of NZP CSI-RS resources 9. Number of predicted CSI (N4) |  |  |  |  |  |  |  |  | Component 5 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {1, 2, 4, 8} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-1 | Rel-16 eType-II regular codebook refinement exploiting channel time domain properties, R=2 | 1. Support of Rel-16 eType-II regular codebook refinement exploiting channel time domain properties with PMI subbands R=2. 2. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 3. Maximum number of Tx ports in one NZP CSI-RS resource 4. Maximum total number of NZP CSI-RS resource 5. Maximum total number of Tx ports of NZP CSI-RS resources 6. Number of predicted CSI (N4) |  |  |  |  |  |  |  |  | Component 2 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {1, 2, 4} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-2 | Rel-16 eType-II regular codebook refinement exploiting channel time domain properties, support of parameter combination with L=6 | 1. Support of Rel-16 eType-II regular codebook refinement exploiting channel time domain properties with parameter combination with L=6. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-3 | Rel-16 eType-II regular codebook refinement exploiting channel time domain properties, rank 3,4 | 1. Support of Rel-16 eType-II regular codebook refinement exploiting channel time domain properties with rank 3,4 |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-4 | Active CSI-RS resources and ports in the presence of eType-II regular refinement exploiting channel time domain properties | 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 |  |  |  |  |  |  |  |  | FFS | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-5 | CQI prediction mode | 1. Supported additional CQI prediction mode for Rel-16 eType-II regular codebook refinement exploiting channel time domain properties |  |  |  |  |  |  |  |  | Component 1 candidate values: {mode 1, mode 2, both}  Mode 1: X=1 CQI and the CQI is associated with:   * The first/earliest slot of the CSI reporting window and the first/earliest predicted PMI, and * The last slot of the CSI reporting window and the last predict PMI   Mode 2: X=2 CQI and   * The 1st CQI is associated with the first/earliest slot of the CSI reporting window and the first/earliest predicted PMI, and * The 2nd CQI is associated with the middle slot of the CSI reporting window and the predicted PMI in the middle | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2b | Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties | 1. Support of Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties with PMI subband R=1. 2. Support of parameter combinations with M=1 3. Support of rank 1,2 4. Support X=1 CQI associated with the first/earliest slot of the CSI reporting window and the first PMI prediction 5. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 6. Maximum number of Tx ports in one NZP CSI-RS resource 7. Maximum total number of NZP CSI-RS resource 8. Maximum total number of Tx ports of NZP CSI-RS resources |  |  |  |  |  |  |  |  | Component 5 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {1, 2,3,4 … 64}  c) {4, …, 256} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2b-1 | Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties, R=2 | 1. Support of Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties with PMI subbands R=2 2. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 3. Maximum number of Tx ports in one NZP CSI-RS resource 4. Maximum total number of NZP CSI-RS resource 5. Maximum total number of Tx ports of NZP CSI-RS resources |  |  |  |  |  |  |  |  | Component 2 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2b-2 | Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties, M=2 and R=1 | 1. Support of Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties with M=2 and PMI subband R=1. 2. A list of supported combinations, up to 16, across all CCs simultaneously, where each combination is 3. Maximum number of Tx ports in one NZP CSI-RS resource 4. Maximum total number of NZP CSI-RS resource 5. Maximum total number of Tx ports of NZP CSI-RS resources |  |  |  |  |  |  |  |  | Component 2 candidate values:  a) {4, 8, 12, 16, 24, 32}  b) {2,3,4 … 64}  c) {4, …, 256}  d) {2,3,4} | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2b-3 | Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties, rank 3,4 | 1. Support of Rel-17 FeType-II port selection codebook refinement exploiting channel time domain properties with rank 3,4. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2b-4 | Active CSI-RS resources and ports in the presence of FeType-II port selection refinement exploiting channel time domain properties | 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 |  |  |  |  |  |  |  |  | FFS | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2c | CSI reference resource as time domain location for CSI prediction | 1. Support of CSI reference resource as time domain location for CSI prediction including Rel-16 eType-II regular codebook and Rel-17 FeType-II portseletion codebook refinement |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3 | TDCP (Time Domain Channel Properties) report | 1. Support of TDCP (Time Domain Channel Properties) report based on TRS meassuremnt. 2. Maximum number of TRS resource set configured in each CSI report setting. 3. Maximum of D, i.e., time offset for time domain correlation estimate. 4. Maximum number of reported time domain correlation Y 5. TDCP report quantities |  |  |  |  |  |  |  |  | Component 2 candidate values: {1, 2}  Component 3 candidate values: {4 symbols, 1 slot, 2 slots, 3 slots, 4 slots, 5 slots}  Component 4 candidate values: {1, 2, 3, 4, 7 }  Component 5 candidate values: {amplitude, amplitude and phase} | Optional with capability signalling | |  | | | | | | | | | | | | | | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1 | Enhanced DMRS with FD-OCC 4 for PDSCH | 1. Support of enhanced DMRS with FD-OCC 4 for PDSCH |  |  |  |  |  |  |  |  | Component 1 candidate value: {eType 1, eType 2, both} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1a | [Place Holder]  MU-MIMO between Rel.15 DMRS ports and Rel.18 DMRS ports for PDSCH within a CDM group | 1. Support of MU-MIMO between Rel.15 DMRS ports and Rel.18 DMRS ports for PDSCH within a CDM group. |  |  |  |  |  |  |  |  | Depending on whether explicit restriction would be agreed in the spefiicaiton | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1b | [Place Holder]  MU-MIMO with Rel.18 DMRS ports for PDSCH when antenna ports are in more than one CDM group | 1. Support of MU-MIMO between Rel.18 DMRS ports and Rel.15/Rel.18 DMRS ports for PDSCH when antenna ports are in more than one CDM group |  |  |  |  |  |  |  |  | Depending on whether explicit restriction would be agreed in the spefiicaiton | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1c | PDSCH scheduling without restriction for eType I DMRS with FD-OCC 4 | 1. Support of PDSCH scheduling without restriction for eType I DMRS with FD-OCC 4 |  |  |  |  |  |  |  |  | Note: If this feature is not supported. UE expects that gNB shall apply at least the following scheduling restriction for PDSCH for FD-OCC 4 in Rel.18 eType 1 DMRS  1) The number of consecutively scheduled PRBs for PDSCH is even.  2) The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) is even. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-2 | Enhanced DMRS with FD-OCC 4 for PUSCH with CP-OFDM | 1. Support of enhanced DMRS with FD-OCC 4 for PUSCH with CP-OFDM |  |  |  |  |  |  |  |  | Component 1 candidate value: {eType 1, eType 2, both} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-2a | [Place Holder]  4 port UL PTRS | 1. Support of 4 port UL PTRS |  |  |  |  |  |  |  |  |  | Optional with capability signaling | |  | | | | | | | | | | | | | | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1 | SRS comb offset and/or cyclic shift hopping | 1. Support of SRS comb offset and/or cyclic shift hopping |  |  |  |  |  |  |  |  | Component 1 candidate value: {comb offset hopping, cyclic shift hopping, both } | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1a | SRS comb offset hopping pattern with repetition factor R>1 | 1. Support of different SRS comb offset hopping pattern with repetition factor R>1 |  |  |  |  |  |  |  |  | Component 1 candidate value: {pattern 1, pattern 2, both}  Note:  Pattern 1: within a slot, the time-domain hopping behavior depends on the OFDM symbol index l' of each symbol.  Pattern 2: within a slot, the time-domain hopping behavior depends on the first symbol across the R repetitions. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1b | SRS comb offset hopping combined with group / sequence hopping on an SRS resource | 1. Support of SRS comb offset hopping combined with group / sequence hopping on an SRS resource. |  |  |  |  |  |  |  |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1c | [Place Holder]  SRS cyclic shift hopping combined with group / sequence hopping on an SRS resource | 1. Support of SRS cyclic shift hopping combined with group / sequence hopping on an SRS resource. |  |  |  |  |  |  |  |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-2 | TDM SRS ports for 8 port SRS | 1. Support of different SRS ports mapped onto different OFDM symbols for 8 port SRS |  |  |  |  |  |  |  |  | Component 1 candidate value for s: {2, [2 and 4], [2 and 4 and 8]}  Note: 8 ports are equally partitioned into s subsets with each subset having 8/s different ports | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-3 | 8 port SRS | 1. Support of 8 port SRS |  |  |  |  |  |  |  |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-3a | 8T8R SRS antenna switching | 1. Support of 8T8R SRS antenna switching. 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. |  |  |  |  |  |  |  |  | Component 1 candidate values: a combination from the set {t1r1, t2r2, t1r2, t4r4, t2r4, t1r4, t2r6, t1r6, t4r8, t2r8, t1r8}  Note: Compnent 1 indicates the supported xTyR in addition to 8T8R.  Component 2 candidate values: {1 to 32}  Component 3 candidate values: {1 to 32}  Note: component 2 and Component 3 are optional. If reported, the reported values for component 2 and component 3 are not valid for the same values of xTyR in component 1 reported with Rel-15/16/17 UE capability reporting | Optional with capability signaling | |  | | | | | | | | | | | | | | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1a | Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) SDM scheme - codebook based | 1. Support of Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) with SDM for codebook based PUSCH. 2. Support of two SRS resource sets with usage set to 'codebook' 3. Maximum number of SRS resources in each SRS resource set 4. Maximum number of SRS antenna ports for each SRS resource in each SRS resource set 5. Maximum number of layers of each panel for Single-DCI STxMP with SDM 6. Maximuml total number of layers across both panels for Single-DCI STxMP with SDM |  |  |  |  |  |  | FR2 only |  | Component 3 candidate values: {1, 2 ,4}  Component 4 candidate values: {1, 2 [,4]}  Component 5 candidate values: {1, 2}  Component 6 candidate values: {2 ,3, 4}  Note: If value 4 is reported for component 3, UE also reports value 4 in FG 16-5c. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1b | Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) SDM scheme - non-codebook based | 1. Support of Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) with SDM for non-codebook based PUSCH. 2. Support of two SRS resource sets with usage set to 'nonCodebook' 3. Maximum number of SRS resources in each SRS resource set 4. Maximum number of simultaneous transmitted SRS at one symbol 5. Maximum number of layers of each panel for Single-DCI STxMP with SDM 6. Maximuml total number of layers across both panels for Single-DCI STxMP with SDM |  |  |  |  |  |  | FR2 only |  | Component 3 candidate values: {1, 2 ,3, 4}  Component 4 candidate values: {1, 2, 3, 4}  Component 5 candidate values: {1, 2}  Component 6 candidate values: {2 ,3, 4} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1c | Dynamic switching between Single-DCI STxMP SDM scheme and Single-TRP scheme - codebook based | 1. Support of dynamic switching between Single-DCI STxMP SDM scheme and Single-TRP scheme for codebook based PUSCH by DCI formats 0\_1/0\_2 |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1d | Dynamic switching between Single-DCI STxMP SDM scheme and Single-TRP scheme - non-codebook based | 1. Support of dynamic switching between Single-DCI STxMP SDM scheme and Single-TRP scheme for non-codebook based PUSCH by DCI formats 0\_1/0\_2 |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2a | Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) SFN scheme - codebook based | 1. Support of Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) with SFN for codebook based PUSCH. 2. Support of two SRS resource sets with usage set to 'codebook' 3. Maximum number of SRS resources in each SRS resource set 4. Maximum number of SRS antenna ports for each SRS resource in each SRS resource set 5. Maximum number of layers for Single-DCI STxMP with SFN |  |  |  |  |  |  | FR2 only |  | Component 3 candidate values: {1, 2 ,4}  Component 4 candidate values: {1, 2 [,4]}  Component 5 candidate values: {1, 2}  Note: If value 4 is reported for component 3, UE also reports value 4 in FG 16-5c. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2b | Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) SFN scheme - non-codebook based | 1. Support of Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) with SFN for non-codebook based PUSCH. 2. Support of two SRS resource sets with usage set to 'nonCodebook' 3. Maximum number of SRS resources in each SRS resource set 4. Maximum number of simultaneous transmitted SRS at one symbol 5. Maximum number of layers for Single-DCI STxMP with SFN |  |  |  |  |  |  | FR2 only |  | Component 3 candidate values: {1, 2 ,3, 4}  Component 4 candidate values: {1, 2, 3, 4}  Component 5 candidate values: {1, 2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2c | Dynamic switching between Single-DCI STxMP SFN scheme and Single-TRP scheme - codebook based | 1. Support of dynamic switching between Single-DCI STxMP SFN scheme and Single-TRP scheme for codebook based PUSCH by DCI formats 0\_1/0\_2 |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2d | Dynamic switching between Single-DCI STxMP SDM scheme and Single-TRP scheme - non-codebook based | 1. Support of dynamic switching between Single-DCI STxMP SFN scheme and Single-TRP scheme for non-codebook based PUSCH by DCI formats 0\_1/0\_2 |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2e | DMRS ports {0, 2, 3} for Single-DCI STxMP SDM scheme | 1. Support of DMRS ports {0, 2, 3} for Single-DCI STxMP SDM scheme. |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3a | Multi-DCI STxMP (Simultaneous Transmission across Multiple Panel) scheme - codebook based | 1. Support of Multi-DCI STxMP (Simultaneous Transmission across Multiple Panel) for codebook based PUSCH with fully overlapping in both frequency and time. 2. Support of two SRS resource sets with usage set to 'codebook' 3. Maximum number of SRS resources in each SRS resource set 4. Maximum number of SRS antenna ports for each SRS resource in each SRS resource set 5. Maximum number of layers of each overlapping PUSCH 6. Maximuml total number of layers across two overlapping PUSCH |  |  |  |  |  |  | FR2 only |  | Component 1 candidate values: a combination from the set {DG PUSCH, Type I CG PUSCH, Type II CG PUSCH}  Component 3 candidate values: {1, 2 ,4}  Component 4 candidate values: {1, 2 [,4]}  Component 5 candidate values: {1, 2}  Component 6 candidate values: {2 ,3, 4}  Note: If value 4 is reported for component 3, UE also reports value 4 in FG 16-5c. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3b | Multi-DCI STxMP (Simultaneous Transmission across Multiple Panel) scheme - non-codebook based | 1. Support of Multi-DCI STxMP (Simultaneous Transmission across Multiple Panel) for non-codebook based PUSCH with fully overlapping in both frequency and time. 2. Support of two SRS resource sets with usage set to 'nonCodebook' 3. Maximum number of SRS resources in each SRS resource set 4. Maximum number of simultaneous transmitted SRS at one symbol 5. Maximum number of layers of each overlapping PUSCH 6. Maximuml total number of layers across two overlapping PUSCH |  |  |  |  |  |  | FR2 only |  | Component 1 candidate values: a combination from the set {DG PUSCH, Type I CG PUSCH, Type II CG PUSCH}  Component 3 candidate values: {1, 2 ,3, 4}  Component 4 candidate values: {1, 2, 3, 4}  Component 5 candidate values: {1, 2}  Component 6 candidate values: {2 ,3, 4} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3c | Multi-DCI STxMP scheme – fully overlapping in frequency, partially overlapping in time | 1. Support of Multi-DCI STxMP schedule with two PUSCHs fully overlapping in frequency and partially overlapping in time. |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3d | Multi-DCI STxMP scheme – partially or non-overlapping in frequency, partially or fully overlapping in time | 1. Support of Multi-DCI STxMP schedule with two PUSCHs partially or non-overlapping in frequency and partially or fully overlapping in time. |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-4 | Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) SFN scheme for PUCCH | 1. Support of Single-DCI STxMP (Simultaneous Transmission across Multiple Panel) with SFN for PUCCH. |  |  |  |  |  |  | FR2 only |  |  | Optional with capability signaling | |  | | | | | | | | | | | | | | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1 | 8 Tx codebook based PUSCH operation | 1. Maximum number of supported layers for codebook based PUSCH operation with 8 Tx. 2. Maximum number of SRS resources in each SRS resource set with usage set to 'codebook’. 3. Support of 2 codewords if the maximum number of supported layers is larger than 4 |  |  |  |  |  |  |  |  | Component 1 candidate values: {1, 2, [3,] 4, [5, 6, 7,] 8}  Component 2 candidate values: {1, 2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1a | PUSCH codebook coherency subset for 8 Tx | 1. Supported codebook coherency subset type when UE is configured with 8Tx codebook based PUSCH operation. |  |  |  |  |  |  |  |  | Component 1 candidate values: FFS {non-coherent, non-coherent and partial coherent Ng=4, non-coherent and partial coherent Ng=2 or Ng=4, non-coherent and partial coherent Ng=2 or Ng=4 and full-coherent N1=4, N2=1, non-coherent and partial coherent Ng=2 or Ng=4 and full-coherent N1=2, N2=2}  Note: for 8 Tx codebook based PUSCH operation, there are total 5 different coherency modes  (1) non-coherent  (2) partial-coherent Ng=4, i.e., 4 coherent port groups with 2 ports each group, while non-coherent between different port groups  (3) partial-coherent Ng=2, i.e., 2 coherent port groups with 4 ports each group, while non-coherent between different port groups  (4) full-coherent N1=4, N2=1, N1 and N2 is the number of antenna elements in vertical and horizontal direction, respectively. Each antenna element contains both V-Pol and H-Pol.  (5) full-coherent N1=2, N2=2.  Note: For codebook based PUSCH operation, the number of Tx is the maximum number of SRS ports of SRS resource(s) configured in the SRS resource set with usage set to “codebook”. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1a-1 | PUSCH codebook coherency subset for 8 Tx when UE is configured with 2 Tx codebook based PUSCH operation | 1. Supported codebook coherency subset type when UE is configured with 2 Tx codebook based PUSCH operation while UE supports 8 Tx. |  |  |  |  |  |  |  |  | Component 1 candidate values: {non-coherent, non-coherent and full-coherent} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1a-2 | PUSCH codebook coherency subset for 8 Tx when UE is configured with 4 Tx codebook based PUSCH operation | 1. Supported codebook coherency subset type when UE is configured with 4 Tx codebook based PUSCH operation while UE supports 8 Tx. |  |  |  |  |  |  |  |  | Component 1 candidate values: {non-coherent, non-coherent and partial coherent, non-coherent and partial coherent and full-coherent}  FFS: whether to resuse legacy FG2-13 assuming UE reports that UE supports 4Tx in legacy | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1b | UL full power transmission mode of fullpower for 8 Tx | 1. Support of UL full power transmission mode of fullpower when UE is capable of 8 Tx codebook based PUSCH operation |  |  |  |  |  |  |  |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1c | [Place Holder]  UL full power transmission mode of fullpowerMode1 for 8 Tx | 1. Support of UL full power transmission mode of fullpowerMode1 when UE is capable of 8 Tx codebook based PUSCH operation |  |  |  |  |  |  |  |  |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1d | [Place Holder]  UL full power transmission mode of fullpowerMode2 for 8 Tx | 1. Maximum number of SRS resources in one SRS resource set with usage set to 'codebook' for 8Tx codebook based PUSCH for Mode 2 |  |  |  |  |  |  |  |  | Component 1 candidate values: {1, 2, 4, 8} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1e | [Place Holder]  UL full power transmission mode of fullpowerMode2 for 8 Tx - SRS resource | 1. The supported SRS configurations with different number of antenna ports per SRS resource for full power Mode 2 when UE is capable of and configured with 8 Tx codebook based PUSCH operation |  |  |  |  |  |  |  |  | Component (1) candidate values: {1\_8, 1\_2\_8, 1\_4\_8, 1\_2\_4\_8}  1st state (1\_8): each SRS resource can be configured with 1 port or 8 ports  2nd state (1\_2\_8): each SRS resource can be configured with 1 port or 2 ports or 8 ports  3rd state (1\_4\_8): each SRS resource can be configured with 1 port or 4 ports or 8 ports  4th state (1\_2\_4\_8): each SRS resource can be configured with 1 port or 2 port or 4 ports or 8 ports | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1f | [Place Holder]  UL full power transmission mode of fullpowerMode2 for 8 Tx - full power TPMP groups | 1. TPMI group(s) which delivers full power when UE is capable of and configured with 8 Tx codebook based PUSCH operation |  |  |  |  |  |  |  |  | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1g | UL full power transmission mode of fullpowerMode2 | FFS How to support downgrade configuration, i.e., UE is configured with 2/4 Tx while UE supports 8Tx  Whether and how to use the legacy FG16-5c, FG16-5c-2, FG16-5c-3 |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-2 | 8 Tx non-codebook based PUSCH operation | 1. Maximum number of supported layers for non-codebook based PUSCH operation with 8 Tx. 2. Maximum number of SRS resources in each SRS resource set with usage set to 'nonCodebook’. 3. Maximum number of simultaneous transmitted SRS at one symbol |  |  |  |  |  |  |  |  | Component 1 candidate values: {1, 2, [3, ]4, [5, 6, 7, ]8}  Component 2 candidate values: {5, 6, 7, 8}  Component 3 candidate values: {1, 2, 3, 4, 5, 6, 7, 8} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-3 | CBG-based re-transmission for UL using CBGTI for 2 CW | 1. Support of CBG-based re-transmission for UL using CBGTI when NW configures a maximum rank larger than 4 for PUSCH operation. |  |  |  |  |  |  |  |  |  | Optional with capability signaling | |
| Qualcomm Incorporated [5] | **Unified TCI framework extension for multi-TRP**  First of all, we have the following general views on the feature dependency   * UE supporting R18 mTRP unifed TCI does not need to support R17 sTRP unified TCI, since R18 mTRP also supports sTRP operation. * R18 sDCI mTRP unified TCI and R18 multi-DCI mTRP unified TCI are two independent features   Based on above principles, at least the following basic FGs are required:   * Support of unified TCI for single DCI mTRP   + Support joint DL/UL TCI for single DCI mTRP     - Support two MAC-CE activated joint TCI states per CC     - Support more than two MAC-CE activated joint TCI states per CC   + Support separate DL/UL TCI for single DCI mTRP     - Support two MAC-CE activated DL and/or UL TCI states per CC     - Support more than two MAC-CE activated DL and/or UL TCI states per CC   + Support per-set or per-resource based TCI association for AP CSI-RS   + Support two default PDSCH/AP CSI-RS beams   + Support [TCI selection field] in DCI format 1\_1 and 1\_2   + Support PDSCH-CJT   + Support common multi-CC TCI state ID update and activation   + Indication/configuration of R18 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, SRS by reusing the Rel-15/16 signaling/configuration design(s) * Support of unified TCI for multi-DCI mTRP   + Support joint DL/UL TCI for multi-DCI mTRP     - Support two MAC-CE activated joint TCI states per CC     - Support more than two MAC-CE activated joint TCI states per CC   + Support separate DL/UL TCI for multi-DCI mTRP     - Support two MAC-CE activated DL and/or UL TCI states per CC     - Support more than two MAC-CE activated DL and/or UL TCI states per CC   + Support two default PDSCH/AP CSI-RS beams   + Support per-TRP BFR with unified TCI framework   + Support common multi-CC TCI state ID update and activation   + Indication/configuration of R18 TCI states for aperiodic CSI-RS, PDCCH, PDSCH, SRS by reusing the Rel-15/16 signaling/configuration design(s)   Based on the discussions above, we propose:  **Proposal 1: R18 mTRP unifed TCI and R17 sTRP unified TCI are two independent features**  **Proposal 2: R18 sDCI mTRP unified TCI and R18 multi-DCI mTRP unified TCI are two independent features**  **Proposal 3: For R18 sDCI mTRP unified TCI, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1 | Unified TCI with joint DL/UL TCI update for single-DCI based multi-TRP with single activated TCI codepoint per CC | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)  2. The maximum number of configured joint TCI states per BWP per CC in a band  3. Maximum of two MAC-CE activated joint TCI states per CC in a band  4. MAC CE based TCI state indication for a single activated TCI codepoint  5. The maximum number of MAC-CE activated joint TCI states across all CC(s) in a band | At least one of 16-2b-1, 16-2b-2, 16-2b-3, 16-2b-4, 16-2b-5, 23-2-1, 23-3-1, 23-3-2, 23-3-3, 23-6-1, 23-6-2, [FGs for STxMP] | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate value {8, 12, 16, 24, 32, 48, 64, 128}  Component 5 candidate value {2, 4, 6, 8, 16}  Note: activated joint TCI state(s) include all PDCCH/PDSCH receptions and PUSCH/PUCCH transmissions | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1a | Unified TCI with joint DL/UL TCI update for single-DCI based multi-TRP with multiple activated TCI codepoints per CC | 1. TCI state indication for update and activation  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  2. The minimum beam application time in Y symbols per SCS  3. The maximum number of MAC-CE activated joint TCI states per CC in a band | 40-1-1 | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate values: {1, 2, 4, 7, 14, 28, 42, 56, 70, 84, 98, 112, 224, 336}, where {84, 98, 112, 224, 336 } only can be indicated in FR2  Component 3 candidate values: {3, 4, 5, 6, 7, 8}  Note: activated joint TCI state(s) include all PDCCH/PDSCH receptions and PUSCH/PUCCH | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-2 | Unified TCI with separate DL/UL TCI update for single-DCI based multi-TRP with single activated TCI codepoint per CC | 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 per CC in a band  5. The maximum number of MAC-CE activated UL TCI states per CC in a band  6. MAC CE based TCI state indication for a single TCI codepoint  7. The maximum number of MAC-CE activated DL TCI states across all CC(s) in a band  8. The maximum number of MAC-CE activated UL TCI states across all CC(s) in a band | 40-1-1 | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate value {4, 8, 12, 16, 24, 32, 48, 64, 128}  Component 3 candidate value {4, 8, 12, 16, 24, 32, 48, 64}  Component 4 candidate value {1, 2}  Component 5 candidate value {1, 2}  Component 7 candidate value {1, 2, 4, 8, 16}  Component 8 candidate value {1, 2, 4, 8, 16}  Note: UE should support candidate value of 2 for at least one of Component 4 and 5 | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-2a | Unified TCI with separate DL/UL TCI update for single-DCI based multi-TRP with multiple activated TCI codepoints per CC | 1. TCI state indication for update and activation  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  2. The minimum beam application time in Y symbols per SCS  3. The maximum number of MAC-CE activated DL TCI states per CC in a band  4. The maximum number of MAC-CE activated UL TCI states per CC in a band | 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate values: {1, 2, 4, 7, 14, 28, 42, 56, 70, 84, 98, 112, 224, 336}, where {84, 98, 112, 224, 336 } only can be indicated in FR2  Component 3 candidate values: {1, 2, 3, 4, 5, 6, 7, 8}  Component 4 candidate values: {1, 2, 3, 4, 5, 6, 7, 8}  Note: activated joint TCI state(s) include all PDCCH/PDSCH receptions and PUSCH/PUCCH  Note: UE should support candidate value of at least 3 for at least one of Component 3 and 4 | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-3 | Two default beams for single-DCI based multi-TRP | Support of default QCL assumption with two TCI states | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | FR2 only |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-4 | Association between joint/DL TCI state and AP CSI-RS based on per CSI-RS resource set for single-DCI based multi-TRP | Support of RRC configuration per CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the CSI-RS resource | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-5 | Association between joint/DL TCI state and AP CSI-RS based on per CSI-RS resource for single-DCI based multi-TRP | Support of RRC configuration per CSI-RS resource to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the CSI-RS resource | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-6 | [TCI selection field] for single DCI based multi-TRP | Support of [TCI selection] field in DCI format 1\_1 and 1\_2 | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-7 | PDSCH-CJT for single DCI based multi-TRP | 1. Support of PDSCH-CJT for single DCI based multi-TRP  2. The maximum number of indicated joint TCI states for PDSCH-CJT per BWP per CC in a band | 40-1-1 | Yes |  |  | Per band | N/A | N/A | FR1 only | Component 2 candidate values: {1, 2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-8 | Common multi-CC TCI state ID update and activation for single-DCI based multi-TRP | Common multi-CC TCI state ID update and activation | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-9 | Indication/configuration of R18 joint/DL TCI states for aperiodic CSI-RS, PDCCH, PDSCH for single-DCI based multi-TRP | Support of indication/configuration of R18 joint/DL TCI states for aperiodic CSI-RS, PDCCH, PDSCH (except for TRS) reusing the Rel-15/16 signaling/configuration design(s) | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-10 | Indication/configuration of R18 joint/UL TCI states for SRS for single-DCI based multi-TRP | Support of indication/configuration of R17 TCI states for SRS (except for periodic/semi-persistent SRS for BM) reusing the Rel-15/16 signaling/configuration design(s) | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |   **Proposal 4: For R18 mDCI mTRP unified TCI, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-13 | Unified TCI with joint DL/UL TCI update for multi-DCI based multi-TRP with single activated TCI codepoint per CORESETPoolIndex per CC | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)  2. The maximum number of configured joint TCI states per BWP per CC in a band  3. Maximum of two MAC-CE activated joint TCI states per CC in a band  4. MAC CE based TCI state indication for a single activated TCI codepoint per CORESETPoolIndex  5. The maximum number of MAC-CE activated joint TCI states across all CC(s) in a band | 16-2a, 23-4, [FGs for STxMP] | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate value {8, 12, 16, 24, 32, 48, 64, 128}  Component 5 candidate value {2, 4, 8, 16}  Note: activated joint TCI state(s) include all PDCCH/PDSCH receptions and PUSCH/PUCCH transmissions | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-13a | Unified TCI with joint DL/UL TCI update for multi-DCI based multi-TRP with multiple activated TCI codepoints per CORESETPoolIndex per CC | 1. TCI state indication for update and activation  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  2. The minimum beam application time in Y symbols per SCS  3. The maximum number of MAC-CE activated joint TCI states per CC in a band | 40-1-13 | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate values: {1, 2, 4, 7, 14, 28, 42, 56, 70, 84, 98, 112, 224, 336}, where {84, 98, 112, 224, 336 } only can be indicated in FR2  Component 3 candidate values: {3, 4, 5, 6, 7, 8}  Note: activated joint TCI state(s) include all PDCCH/PDSCH receptions and PUSCH/PUCCH | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-14 | Unified TCI with separate DL/UL TCI update for multi-DCI based multi-TRP with single activated TCI codepoint per CORESETPoolIndex per CC | 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. Maximum of two MAC-CE activated DL TCI states per CC in a band  5. The maximum number of MAC-CE activated UL TCI states per CC in a band  6. MAC CE based TCI state indication for a single activated TCI codepoint per CORESETPoolIndex  7. The maximum number of MAC-CE activated DL TCI states across all CC(s) in a band  8. The maximum number of MAC-CE activated UL TCI states across all CC(s) in a band | 40-1-13 | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate value {4, 8, 12, 16, 24, 32, 48, 64, 128}  Component 3 candidate value {4, 8, 12, 16, 24, 32, 48, 64}  Component 5 candidate value {1, 2}  Component 7 candidate value {2, 4, 6, 8, 16}  Component 8 candidate value {1, 2, 4, 6, 8, 16} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-14a | Unified TCI with separate DL/UL TCI update for multi-DCI based multi-TRP with multiple activated TCI codepoints per CORESETPoolIndex per CC | 1. TCI state indication for update and activation  a) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment)  b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)  2. The minimum beam application time in Y symbols per SCS  3. The maximum number of MAC-CE activated DL TCI states per CC in a band  4. The maximum number of MAC-CE activated UL TCI states per CC in a band | 40-1-14 | Yes |  |  | Per band | N/A | N/A | N/A | Component 2 candidate values: {1, 2, 4, 7, 14, 28, 42, 56, 70, 84, 98, 112, 224, 336}, where {84, 98, 112, 224, 336 } only can be indicated in FR2  Component 3 candidate values: {2, 3, 4, 5, 6, 7, 8}  Component 4 candidate values: {1, 2, 3, 4, 5, 6, 7, 8}  Note: activated joint TCI state(s) include all PDCCH/PDSCH receptions and PUSCH/PUCCH  Note: UE should support candidate value of at least 3 for at least one of Component 3 and 4 | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-15 | Two default beams for multi-DCI based multi-TRP | Support of default QCL assumption with two TCI states | 40-1-13, 40-1-14 | Yes |  |  | Per band | N/A | N/A | FR2 only |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-16 | Per-TRP BFR with unified TCI framework for multi-DCI based multi-TRP | Support of per-TRP BFR with unified TCI framework | 40-1-13, 40-1-14 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-17 | Common multi-CC TCI state ID update and activation for multi-DCI based multi-TRP | Common multi-CC TCI state ID update and activation | 40-1-13, 40-1-14 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-18 | Indication/configuration of R18 joint/DL TCI states for aperiodic CSI-RS, PDCCH, PDSCH for multi-DCI based multi-TRP | Support of indication/configuration of R18 joint/DL TCI states for aperiodic CSI-RS, PDCCH, PDSCH (except for TRS) reusing the Rel-15/16 signaling/configuration design(s) | 40-1-13, 40-1-14 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-19 | Indication/configuration of R18 joint/UL TCI states for SRS for multi-DCI based multi-TRP | Support of indication/configuration of R17 TCI states for SRS (except for periodic/semi-persistent SRS for BM) reusing the Rel-15/16 signaling/configuration design(s) | 40-1-13, 40-1-14 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |   **Two TAs for multi-DCI**  Based on the existing agreements, at least the following basic FGs are required:   * Support of two TAGs in the same CC for intra-cell multi-DCI based multi-TRP * Support of two TAGs in the same CC for inter-cell multi-DCI based multi-TRP * Support of two TAGs in the same CC for Rel-18 multi-DCI based STxMP PUSCH+PUSCH   Furthermore, it is already agreed that “as an optional UE capability, Rx timing difference between the two DL reference timings can be assumed to be larger than CP length”. Hence, a separate FG is needed for that. Also, the max number of additional PRACH configurations should be a component for inter-cell case.  Based on the discussions above, we propose:  **Proposal 5: For Rel-18 two TAs for multi-DCI, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-1 | Two TAs for multi-DCI based mTRP – intra-cell | Support of two TAGs in a same CC for intra-cel multi-DCI based multi-TRP | 16-2a | Yes | N/A |  | FS | No | No | N/A | Note: Rx timing difference between the two DL reference timings associated with the two TAGs is within a CP | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-2 | Two TAs for multi-DCI based mTRP – inter-cell | 1. Support of two TAGs in a same CC inter-cel multi-DCI based multi-TRP  2. The maximum number of additional PRACH configurations corresponding to different additional PCIs | 23-4 | Yes | N/A |  | FS | No | No | N/A | Note: Rx timing difference between the two DL reference timings associated with the two TAGs is within a CP  Component 2 candidate values: {1,2,…,7} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-3 | Two TAs for multi-DCI based STxMP PUSCH+PUSCH | Support of two TAGs in a same CC for Rel-18 multi-DCI based STxMP PUSCH+PUSCH | FFS | Yes | N/A |  | FS | No | No | N/A | Note: Rx timing difference between the two DL reference timings associated with the two TAGs is within a CP | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-2-4 | Rx timing larger than CP length for multi-DCI based mTRP | Maximum receive timing difference between the DL transmissions from two TRPs can exceed a CP for multi-DCI based mTRP operation | 16-2a | Yes | N/A |  | FSPC | No | No | N/A |  | Optional with capability signaling |   **CSI enhancement**  Based on CSI agreements on Type-II-CJT, we propose:  **Proposal 6: For Rel-18 Type-II-CJT CSI, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a | Regular eType-II-CJT | Basic components:  1. {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support regular eType-II-CJT for R=1  2. Support of parameter combinations satisfying  - N\_TRP = 2, and  - L\_total <= 8, and  - p\_v != {1/8, 1/8, 1/16, 1/16}  3. Support of rank 1,2 | 2-35 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource set: {8,...,128}  - Max # resource sets: {1 to 16}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-1 | Support of PMI sub-bands with R=2 | 1. {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support regular eType-II-CJT for R=1 | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource set: {8,...,128}  - Max # resource sets: {1 to 16}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-2a | Support of parameter combinations other than basic components | Support of parameter combinations satisfying N\_TRP = {3,4} | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-2b | Support of parameter combinations other than basic components | Support of parameter combinations satisfying L\_total > 8 | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-2c | Support of parameter combinations other than basic components | Support of parameter combinations satisfying p\_v != {1/8,1/8, 1/16, 1/16} | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-3 | Support of rank 3,4 | Support of rank 3,4 | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-4 | Support of mode-1 FD-separate CB | Support of mode-2 FD-separate CB | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-4-1 | Support of fractional FD selection index offset | Support of fractional FD selection index offset | 40-3-1a-4 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-5 | Number of CPUs | Counting of number of CPUs for regular eType-II-CJT CSI | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-6 | Active CSI-RS resources and ports in the presence of regular eType-II-CJT CSI | Counting of active CSI-RS resources and ports in the presence of regular eType-II-CJT CSI | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1a-7 | Timeline for regular eType-II-CJT CSI | Timeline for regular eType-II-CJT CSI | 40-3-1a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b | Port selection FeType-II-CJT | Basic components:  1. {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support port selection FeType-II-CJT for M=1 and R=1  2. Support rank 1,2  3. Support of parameter combinations satisfying  - M=1, and  - …(FFS) | 2-35 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource set: {8,...,128}  - Max # resources: {1 to 64}  - Max # resource sets: {1 to 16}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-1 | Support of M=2 and R=1 for port selection FeType-II-CJT | {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support regular eType-II-CJT for M=2 and R=1 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource set: {8,...,128}  - Max # resources: {1 to 64}  - Max # resource sets: {1 to 16}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-2 | Support of M=2 and R=2 for port selection FeType-II-CJT | {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support port selection FeType-II-CJT for M=2 and R=2 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource set: {8,...,128}  - Max # resources: {1 to 64}  - Max # resource sets: {1 to 16}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-3 | Support of rank 3,4 | Support of rank 3,4 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-4 | Number of CPUs | Counting of number of CPUs for port selection FeType-II-CJT CSI | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-5 | Active CSI-RS resources and ports in the presence of port selection FeType-II-CJT CSI | Counting of active CSI-RS resources and ports in the presence of port selection FeType-II-CJT CSI | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-6 | Timeline for port selection FeType-II-CJT CSI | Timeline for port selection FeType-II-CJT CSI | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-x | Active CSI-RS resources and ports for mixed Type-II-CJT 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 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Codebook 1 = {Type I SP, Type I MP}  (Codebook 2, Codebook 3) = {(eType-II-CJT R=1, NULL), (eType-II-CJT R=2, NULL), (FeType-II-CJT PS R=1 M=1, NULL), (FeType-II-CJT PS R=1 M=2, NULL), (FeType-II-CJT PS R=2 M=2, NULL), (FFS CB combos…)} | Optional with capability signaling |   Based on CSI agreements on Type-II-Doppler, we propose:  **Proposal 7: For Rel-18 Type-II-Doppler CSI, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a | Regular eType-II-Doppler | Basic components:  1. {Max # of Tx ports in one resource, Max # of resources, and total # of Tx ports} to support regular eType-II-Doppler for R=1  2. Support of parameter combinations satisfying  - L = {2,4}  3. Support of rank 1,2  4. Supported number of aperiodic CSI-RS occasions K=4 | 2-35 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource: {4,...,64}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-1 | Support of PMI sub-bands with R=2 | 1. {Max # of Tx ports in one resource, Max # of resources, and total # of Tx ports} to support regular eType-II-Doppler for R=1 | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource: {4,...,64}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-2 | Support of parameter combinations other than basic components | Support of parameter combinations satisfying L = 6 | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-3 | Support of rank 3,4 | Support of rank 3,4 | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 41. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-4 | Number of aperiodic CSI-RS occasions K>4 | Supported number of aperiodic CSI-RS occasions K>4 | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for K: {8,12} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-5 | Number of CPUs | Counting of number of CPUs for regular eType-II-Doppler CSI | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-6 | Active CSI-RS resources and ports in the presence of regular eType-II-Doppler CSI | Counting of active CSI-RS resources and ports in the presence of regular eType-II-Doppler CSI | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-7 | Timeline for regular eType-II-Doppler CSI | Timeline for regular eType-II-Doppler CSI | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b | Port selection FeType-II-Doppler | Basic components:  1. {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support Port selection FeType-II-Doppler for M=1 and R=1  2. Support rank 1,2  3. Support of parameter combinations satisfying  - M=1, and  - …(FFS)  4. Support aperiodic CSI-RS with number of occasions K=4, and support periodic CSI-RS  5. Supported N4=1 | 2-35 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource: {4,...,64}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-1 | Support of M=2 and R=1 for port selection FeType-II-Doppler | {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support Port selection FeType-II-Doppler for M=2 and R=1 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource: {4,...,64}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-2 | Support of M=2 and R=2 for port selection FeType-II-Doppler | {Max # of Tx ports in one resource set, Max # of resource sets, and total # of Tx ports} to support Port selection FeType-II-Doppler for M=2 and R=2 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1:  - Maximum 16 triplets  - Max # of Tx ports in one resource: {4,...,64}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-3 | Support of rank 3,4 | Support of rank 3,4 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 41. NR\_MIMO\_evo\_DL\_UL | 40-3-2a-4 | Number of aperiodic CSI-RS occasions K>4 | Supported number of aperiodic CSI-RS occasions K>4 | 40-3-2a | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for K: {8,12} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-5 | Number of CPUs | Counting of number of CPUs for port selection FeType-II-Doppler CSI | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-6 | Active CSI-RS resources and ports in the presence of port selection FeType-II-Doppler CSI | Counting of active CSI-RS resources and ports in the presence of port selection FeType-II-Doppler CSI | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1b-7 | Timeline for port selection FeType-II-Doppler CSI | Timeline for port selection FeType-II-Doppler CSI | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | FFS | Optional with capability signaling | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-x | Active CSI-RS resources and ports for mixed Type-II-Doppler 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 | 40-3-1b | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Codebook 1 = {Type I SP, Type I MP}  (Codebook 2, Codebook 3) = {(eType-II-Doppler R=1, NULL), (eType-II-Doppler R=2, NULL), (FeType-II-Doppler PS R=1 M=1, NULL), (FeType-II-Doppler PS R=1 M=2, NULL), (FeType-II-Doppler PS R=2 M=2, NULL), (FFS CB combos…)} | Optional with capability signaling |   Based on CSI agreements on TDCP, we propose:  **Proposal 8: For Rel-18 TDCP CSI, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3 | TDCP | Basic components:  1. Support of Y=1 delay value for TDCP report 2. Support of delay<=D\_basic symbols (FFS D\_basic=[1] slot)  3. Support of amplitude report | 2-35 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-1 | Number of delay values | Supported number (Y>1) of delay values | 40-3-3 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values: {2,3,4} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-2 | Delay value | Supported delay value (>D\_basic) | 40-3-3 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values: {[2],3,4,5,6,10} slots | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-3 | Phase report | Support of phase report | 40-3-3 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-4 | Aperiodic CSI-RS resource | DCI triggered aperiodic CSI-RS resource /resource set | 40-3-3 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-5 | Number of CSI-RS resources for TDCP | 1. Supported max # of configured CSI-RS resources for TDCP per CC  2. Supported max # of configured CSI-RS resources for TDCP across all CCs  3. Supported max # of CSI-RS resources for simultaneous TDCP measurement across all CCs | 40-3-3 | Yes | N/A |  | Per-band  Per-BC | No | N/A | N/A | Candidate values for component 1: {1,...,Y+1}  Candidate values for component 2: {2,4,8}  Candidate values for component 3 <= value configured for componenet 2 | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-3-x | Resources for TDCP, beam management, pathloss measurement, BFD, RLM and new beam identification | 1. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure simultaneously across all CCs in FR1 for any of TDCP measurement, 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 FR1 for any of TDCP measurement, L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification | 16-1g, 40-3-3 | Yes | N/A |  | Per-band  Per-BC | No | Yes | Yes | FR1-only  Component-1: candidate value set is {2, 4, 8, 12, 16, 32, 64, 128}  Component-2: candidate value set is {2, 4, 8, 12, 16, 32, 40, 48, 64, 72, 80, 96, 128, 256} | Optional with capability signaling |   **Increased number of orthogonal DMRS ports**  For Rel-18 DMRS FGs, the structure of Rel-15 DMRS FGs should be reused as baseline. With this principle, the following proposal is made.  **Proposal 9: For Rel-18 DMRS enhancement, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1 | Downlink DMRS  for scheduling type A | 1. Support 1 symbol FL DMRS without additional symbol(s)  2. Support 1 symbol FL DMRS and 1 additional DMRS symbol  3. Support 1 symbol FL DMRS and 2 additional DMRS symbols for at least one port. |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-2 | Downlink DMRS  for scheduling type B | 1. Support 1 symbol FL DMRS without additional symbol(s)  2. Support 1 symbol FL DMRS and 1 additional DMRS symbol |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-3 | Support 1+2 DMRS (downlink) | 1. Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-4 | Supported 2 symbols front-loaded DMRS(downlink) | 1. Support 2 symbols FL-DMRS |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-5 | Supported 2 symbols front-loaded +2 symbols additional DMRS(downlink) | 1. Support 2-symbol FL DMRS + one additional 2-symbols DMRS |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-6 | Support 1+3 DMRS symbols(downlink) | 1. Support 1 symbol FL DMRS and 3 additional DMRS symbols |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-7 | Support DMRS type (downlink) | 1. Supported DMRS types |  | YES | N/A |  | Per FS | NO | NO | N/A | Candidate values for component 1 = {type 1, type 2, both type 1 and type 2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-8 | Layers to CDM group mapping for 2 CWs PDSCH | 1. For 2CW PDSCH, support map layers of a CW to more than 1 DMRS CDM groups. |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-9 | Even RB restriction for type 1 DMRS | 1. Support type 1 DMRS with or without even RB restriction |  | YES | N/A |  | Per FS | NO | NO | N/A | Candidate values for component 1 = {Type 1 DMRS with even RB restrictions, Type 1 DMRS without even RB restrictions}  Note: Even RB restrictions are the following.  1. The number of consecutively scheduled PRBs for PDSCH is even.  2. The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) is even. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-10 | Even RB restriction for type 2 DMRS | 1. Support type 2 DMRS with or without even RB restriction |  | YES | N/A |  | Per FS | NO | NO | N/A | Candidate values for component 1 = {Type 2 DMRS with even RB restrictions, Type 2 DMRS without even RB restrictions}  1. The number of consecutively scheduled PRBs for PDSCH is even.  2. The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) is even. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-11 | Support Rel-18 DL DMRS with S-DCI based M-TRP | 1. Support Rel-18 DL DMRS with S-DCI based M-TRP PDSCH |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-12 | Support new DMRS port entry {0,2,3} for S-DCI based SDM for M-TRP PDSCH | 1.Support DMRS port entry {0,2,3} for S-DCI based SDM for M-TRP PDSCH | 40-4-11 | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-13 | Support Rel-18 DL DMRS with M-DCI based M-TRP | 1. Support Rel-18 DL DMRS with M-DCI based M-TRP |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-14 | Rank >4 PUSCH for a Rel-18 UE configured with Rel-15 DMRS ports by RRC | 1. Support Rank >4 PUSCH for a Rel-18 UE configured with Rel-15 DMRS ports by RRC |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-15 | New DMRS port entry for SDM scheme for PUSCH | Support of new DMRS port entry {0,2,3} for single-DCI based SDM STxMP PUSCH with Rel-18 DMRS |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-16 | Uplink DMRS for scheduling type A | 1. Support 1 symbol FL DMRS without additional symbol(s) 2. Support 1 symbol FL DMRS and 1 additional DMRS symbols  3. Support 1 symbol FL DMRS and 2 additional DMRS symbols |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-17 | Uplink DMRS  for scheduling type B | 1. Support 1 symbol FL DMRS without additional symbol(s)  2. Support 1 symbol FL DMRS and 1 additional DMRS symbol |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-18 | Support 1+2 DMRS (uplink) | 1. Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-19 | Supported 2 symbols front-loaded DMRS (uplink) | 1. Support 2 symbols FL-DMRS |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-20 | Supported 2 symbols front-loaded +2 symbols additional DMRS (uplink) | 1. Support 2-symbol FL DMRS + one additional 2-symbols DMRS |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-21 | Support 1+3 uplink DMRS symbols(uplink) | 1. Support 1 symbol FL DMRS and 3 additional DMRS symbols |  | YES | N/A |  | Per FS | NO | NO | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-22 | Support DMRS type (uplink) | 1. Supported DMRS types |  | YES | N/A |  | Per FS | NO | NO | N/A | Candidate values for component 1 = {type 1, type 2, both type 1 and type 2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-4-23 | PTRS enhancement for S-TRP based PUSCH with more than 4 layers | 1. Support 1 port PTRS for full coherent PUSCH with more than 4 layers  2. Support 2 port PTRS for partial coherent PUSCH with more than 4 layers  3. Support 2 port PTRS for non coherent PUSCH with more than 4 layers  4. Supported PTRS power boost configurations |  | YES | N/A |  | Per FS | NO | NO | N/A | Candidate values for component 4 = {ptrs-Power configures 00, ptrs-Power configures 01, both ptrs-Power configures 00 and 01} | Optional with capability signaling |   **SRS enhancement targeting TDD CJT and 8 TX operation**  For TDD CJT, based on the existing agreements, at least the following basic FGs are required:   * Support of cyclic shift hopping for SRS * Support of comb offset hopping for SRS   Furthermore, combination of the above schemes with legacy group/sequence hopping should be a dependent FG. For com offset hopping, as agreed during the WI, UE should be able to indicate the support of the granularity of hopping. Component 2 is added for this purpose.  Based on the discussions above, we propose:  **Proposal 10: For Rel-18 SRS targeting TDD CJT, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1 | Cyclic shift hopping for SRS | Support of cyclic shift hopping for SRS |  | Yes | N/A |  | band | No | No | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1a | Combination of cyclic shift hopping and group / sequence hopping | Support of cyclic shift hopping combined with one of group / sequence hopping on a SRS resource | 40-5-1 | Yes | N/A |  | band | No | No | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-2 | Comb offset hopping for SRS | 1. Support of comb offset hopping for SRS  2. Hopping granularily |  | Yes | N/A |  | band | No | No | N/A | Component 2 candidate values: {‘per SRS symbol’,’per R SRS symbols’, ‘both’}  Note: In case of ’per R SRS symbols’, R is the repetitionFactor, and the comb offset is unchaged within the R symbols. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-2a | Combination of comb offset hopping and group / sequence hopping | Support of comb offset hopping combined with one of group / sequence hopping on a SRS resource | 40-5-2 | Yes | N/A |  | band | No | No | N/A |  | Optional with capability signaling |   Given 8Tx is a very high-cost UE feature (i.e., a lot of Tx), it is likely a UE will implement this feature on one CC (or at most a few CCs) in UL CA. Therefore, per FSPC granularity is needed for the SRS sounding for 8 Tx PUSCH.  **Proposal 11: For Rel-18 SRS targeting 8 Tx PUSCH, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-3 | 8-ports SRS without TDM for antenna switch | 1. Support 8-ports SRS without TDM for antenna switch, without SRS repetition and without SRS frequency hopping  2. Support 8-ports SRS without TDM for antenna switch, with SRS repetition and without SRS frequency hopping  3. Support 8-ports SRS without TDM for antenna switch, without SRS repetition and with SRS frequency hopping  4. Support 8-ports SRS without TDM for antenna switch, with SRS repetition and with SRS frequency hopping  5. Supported repetition factor R  6. Supported number of SRS symbols m in one slot |  | Yes | N/A |  | Per FSPC | No | No | N/A | Candidate value for component 5 = a subset of {1, 2, 4, 5, 6, 7, 8, 10, 12, 14}  Candidate value for component 6 = a subset {1, 2, 4, 8, 10, 12, 14} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-4 | 8-ports SRS without TDM for codebook PUSCH | 1. Support 8-ports SRS without TDM for codebook PUSCH, without SRS repetition and without SRS frequency hopping  2. Support 8-ports SRS without TDM for codebook PUSCH, with SRS repetition and without SRS frequency hopping  3. Support 8-ports SRS without TDM for codebook PUSCH, without SRS repetition and with SRS frequency hopping  4. Support 8-ports SRS without TDM for codebook PUSCH, with SRS repetition and with SRS frequency hopping  5. Supported repetition factor R  6. Supported number of SRS symbols m in one slot |  |  | N/A |  | Per FSPC |  |  |  | Candidate value for component 5 = a subset of {1, 2, 4, 5, 6, 7, 8, 10, 12, 14}  Candidate value for component 6 = a subset {1, 2, 4, 8, 10, 12, 14} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-5 | 8-ports SRS with TDM for antenna switch | 1. Support 8-ports SRS with TDM for antenna switch, without SRS repetition and without SRS frequency hopping  2. Support 8-ports SRS with TDM for antenna switch, with SRS repetition and without SRS frequency hopping  3. Support 8-ports SRS with TDM for antenna switch, without SRS repetition and with SRS frequency hopping  4. Support 8-ports SRS with TDM for antenna switch, with SRS repetition and with SRS frequency hopping  5. Supported repetition factor R  6. Support number of SRS symbols m  7. Supported TDM factor s |  | Yes | N/A |  | Per FSPC | No | No | N/A | Candidate value for component 5 = a subset of {1, 2, 4, 5, 6, 7, 8, 10, 12, 14}  Candidate value for component 6 = a subset {1, 2, 4, 8, 10, 12, 14}  Candidate value for component 7 = {2,[4]} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-6 | 8-ports SRS with TDM for codebook PUSCH | 1. Support 8-ports SRS with TDM for codebook PUSCH, without SRS repetition and without SRS frequency hopping  2. Support 8-ports SRS with TDM for codebook PUSCH, with SRS repetition and without SRS frequency hopping  3. Support 8-ports SRS with TDM for codebook PUSCH, without SRS repetition and with SRS frequency hopping  4. Support 8-ports SRS with TDM for codebook PUSCH, with SRS repetition and with SRS frequency hopping  5. Supported repetition factor R  6. Support number of SRS symbols m  7. Supported TDM factor s |  | Yes | N/A |  | Per FSPC | No | No | N/A | Candidate value for component 5 = a subset of {1, 2, 4, 5, 6, 7, 8, 10, 12, 14}  Candidate value for component 6 = a subset {1, 2, 4, 8, 10, 12, 14}  Candidate value for component 7 = {2,[4]} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-5-7 | 8-ports SRS for noncodebook PUSCH | 1. Support 8-ports SRS for noncodebook PUSCH, without SRS repetition and without SRS frequency hopping  2. Support 8-ports SRS for noncodebook PUSCH, with SRS repetition and without SRS frequency hopping  3. Support 8-ports SRS for noncodebook PUSCH, without SRS repetition and with SRS frequency hopping  4. Support 8-ports SRS for noncodebook PUSCH, with SRS repetition and with SRS frequency hopping  5. Supported repetition factor R  6. Supported number of SRS symbols m in one slot  7. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook transmission).  8. Maximum number of simultaneous transmitted SRS resources at one OFDM symbol |  | Yes | N/A |  | Per FSPC | No | No | N/A | Candidate value for component 5 = a subset of {1, 2, 4, 5, 6, 7, 8, 10, 12, 14}  Candidate value for component 6 = a subset {1, 2, 4, 8, 10, 12, 14}  Candidate value for component 7 = {1,2,3,4,5,6,7,8}  Candidate value for component 8 = {1,2,4,8} | Optional with capability signaling |   **Simultaneous multi-panel transmission**  For this Rel-18 enhacement (STxMP), at least the following basic FGs are required:   * Single-DCI based SDM scheme – codebook-based PUSCH * Single-DCI based SDM scheme – non-codebook-based PUSCH * Single-DCI based SFN scheme – codebook-based PUSCH * Single-DCI based SFN scheme – non-codebook-based PUSCH * Single-DCI based SFN scheme for PUCCH * Multi-DCI based PUSCH+PUSCH – codebook-based PUSCH * Multi-DCI based PUSCH+PUSCH – non-codebook-based PUSCH   For each of the basic FGs above, the details including components/type/other dependent FGs should be similar to the related Rel-15 FGs 2-14 / 2-15 / 2-15a / 2-15b as well as the related Rel-17 FGs 23-3-1 / 23-3-1-2 / 23-3-1-2a / 23-3-1-2b / 23-3-2 / 23-3-3. Furthermore, for multi-DCI based STxMP PUSCH, similar structure of Rel-16 FG 16-2a can be considered wrt overlap in time/freq and max number of PUSCHs per slot. Given these, we propose the following:  **Proposal 12: For Rel-18 STxMP, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1 | Single-DCI based SDM STxMP -codebook based PUSCH | 1. Support of single-DCI based SDM STxMP for codebook-based PUSCH  2. Support of two SRS resource sets with usage set to 'codebook'  3. Supported number of SRS resources in one SRS resource set  4. Supported number of layers associated with one SRS resource set for SDM scheme  5. Assumption on PUSCH ports | 2-14 | Yes | N/A |  | Per FSPC | No | No | N/A | Component 3 candidate values: {1,2,4}  Note: If value 4 is reported for component 3, UE also reports value 4 in FG 16-5c.  Component 4 candidate values: {1,2}  Component 5 candidate values: {‘separate’, ‘shared’, ‘both’}  Note: ‘separate’ means the max number of PUSCH ports for SDM scheme is twice the max number of PUSCH ports for sTRP. ‘shared’ means the max number of PUSCH ports for SDM scheme is the same as the max number of PUSCH ports for sTRP. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2 | Single-DCI based SDM STxMP -non-codebook based PUSCH | 1. Support of single-DCI based SDM STxMP for non-codebook-based PUSCH  2. Support of two SRS resource sets with usage set to 'nonCodebook'  3. Supported number of SRS resources in one SRS resource set  4. Supported number of layers associated with one SRS resource set for SDM scheme | 2-15 | Yes | N/A |  | Per FSPC | No | No | N/A | Component 3 candidate values: {1,2,4}  Component 4 candidate values: {1,2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2a | Associated CSI-RS resources for SDM scheme | 1. Support of up to two NZP CSI-RS resources associated with the two SRS resource sets for non-codebook-based SDM scheme  2. Maximum number of periodic SRS resources associated with first and second CSI-RS per BWP  3. Maximum number of aperiodic SRS resources associated with first and second CSI-RS per BWP  4. Maximum number of semi-persistent SRS resources associated with first and second CSI-RS per BWP  5. UE can process Y SRS resources associated with first and second CSI-RS resources simultaneously in a CC. Includes P/SP/A SRS  6. UE can process up to X CSI-RS resources associated with SRS for non-codebook-based transmission simultaneously | 2-15a, 40-6-2 | Yes | N/A |  | Per band | No | No | N/A | Component 2: {1 to 8}  Component 3: {1 to 8}  Component 4: {0 to 8}  Component 5: {1 to 16}  Component 6: {1,2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3 | New DMRS port entry for SDM scheme | Support of new DMRS port entry {0,2,3} for single-DCI based SDM STxMP PUSCH | 40-6-1 or 40-6-2 | Yes | N/A |  | Per band | No | No | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-4 | 2 PTRS ports for SDM scheme | Support of 2 PTRS ports for single-DCI based SDM STxMP PUSCH | 40-6-1 or 40-6-2 | Yes | N/A |  | Per band | No | No | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-5 | Single-DCI based SFN STxMP -codebook based PUSCH | 1. Support of single-DCI based SFN STxMP for codebook-based PUSCH  2. Support of two SRS resource sets with usage set to 'codebook'  3. Supported number of SRS resources in one SRS resource set  4. Supported number of layers for SFN scheme  5. Assumption on PUSCH ports | 2-14 | Yes | N/A |  | Per FSPC | No | No | N/A | Component 3 candidate values: {1,2,4}  Note: If value 4 is reported for component 3, UE also reports value 4 in FG 16-5c.  Component 4 candidate values: {1,2,4}  Component 5 candidate values: {‘separate’, ‘shared’, ‘both’}  Note: ‘separate’ means the max number of PUSCH ports for SFN scheme is twice the max number of PUSCH ports for sTRP. ‘shared’ means the max number of PUSCH ports for SFN scheme is the same as the max number of PUSCH ports for sTRP. | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-6 | Single-DCI based SFN STxMP -non-codebook based PUSCH | 1. Support of single-DCI based SFN STxMP for non-codebook-based PUSCH  2. Support of two SRS resource sets with usage set to 'nonCodebook'  3. Supported number of SRS resources in one SRS resource set  4. Supported number of layers for SFN scheme | 2-15 | Yes | N/A |  | Per FSPC | No | No | N/A | Component 3 candidate values: {1,2,4}  Component 4 candidate values: {1,2,4} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-6a | Associated CSI-RS resources for SFN scheme | 1. Support of up to two NZP CSI-RS resources associated with the two SRS resource sets for non-codebook-based SFN scheme  2. Maximum number of periodic SRS resources associated with first and second CSI-RS per BWP  3. Maximum number of aperiodic SRS resources associated with first and second CSI-RS per BWP  4. Maximum number of semi-persistent SRS resources associated with first and second CSI-RS per BWP  5. UE can process Y SRS resources associated with first and second CSI-RS resources simultaneously in a CC. Includes P/SP/A SRS  6. UE can process up to X CSI-RS resources associated with SRS for non-codebook-based transmission simultaneously | 2-15a, 40-6-6 | Yes | N/A |  | Per band | No | No | N/A | Component 2: {1 to 8}  Component 3: {1 to 8}  Component 4: {0 to 8}  Component 5: {1 to 16}  Component 6: {1,2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-7 | Single-DCI based SFN scheme for PUCCH | 1. Support of Single-DCI based SFN STxMP scheme for PUCCH  2. Supported PUCCH formats for this scheme |  | Yes | N/A |  | Per FS | No | No | N/A | Component 2 candidate values: {PF0/2, PF1/3/4, PF0-4} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-8 | Multi-DCI based STxMP - codebook based PUSCH | 1. Support of multi-DCI based STxMP PUSCH+PUSCH for codebook-based PUSCH: Support fully-overlapping PUSCHs in time and non-overlapping in frequency  2. Support of two SRS resource sets with usage set to 'codebook' associated with two coresetPoolInde values  3. Supported number of SRS resources in one SRS resource set  4. Supported number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain  5. Supported number of used PUSCH ports for each PUSCH of PUSCH+PUSCH overlapping in time domain  6. Maximum number of PUSCHs per CORESETPoolIndex per slot | 2-14 | Yes | N/A |  | Per FSPC | No | No | N/A | Note: Processing capability 2 is not supported in any CC if at least one CC is configured with two values of CORESETPoolIndex.  Component 3 candidate values: {1,2,4}  Note: If value 4 is reported for component 3, UE also reports value 4 in FG 16-5c.  Component 4 candidate values: {1,2}  Component 5 candidate values: {1,2,4}  Note: If a row of the TPMI consists of all 0’s, the corresponding PUSCH port is not used.  Component 6 candidate values: {1,2,3,4,7}  Note: per SCS, similar with Rel-15 | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-9 | Multi-DCI based STxMP -non-codebook based PUSCH | 1. Support of multi-DCI based STxMP PUSCH+PUSCH for non-codebook-based PUSCH: Support fully overlapping PUSCHs in time and non-overlapping in frequency  2. Support of two SRS resource sets with usage set to 'nonCodebook' associated with two coresetPoolInde values  3. Supported number of SRS resources in one SRS resource set  4. Supported number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain  5. Maximum number of PUSCHs per CORESETPoolIndex per slot | 2-15 | Yes | N/A |  | Per FSPC | No | No | N/A | Note: Processing capability 2 is not supported in any CC if at least one CC is configured with two values of CORESETPoolIndex.  Component 3 candidate values: {1,2,4}  Component 4 candidate values: {1,2}  Component 5 candidate values: {1,2,3,4,7}  Note: per SCS, similar with Rel-15 | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-9a | Associated CSI-RS resources for multi-DCI based STxMP | 1. Support of up to two NZP CSI-RS resources associated with the two SRS resource sets for non-codebook-based multi-DCI based STxMP  2. Maximum number of periodic SRS resources associated with first and second CSI-RS per BWP  3. Maximum number of aperiodic SRS resources associated with first and second CSI-RS per BWP  4. Maximum number of semi-persistent SRS resources associated with first and second CSI-RS per BWP  5. UE can process Y SRS resources associated with first and second CSI-RS resources simultaneously in a CC. Includes P/SP/A SRS  6. UE can process up to X CSI-RS resources associated with SRS for non-codebook-based transmission simultaneously | 2-15a, 40-6-9 | Yes | N/A |  | Per band | No | No | N/A | Component 2: {1 to 8}  Component 3: {1 to 8}  Component 4: {0 to 8}  Component 5: {1 to 16}  Component 6: {1,2} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-10 | Partial-overlapping PUSCHs in time and non-overlapping in frequency | Support partial-overlapping PUSCHs in time and non-overlapping in frequency | 40-6-8 or 40-6-9 | Yes | N/A |  | Per band | No | No | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-11 | Overlapping PUSCHs in time and fully overlapping in frequency and time | Support PUSCHs with fully overlapping REs, i.e. the allocated REs for PUSCH associated with CORESETPoolIndex = 0 and PUSCH associated with CORESETPoolIndex = 1 are exactly the same REs | 40-6-8 or 40-6-9 | Yes | N/A |  | Per band | No | No | N/A |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-6-12 | Overlapping PUSCHs in time and partially overlapping in frequency | Support PUSCHs with partially overlapping REs, i.e. the allocated REs for PUSCH associated with CORESETPoolIndex = 0 and PUSCH associated with CORESETPoolIndex = 1 are partially overlapped, with at least one RE | 40-6-8 or 40-6-9 | Yes | N/A |  | Per band | No | No | N/A |  | Optional with capability signaling |   **SRI/TPMI for 8 TX UL transmission**  Given 8Tx is a very high-cost UE feature (i.e., a lot of Tx), it is likely a UE will implement this feature on one CC (or at most a few CCs) in UL CA. Therefore, per FSPC granularity is needed for 8 Tx PUSCH.  **Proposal 13: For Rel-18 8 TX PUSCH, adopt the following FGs.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1 | Codebook based PUSCH | 1.Supported maximal PUSCH MIMO layers for codebook based PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO | Component 1 candidate values: {1,2,3,4,5,6,7,8} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-2 | Noncodebook based PUSCH | 1.Supported maximal PUSCH MIMO layers for noncodebook based PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO | Component 1 candidate values: {1,2,3,4,5,6,7,8} | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-3 | CBG based 2 CWs PUSCH | 1.Support CBG based transmission for 2 CWs PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-4 | 2 CWs CG-PUSCH type 1 | 1.Support 2 CWs type 1 CG-PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-5 | 2 CWs CG-PUSCH type 2 | 1. Support 2 CWs type 2 CG-PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-6 | Full power mode 0 for 8 Tx PUSCH | 1. Support full power mode 0 for 8 Tx PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-7 | Full power mode 1 for 8 Tx PUSCH | 1. Support full power mode 1 for 8 Tx PUSCH |  | YES | N/A |  | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | 40. NR\_MIMO\_evo\_DL\_UL | 40-7-8 | Full power mode 2 for 8 Tx PUSCH | 1. Support full power mode 2 for 8 Tx PUSCH  FFS how to indicate full power precoders under full power mode 2. |  | YES | N/A |  | Per FSPC | NO | NO | NO |  | Optional with capability signaling | |
| OPPO [6] | **UE feature for multi-TRP enhancement**  UE feature for unified TCI framework extension for multi-TRP  In the achieved progress, the following UE capabilities were discussed and agreed.   * Support of 1 or 2 indicated joint TCI states for PDSCH-CJT is up to UE capability * RRC configuration on aperiodic CSI-RS for CSI/BM to apply the first or second indicated DL/joint TCI state per CSI-RS resource set or per CSI-RS resource is up to UE capability   The UE capabilities to be discussed can be listed as below.   * For S-DCI MTRP based PDCCH, support of none or both of indicated DL/joint TCI state(s) * For S-DCI MTRP based PDSCH, support of both of indicated DL/joint TCI state(s) * For S-DCI MTRP based PUCCH, support of none or both of indicated UL/joint TCI state(s) * For S-DCI MTRP based PUSCH, support of both of indicated UL/joint TCI state(s) * For PDSCH-CJT, the support of PDSCH DMRS QCLed with a) QCL-TypeA b) QCL-TypeB and c) QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} is up to UE capability * Support of a set of CCs configured for common TCI state ID activation/update including CC(s) operating in STRP and CC(s) operating in S-DCI MTRP (if supported) * Support of a set of CCs configured for common TCI state ID activation/update including CC(s) operating in STRP and CC(s) operating in M-DCI MTRP (if supported) * Support of a set of CCs configured for common TCI state ID activation/update including CC(s) operating in M-DCI MTRP and CC(s) operating in S-DCI MTRP (if supported) * Support of a set of CCs configured for common TCI state ID activation/update including CC(s) operating in STRP, CC(s) operating in M-DCI MTRP and CC(s) operating in S-DCI MTRP (if supported) * Support of UE determines two UL Tx power values for PUCCH/PUSCH STxMP based on two UE-configured maximum output power (if per panel or per indicated UL/joint TCI states maximum output power is supported)   ***Proposal 1: The above information can be considered and reported via UE capability (if supported) for Rel-18 unified TCI state extension.***  UE feature for two TAs enhancements  In previous agreement, the following UE capabilities were discussed and agreed.   * For the case of two DL reference timing, support of Rx timing difference between two DL reference timings can be assumed as larger than a CP length is up to UE capability   For intra-cell MTRP and inter-cell MTRP, the following UE capabilities should be discussed for two TA enhancement.   * For both inter-cell and intra-cell MDCI MTRP, support of two TAGs associated with one serving cell * Support of associated TAG to UL/joint TCI state and spatial relation or *CORESETPoolIndex* (if supported) * For inter-cell M-DCI MTRP, support of cross-TRP RACH triggering by PDCCH order * Support of PRACH configuration per *additionalPCI* * Support of overlapped UL transmission in case the UE supports STxMP * Support of reducing the overlapped duration in case the UE does not support STxMP   ***Proposal 2: The above information can be considered and reported via UE capability (if supported) for Rel-18 two TA enhancement.***  **UE feature for CSI enhancement**  It was agreed that a set of *NL* combinations of values for {*L1, ..., LNTRP*} could be gNB-configured via RRC signaling for SD basis selection, and candidate combinations of *{Ln}* were also agreed. Based on the agreed combinations, the total number of *Ln* can be up to 16 for one layer, which is significantly lager than the value with S-TRP. Considering the UE complexity would be increased accordingly, the supported total number of SD basis across all CSI-RS resources should be reported via UE capability, and then gNB can configure a proper combination based on the reporting.  To support CJT CSI, some fundamental features should also be reported by UE, e.g. the supported number of TRP for CJT, the supported number of total antenna ports for CJT, supported number of CSI-RS ports per TRP, supported rank for CJT transmission. Also, whether to support mode 1 or mode 2 for CJT codebook should be separate UE capability, that is, UE can support either one or both of the modes. The support of some additional functionality should also be reported by UE capability, e.g. support UE selection of *N<= NTRP* TRPs, or support selection from *NL>1* combinations for SD basis. For parameter combination, the values of {*pv*} not supported in Rel-17 can also be reported by UE.  ***Proposal 3: The following information can be reported via UE capability for Rel-18 CJT codebook enhancement:***   * ***The supported total number of SD basis Ltot across CSI-RS resources for one layer*** * ***The supported number of TRPs for CJT NTRP*** * ***Supported values of 2NN1N2 >32*** * ***Supported number of CSI-RS ports per TRP*** * ***Supported rank for CJT*** * ***Support of mode 1 and/or mode 2 for CJT*** * ***Support UE selection of N<= NTRP TRPs from NTRP TRPs.*** * ***Supported number of NL>1 for SD basis*** * ***Support of  = 1/8 in addition to the legacy values*** * ***Support of pv = 1/8 for v=1,2 (1/16 for v=3,4) and/or pv=1/2 for v=1,2,3,4 in addition to legacy values***   ***Proposal 4: The following information can be reported via UE capability for Rel-18 medium/high mobility codebook enhancement:***   * ***Support of the values of N4 lager than 1 (e.g. 2,4,8) for Rel-16 etypeII codebook*** * ***Support of the values of K larger than 4 (e.g. 8)*** * ***Supported value of δ>0 (e.g.,1,2)*** * ***Support of  = 1/8 in addition to the legacy values*** * ***Support of pv = 1/8 for v=1,2 (1/16 for v=3,4) and/or pv=1/2 for v=1,2,3,4 in addition to legacy values***   ***Proposal 5: The following information can be reported via UE capability for Rel-18 TDCP enhancement:***   * ***Joint use of P and AP-TRS resource sets if agreed*** * ***Support Y=2, 3, 4***   **UE feature for reference signal enhancement**  UE feature for increased number of orthogonal DMRS ports  Rel-18 DMRS is introduced to support more orthogonal DMRS ports for PUSCH and PDSCH. For PUSCH, at UE side, this feature only impacts the DMRS sequence generation. But for PDSCH reception at UE, the feature not only impacts the DMRS sequence, but also the channel estimation process and interference estimation on DMRS ports. Significant UE complexity would be introduced especially for downlink interference estimation at more DMRS ports not used for target UE. Hence, it is proposed that Rel-18 DMRS enhancements for PDSCH and PUSCH are reported with separate UE capability.  ***Proposal 6: Support separate UE capability for Rel-18 DMRS for PDSCH and Rel-18 DMRS for PUSCH.***  UE feature for SRS enhancements  It was agreed to support both cyclic shifting hopping and comb offset hopping in the past meeting. The details for these two types of hopping were also discussed. Both schemes are beneficial for interference randomization of inter-TRP SRS transmission. However, the benefits of the other scheme would be very small if one scheme has been supported since most interference can already be restricted by the scheme. By now no evaluation result can show the gain of CS hopping in case that comb offset hopping has already been applied or vice versa. Hence, we propose not to introduce combination of the two schemes. Combined scheme would also introduce additional scheduling complexity at gNB to avoid potential collision. Considering different UEs may support different hopping schemes, cyclic shift hopping and comb offset hopping should be reported via separate UE capability.  ***Proposal 7: Support of Cyclic shift hopping and comb offset hopping are reported via separate UE capability.***  ***Proposal 8: The following information can be reported via UE capability for Rel-18 SRS enhancement:***   * ***Support of cyclic shift hopping*** * ***Support of comb offset hopping***   + ***Support of comb offset hopping without group/sequence hopping (basic)***   + ***Support of comb offset hopping with sequence hopping (optional)***   + ***Support of comb offset hopping with group hopping (optional)***   + ***Comb offset hopping within R repetitions or not***   **UE feature for enhanced uplink transmission**  UE feature for UL precoding indication for multi-panel transmission  For single-DCI based STxMP PUSCH transmission, it is agreed that it is optional UE capability to support DMRS table with new entry {0, 2, 3}. Both SDM scheme and SFN scheme are supported, UE can report the supportive of the two schemes. In addition, the maximal number of layers for SDM/SFN scheme can be different from legacy PUSCH transmission, a separate UE capability to report the supported maximal number of layers for SDM/SFN scheme can be discussed.  For single-DCI based STxMP PUCCH transmission, SFN scheme is supported and UE can report to support the scheme via UE capability.  For multi-DCI based STxMP PUSCH transmission, it is agreed that the maximal number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain can be 1 or 2 subjects to UE capability. Besides, fully/partially/non-overlapping in frequency domain and fully/partially overlapping in time domain are supported for multi-DCI based STxMP PUSCH transmission. The overlapping types have impact on the power control, UE capability of overlapping types can be considered.  ***Proposal 9: The following information can be reported via UE capability for Rel-18 STxMP transmission.***   * ***For single-DCI based STxMP PUSCH transmission,***    + ***Support of single-DCI based SDM scheme.***   + ***Support of single-DCI based SFN scheme.***   + ***Support of new DMRS port entry for single-DCI based SDM scheme.***   + ***Supported maximal number of layers for SDM/SFN scheme.*** * ***For single-DCI based STxMP PUCCH transmission,***    + ***Support of single-DCI based SFN scheme for PUCCH.*** * ***For multi-DCI based STxMP PUSCH transmission,***   + ***Support of multi-DCI based STxMP PUSCH transmission.***   + ***Maximal number of transmission layers for STxMP PUSCH overlapping in time domain can be 1 or 2 subjects to UE capability.***   + ***Support of overlapping types, including: fully/partially/non-overlapping in frequency domain and fully/partially overlapping in time domain.***   UE feature for SRI/TPMI enhancement for enabling 8 TX UL transmission  Two antenna architectures, (N1,N2)=(4,1) (2,2) are supported in Rel-18 for 8Tx transmission. UE can report one of the antenna architectures to gNB, and gNB is not expected to configure a different (N1, N2) from the one reported by UE. For a UE supporting partial coherency, the value of *Ng* should also be reported from 2 and 4. UE can also report corresponding coherency codebook subset instead. Furthermore, considering codebook and non-codebook based 8Tx transmission requires different UE complexity, separate UE capabilities are expected. For codebook based transmission, the coherency capability can reuse that of Rel-17. If full power transmission Mode 2 is supported in RAN1, the supported precoder groups should also be reported similar to Rel-15.  ***Proposal 10: The following information can be reported via UE capability for 8Tx transmission:***   * ***Support of codebook based 8Tx transmission***   + ***(N1, N2)***   + ***Ng=2 or 4 for a UE supporting partial coherency CB***   + ***Supported precoder groups if full power Mode 2 is supported for 8Tx*** * ***Support of non-codebook based 8Tx transmission*** |
| Rapporteur (Samsung) [7] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1 | Unified TCI framework extension for MTRP operation | 1. Support TCI state activation and update for two indicated joint/DL/UL TCI states 2. Support TCI selelction from two indicated joint/DL/UL TCI states for applying to channels/signals 3. Supprot UL Tx power detetminaiton for PUSCH/PUCCH/SRS Tx occasion(s) or antenna port(s) based on the UL PC parameter setting for PUSCH/PUCCH/SRS, if any, and the PL-RS included in the applied indicated joint/UL TCI state |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-1-1a | TCI selection for aperiodic CSI-RS in S-DCI based MTRP | 1. Support “per resource” or “per resource set” configuration to inform that the UE shall apply the first or the second indicated joint/DL TCI state to an aperiodic CSI-RS resource or an aperiodic CSI-RS resource set |  |  |  |  |  |  |  |  | Component candidate values: {per resource, per resource set, both} | Optional with capability signalling | |  | 40-1-2 | CJT Tx scheme for PDSCH | 1. Support PDSCH-CJT with two indicated joint TCI states |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-1-3 | TRP-specific BFR with unified TCI framework | 1. Support TRP-specific BFR with unified TCI framework for M-DCI based MTRP operation |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-2-1 | Basic feature for multi-DCI based intra-cell Multi-TRP operation with two TA enhancement | 1. Support for multi-DCI based intra-cell Multi-TRP operation with two TA enhancement  2. Support of Rx timing difference between two DL reference timings being no larger than CP length  3. Support for the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESET Pool Index to be corresponding to one TAG | 16-2a |  |  |  |  |  |  |  |  | Optional with capability signaling | |  | 40-2-2 | Basic feature for multi-DCI based inter-cell Multi-TRP operation with two TA enhancement | 1. Support for multi-DCI based inter-cell Multi-TRP operation with two TA enhancement  2. Support of Rx timing difference between two DL reference timings being no larger than CP length  3. Support for the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESET Pool Index to be corresponding to one TAG | 23-4 |  |  |  |  |  |  |  |  | Optional with capability signaling | |  | 40-2-3 | Rx timing difference larger than CP length | 1. Support of Rx timing difference between the two DL reference timings to be larger than CP length | 16-2a or 23-4 |  |  |  |  |  |  |  |  | Optional with capability signaling | |  | [40-2-4] | [TCI states of one CORESET Pool associated to both TAGs] | [1. Support for the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESET Pool Index to be corresponding to both TAGS] | [16-2a or 23-4] |  |  |  |  |  |  |  |  | [16-2a or 23-4] | |  | 40-3-1-1 | Basic features of CSI-mTRPCJT | Comp1: Mode2  Comp2: Mode1 with O3=1  Comp3:   * R16: paraCombs for {Ln} with L=2,4 for NTRP=1 * R17: paraCombs for {M,beta} with M=1   Comp4: R=1 |  |  |  |  |  |  |  |  |  | Mandatory | |  | 40-3-1-2 | Optional features of CSI-mTRPCJT | Comp1: CSI-RS resource selection (TRP selection)  Comp2:  Comp3:   * 6th combination of ParaCombs for (pv,beta), i.e., ({pv},beta)=({1/2,1/2,1/2,1/2},1/2) * R16: paraCombs for {Ln} with L=6 for NTRP=1 * R17: paraCombs for {M,beta} with M=2   Comp4: Mode 1 with O3=4  Comp5: R=2 |  |  |  |  |  |  |  |  |  | Optional | |  | 40-3-2-1 | Basic features of CSI-Doppler | Comp1: X=1, one slot (  Comp2:   * R16: paraCombs with L=2,4 * R17: paraCombs with M=1   Comp3: R=1 |  |  |  |  |  |  |  |  |  | Mandatory | |  | 40-3-2-2 | Optional features of CSI-Doppler | Comp1: *l* = (*n* – *nCSI,ref* )  Comp2: value(s) of N4 (TBD)  Comp3: {X=1, two slots, and }, X=2  Comp4: K=12  Comp5:   * R16: paraCombs with L=6 * R17: paraCombs with M=2   Comp6: R=2 |  |  |  |  |  |  |  |  | For a UE that supports UE-side prediction, the support of *l* = (*n* – *nCSI,ref* ) is UE optional. | Optional | |  | 40-3-3-1 | Basic features of CSI-TDCP | Comp1: Y=1 and delay <= Dbasis, amplitude only  Comp2: D=4 symbols, 1,2,3,4,5 slots |  |  |  |  |  |  |  |  |  | Mandatory | |  | 40-3-3-2 | Optional features of CSI-TDCP | Comp1: Y=1 and delay > Dbasis; Y>=1, amplitude and phase  Comp2: D=6,10 slots |  |  |  |  |  |  |  |  |  | Optional | |  | 40-4-1 | Basic feature of Rel.18 enhanced DMRS ports for PDSCH | 1. Supported DMRS type: eType1  2. Supported value of maxLength: 1  3. Support of DL PTRS RE mapping for Rel.18 enhanced DMRS ports, if PTRS is suppored |  | Yes |  | Rel.18 enhanced DMRS ports for PDSCH is not supported | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-1a | Additional support of eType2 DMRS for PDSCH | 1. Additional support of eType2 DMRS for PDSCH | 40-4-1 | Yes |  | eType2 DMRS for PDSCH is not supported | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-1b | Additional support of maxLength = 2 for enhanced DMRS for PDSCH | 1. Additional support of maxLength = 2 for enhanced DMRS for PDSCH | 40-4-1 | Yes |  | Rel.18 DMRS ports with maxLength = 2 for PDSCH is not supported. | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-1-1 | Reception of PDSCH without the scheduling restriction for Rel.18 eType1 DMRS ports |  | 40-4-1 | Yes |  | UE can receive PDSCH with eType1 DMRS ports only if the scheduling restriction is satisfied | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-1-2 | Additional row(s) of Rel.18 DMRS ports for single-DCI based M-TRP | 1. Supported DMRS type(s)  2. Supported value of maxLength(s) | 40-4-1 | Yes |  | Additional row(s) of Rel.18 DMRS ports for single-DCI based M-TRP is not supported | Per band | No | No |  | Component 1 candidate values: {eType1 only, both eType1 and eType2}  Component 2 candidate values: {1 only, both 1 and 2} | Optional with capability signalling | |  | 40-4-2 | Basic feature of Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 | 1. Supported DMRS type: eType1  2. Supported value of maxLength: 1  3. Support of UL PTRS RE mapping for Rel.18 enhanced DMRS ports, if PTRS is suppored |  | Yes |  | Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 is not supported | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-2a | Additional support of eType2 DMRS for PUSCH | 1. Additional support of eType2 DMRS for PUSCH | 40-4-2 | Yes |  | eType2 DMRS for PUSCH is not supported | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-2b | Additional support of maxLength = 2 for enhanced DMRS for PUSCH | 1. Additional support of maxLength = 2 for enhanced DMRS for PUSCH | 40-4-2 | Yes |  | Rel.18 DMRS ports with maxLength = 2 for PUSCH is not supported. | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-4 | UL PTRS RE mapping for Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 | 1. Support of UL PTRS RE mapping for Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 | 40-4-2 | Yes |  | UL PTRS for Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 is not supported | Per band | No | No |  |  | Optional with capability signalling | |  | 40-4-10 | Rel.15 DMRS ports for PUSCH with rank 5-8 | 1. Supported DMRS type(s)  2. Supported value of maxLength(s) | 40-7-1-1 | Yes |  | Rel.15 DMRS ports for PUSCH with rank 5-8 is not supported | Per band | No | No |  | Component 1 candidate values: {Type1, Type2, both}  Component 2 candidate values: {1, 2, both} | Optional with capability signalling  Note: for UE supporting FG 40-7-1-1 shall report at least one of FG40-4-10 or FG40-4-11 | |  | 40-4-11 | Rel.18 enhanced DMRS ports for PUSCH with rank 5-8 | 1. Supported DMRS type(s)  2. Supported value of maxLength(s) | 40-4-2, 40-7-1-1 | Yes |  | Rel.18 enhanced DMRS ports for PUSCH with rank 5-8 is not supported | Per band | No | No |  | Component 1 candidate values: {eType1 only, both eType1 and eType2}  Component 2 candidate values: {1 only, both 1 and 2} | Optional with capability signalling  Note: for UE supporting FG 40-7-1-1 shall report at least one of FG40-4-10 or FG40-4-11 | |  | 40-4-12 | UL PTRS for PUSCH with rank 5-8 | 1. Supported PTRS port(s)  2. Support of UL PTRS RE mapping for Rel.18 enhanced DMRS ports for PUSCH with rank 5-8 | 40-7-1-1 | Yes |  | UL PTRS for rank 5-8 PUSCH with rank 5-8 is not supported | Per band | No | No |  | Component 1 candidate values: {1, 2, both} | Optional with capability signalling | |  | 40-5a | SRS comb offset hopping/cyclic shift hopping | 1. Support SRS comb offset hopping  2. Support SRS cyclic shift hopping | 2-52, 2-53 | Yes |  | gNB cannot configure SRS comb offset hopping/cyclic shift hopping | Per UE | No | No |  |  | Optional with capability signalling | |  | 40-5a-0 | Comb offset hopping time-domain behavior when reprtiton factor R>1 | 1. Hopping depends on the OFDM symbol index l' of each symbol  2. Hopping depends on the OFDM symbol index l' of the first symbol across the R repetitions | 40-5a | Yes |  | gNB cannot configure SRS comb offset hopping when reprtiton factor R>1 | Per UE | No | No |  |  | Optional with capability signalling | |  | 40-5a-1 | Comb offset hopping combined with one of group / sequence hopping on a SRS resource | 1. Comb offset hopping combined with group hopping on a SRS resource 2. Comb offset hopping combined with sequence hopping on a SRS resource | 40-5a | Yes |  | gNB cannot configure SRS comb offset hopping combined with one of group / sequence hopping on a SRS resource | Per UE | No | No |  |  | Optional with capability signalling | |  | 40-5b | SRS with 8 Tx ports | 1. Support transmission of SRS for 8T8R based antenna switching and SRS for CB/NCB with up to 8 layers | 2-52, 2-53 | Yes |  | gNB cannot configure 8 Tx ports SRS resource in a SRS resource set with usage ‘codebook’ or ‘antennaSwitching’, or a SRS resource set with more than 4 and up to 8 1-port SRS resources and with usage ‘nonCodebook’ | Per Band | No | No |  |  | Optional with capability signalling | |  | 40-5b-0 | SRS with 8 Tx ports and comb 8 | 1. Support transmission of SRS with comb 8 for 8T8R based antenna switching and SRS for CB/NCB with up to 8 layers | 40-5b, 23-8-8 | Yes |  | gNB cannot configure comb 8 for SRS with 8 Tx ports | Per Band | No | No |  |  | Optional with capability signalling | |  | 40-5b-1 | SRS with TDMed 8 Tx ports | 1. Support transmission of SRS for 8T8R based antenna switching and SRS for CB with up to 8 layers, and the 8 ports are split and mapped to more than 1 OFDM symbol with TDM | 40-5b | Yes |  | gNB cannot configure TDM for SRS with 8 Tx ports | Per Band | No | No |  |  | Optional with capability signalling | |  | 40-6-1-1 | Basic features of STx2P SDM scheme for PUSCH | 1.Support STx2P SDM scheme for PUSCH transmission  2.Maximal number of MIMO layers per UE panel in SDM scheme, the candidate values are {1, 2} |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-6-1-2 | Optional feature for STx2P SDM scheme | 1.Support the new entry {0, 2, 3} in DMRS table for the layer combination {1+2} of SDM scheme |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-6-2-1 | Basic features of STx2P SFN scheme for PUSCH | 1.Support STx2P SFN scheme for PUSCH transmisson  2.Maximal number of layers of PUSCH in SFN scheme and the candidate values are {1, 2} |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-6-3-1 | Basic feature of STx2P PUSCH+PUSCH in multi-DCI based mTRP system | 1. Support two indepent PUSCHs with fully/partially/non-overlapping in frequency domain and fully/partially overlapping in time domain in a same active BWP  2. Maximal number of layers in each PUSCH of STx2P PUSCH+PUSCH overlapping in time domain and the candidate values are {1,2} |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-6-4-1 | Basic feature of STx2P SFN scheme for PUCCH | 1.Support STx2P SFN scheme for PUCCH transmission |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-6-5-1 | Support grouped-based beam reporting for STx2P | 1.Support group-based beam reporting for STx2P.  2. The maximum number of reported CRI/SSBRI pairs  3. The maximum number of CSI-RS and SSB configured for group-based beam reporting for STx2P. |  |  |  |  |  |  |  |  |  |  | |  | 40-7-1-1 | Basic features of UL-8Tx | 1. Support UL-8Tx based PUSCH transmission |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  | 40-7-1-2 | MaxMIMO layers for UL-8Tx | 1. Maximal number of MIMO layers for UL-8Tx based PUSCH transmission | 40-7-1-1 | Yes |  |  |  |  |  |  | Component candidate values: {4, 8} | Optional with capability signalling | |  | 40-7-2-1 | Number of antenna groups (Ng) | 1. Supported number of antenna groups for UL-8Tx based PUSCH transmission | 40-7-1-1 | Yes |  |  |  |  |  |  | Component candidate values: {1,2,4} | Optional with capability signalling | |  | 40-7-3-1 | Full-coherent codebook parameters | 1. Supported combination of a pair of parameters (N1, N2) | 40-7-1-1 | Yes |  |  |  |  |  |  | Component candidate values: {(4,1),(2,2)} | Optional with capability signalling | |
| Ericsson [8] | **Multi-TRP enhancement**  Unified TCI framework extension for multi-TRP  Support of mTRP, but mTRP features are separate – focus on how to convey the TCI states. A UE that would support for example sDCI NC-JT with the unified TCI framework would have to support also FG 16-2b-x. What would be specified here is the functionality related to how to convey the TCI states, which should be independent from the exact multi-TRP scheme to support.  The features related to TCI states are typically provided per band, or per UE. This follows the RAN2 guidance in [1]. We propose to reuse this for the features related to the multi-TRP extension of the unified TCI framework:   1. The UE features related to the multi-TRP extension of the unified TCI framework are provided per band.   We propose to start from the UE features specified for the unified TCI framework in Rel-17 [2]. On high level, the same structure could be used:   * Unified TCI with joint TCI state, MAC CE activation only, intra-cell operation (23-1-1)   + More than one activated joint TCI state, intra+inter-cell operation (23-1-1a)   + More than one activated joint TCI state, intra+inter-cell operation, DCI indication (23-1-1b) * CC pools, common CC update for joint TCI states (23-1-1d, 23-1-1e, 23-1-1f, 23-1-1k) * Unified TCI with separate DL/UL TCI state, MAC CE activation only, intra-cell operation (23-10-1)   + More than one activated DL and UL TCI state, intra+inter-cell operation (23-10-1m)   + More than one activated DL and UL TCI state, intra+inter-cell operation, DCI indication (23-10-1b) * CC pools, common CC update for separate DL/UL TCI states (23-10-1d, 23-10-1e, 23-10-1f)   It should be possible to use these FGs as a blueprint to handle multiple indicated TCI states. Unfortunately, RAN1 has chosen to use different ways to convey TCI states for single-DCI and multi-DCI based multi-TRP. This would double the amount of required FGs.  Preferably, we could start with the FGs for joint TCI states: the addition of the corresponding FGs for separate TCI states could be added once the structure for joint TCI states has been settled.  We will describe single-DCI (40-1-1x) and multi-DCI (40-1-2x) based operation separately. To simplify interpretation, corresponding FGs use the same letters: this is why not all letters are used for single-DCI and multi-DCI: for example, 40-1-1f exists, but not 40-2-1f, since CJT is only supported for single-DCI.  **Proposed feature groups for single-DCI and joint TCI states**   |  |  |  |  | | --- | --- | --- | --- | | Index | Feature group | Components | Note | | 40-1-1 | Unified TCI with joint DL/UL TCI update for single-DCI based multi-TRP operation | 1. Joint DL/UL TCI state update with their components: (configuration mechanism, QCL rules, applicable source and target signals)  2. Two MAC-CE activated joint TCI per CC in a band  3. The maximum number of configured joint TCI states per BWP per CC in a band  4. TCI state indication for update and activation:a) MAC CE based TCI state indication for two active TCI state  5. The maximum number of MAC-CE activated joint TCI states across all CC(s) in a band | Note: this includes support for the configuration of {none, first, second, both} for the relevant channels | | 40-1-1b | Unified TCI with joint DL/UL DCI-based TCI update for single-DCI based multi-TRP operation | 1. TCI state indication for update and activation 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)  2. The minimum beam application time in Y symbols per SCS  3. The maximum number of MAC-CE activated joint TCI states per CC in a band |  | | 40-1-1c | Maximum number of configured CC lists for joint DL/UL TCI update for single-DCI based multi-TRP operation. | Maximum number of configured CC lists per cell group for common multi-CC TCI state ID update and activation | If the UE does not report this FG, common multi-CC TCI state update is not supported | | 40-1-1d | Time to perform DCI-based switching between single-TRP and multi-TRP PDSCH reception | Time duration (definition follows clause 5.1.5 in TS 38.214), Xi, to determine and apply spatial QCL information for corresponding PDSCH reception.  Time duration is defined counting from end of last symbol of PDCCH to beginning of the first symbol of PDSCH.  Xi is the number of OFDM symbols, i is the index of SCS, l=1,2, corresponding to 60,120 kHz SCS. | If the UE does not report this FG, DCI-based switching between single-TRP and multi-TRP is not supported. | | 40-1-1e | Two default beams for single-DCI based multi-TRP | Support of default QCL assumption with two indicated TCI states |  | | 40-1-1f | Support for CJT with two indicated TCI states | Support for coherent joint transmission for PDSCH with two indicated TCI states |  | | 40-1-1g | Association between CSI-RS and indicated TCI states | Defines how aperiodic CSI-RS is associated with indicated TCI states: per CSI-RS resource, per CSI-RS resource set or both |  |   **Proposed feature groups for multi-DCI and joint TCI states**  Here we propose a list for the UE features for multi-DCI and joint TCI states. Only the first four columns of the UE feature table will be used:   |  |  |  |  | | --- | --- | --- | --- | | Index | Feature group | Components | Note | | 40-1-2 | Unified TCI with joint DL/UL TCI update for intra-cell multi-DCI based multi-TRP operation | 1. Joint DL/UL TCI state update per coresetPoolIndex with their components: (configuration mechanism, QCL rules, applicable source and target signals)  2. One MAC-CE activated joint TCI state per coresetPoolIndex per CC in a band  3. The maximum number of configured joint TCI states per BWP per CC in a band  4. TCI state indication for update and activation:a) MAC CE based TCI state indication for one active TCI state per coresetPoolIndex  5. The maximum number of MAC-CE activated joint TCI states across all CC(s) in a band |  | | 40-1-2a | Unified TCI with joint DL/UL TCI update for inter-cell multi-DCI based multi-TRP operation | Support of unified TCI with joint DL/UL TCI update for inter-cell multi-DCI based multi-TRP operation |  | | 40-1-2b | Unified TCI with joint DL/UL DCI-based TCI update for inter-cell multi-DCI based multi-TRP operation | 1. TCI state indication for update and activation 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)  2. The minimum beam application time in Y symbols per SCS  3. The maximum number of MAC-CE activated joint TCI states per coresetPoolIndex per CC in a band |  | | 40-1-2c | Maximum number of configured CC lists for joint DL/UL TCI update for multi-DCI based multi-TRP operation. | Maximum number of configured CC lists per cell group for common multi-CC TCI state ID update and activation | If the UE does not report this FG, common multi-CC TCI state update is not supported | | 40-1-2h | TRP-specific BFR for multi-DCI based multi-TRP operation | Support TRP-specific BFR for multi-DCI based multi-TRP operation |  |     **Extension to separate TCI states**  As previously remarked, there will be a need to add feature groups for separate DL/UL TCI states. Here we make a first assessment what FG will have to be duplicated:  For single-DCI based multi-TRP:   * 40-1-1 * 40-1-1b * 40-1-1c   For multi-DCI based multi-TRP:   * 40-1-2 * 40-1-2a * 40-1-2b * 40-1-2c   **Feature groups that may be reused from the Rel-17 framework**  In our understanding, the following feature groups from the Rel-17 TCI framework can be reused:   * 23-1-1c: SCell BFR * 23-1-1d: Per BWP TCI state configuration * 23-1-1e: Support of reference CC for TCI state configuration * 23-1-1g: Beam misalignment * 23-1-1h: Association between PC parameters and TCI state * 23-1-1i, 23-1-1m, 23-1-1j: Configuration of a single Rel-17 TCI state for PDCCH, CSI-RS, SRS and CORESET#0   In our understanding, none of the above FGs are related to multi-TRP operation, or multiple indicated TCI states, and hence the Rel-17 FGs can be reused.  **Support of multi-TRP schemes with unified TCI framework**  The unified TCI framework supports all schemes specified in Rel-16 and Rel-17, and also STxMP and CJT. The UE must be able to report which multi-TRP schemes it supports together with the unified TCI framework. We propose to add one FG with multiple components, where each component states if the UE supports the multi-TRP feature or not:   |  |  |  |  | | --- | --- | --- | --- | | Index | Feature group | Components | Note | | 40-1-5 | Multi-TRP schemes supported with the unified TCI framework | 1. Single-DCI NC-JT 2. Multi-DCI NC-JT 3. PDCCH repetition 4. PUCCH repetition 5. PUSCH repetition 6. HST-SFN |  |   Two TAs for multi-DCI  Following the RAN2 guidance in [1], we propose that the UE features related to two TAs for multi-DCI based multi-TRP operation are provided per band:   1. The UE features related to two TAs for multi-DCI based multi-TRP operation are provided per band.   As the name indicates, two TAs for multi-DCI based operation can only be used for multi-DCI based operation. Hence, the network can only configure two TAs in one serving cell if the UE supports multi-DCI based multi-TRP. NR specifies intra-cell multi-DCI based multi-TRP operation in Rel-15, and inter-cell multi-DCI based multi-TRP operation in Rel-17. The two TA extension is applicable to both modes, and there is a need to have separate capabilities.  So far, RAN1 has only agreed how to support two TA enhancement with the Rel-17 TCI framework. Here we probably need to separate this feature for joint and separate TCI states.  **Proposed feature groups**   |  |  |  |  | | --- | --- | --- | --- | | Index | Feature group | Components | Note | | 40-2-1 | Two TA enhancement for intra-cell multi-DCI based multi-TRP with joint TCI states | 1. Support to configure two TAG IDs in one serving cell 2. Support to configure TAG ID in a joint TCI state 3. Support difference between Rx timing references no larger than CP 4. Support PDCCH order triggering RACH procedure towards different TRP 5. Support for absolute TA command MAC CE with TAG ID 6. Support for the [activated] joint TCI states [of UL signals/channels] associated to one CORESET Pool Index to be corresponding to one TAG | Copy for separate DL/UL TCI states | | 40-2-2 | Two TA enhancement for inter-cell multi-DCI based multi-TRP with joint TCI states | 1. Support to configure two TAG IDs in one serving cell 2. Support to configure TAG ID in a joint TCI state 3. Support difference between Rx timing references no larger than CP 4. Support PDCCH order triggering RACH procedure towards different cell 5. Support for absolute TA command MAC CE with TAG ID 6. Support for the [activated] joint TCI states [of UL signals/channels] associated to one CORESET Pool Index to be corresponding to one TAG | Copy for separate DL/UL TCI states | | 40-2-3 | Difference between Rx timing references larger than CP | Support difference between Rx timing references larger than CP |  | | 40-2-4 | TCI states of one CORESET Pool associated to both TAGs | Support for the [activated] joint TCI states [of UL signals/channels] associated to one CORESET Pool Index to be corresponding to both TAGS] | Copy for separate DL/UL TCI states |   **CSI enhancement**  In agenda 9.1.2, the largest correlation delay for the basic TDCP feature is denoted as Dbasic. The exact value for Dbasic has not been decided yet. To measure the correlation delay over a reasonably large delay D is important in order for the channel variation to be large compared to noise and interference and thus to achieve good accuracy for the estimate. However, according to UE and chipset manufacturers storing RX data longer than what is needed for D=2slots gives a considerable increase in UE complexity. Therefore, we propose to have a basic feature group with Dbasic = 28 symbols or equivalently 2slots. Note that simulation results shown in Figure 1 and Figure 2 show that a Dbasic value of 14 symbols or 1 slot results in significant performance degradation for the type I vs type II CSI switching use case based on TDCP reporting.   1. Support Dbasic = 28 symbols or equivalently 2 slots   Chart, line chart  Description automatically generated  Figure 1 Performance for CSI type I/type II switching based on the TDCP channel correlation for different correlation delays at 22dB SNR.    Figure 2 Performance for CSI type I/type II switching based on the TDCP channel correlation for different correlation delays at 10dB SNR.  **Reference signal enhancement**  Increased number of orthogonal DMRS ports  In RAN1#110-bis meeting there’s following agreement on introducing UE capability for orphan REs.  **Agreement**  For FD-OCC length 4 in Rel.18 eType 1 DMRS for PDSCH, support the following:   * Introduce UE capability to report whether UE can be scheduled PDSCH without the scheduling restriction for FD-OCC length 4 in Rel.18 eType 1 DMRS.   + If this capability is not supported by the UE, UE expects that gNB shall apply the scheduling restriction for PDSCH for FD-OCC length 4 in Rel.18 eType 1 DMRS. * The scheduling restriction above means satisfying all of the following at least for other than M-TRP PDSCH transmission with FDM 2a or FDM 2b scheme.   + 1) The number of consecutively scheduled PRBs for PDSCH is even.   + 2) The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) is even.   + 3) FFS: Restriction on scheduling of different UEs in case of MU-MIMO.   + FFS: Scheduling restriction for M-TRP PDSCH transmission with FDM 2a or FDM 2b scheme. * Note1: Up to UE how to implement DMRS channel estimation. * Note2: No further RAN1 specification enhancement is introduced to handle the orphan REs (e.g. if the total number of REs of DMRS in a CDM group is not multiples of 4, how to handle the remainder of REs) for UE that is scheduled PDSCH without the scheduling restriction. * Note 3: Other scheduling restrictions, if identified in future meetings, are not precluded.   Based on above agreement, UE capability for handling orphan REs shall be introduced.   1. Introduce UE capability for orphan RE handling as below.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Feature group** | **Components** | **Type** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | | Orphan RE handling | 1. Number of consecutively scheduled PRBs for PDSCH is even, and number of PRB starting offset of scheduled PDSCH from CRB0 is even. | Per UE or Per Band | No | No | |
| Nokia/Nokia Shanghai Bell [9] | Based on the agreements reached so far under the MIMO evolution WI, a skeleton of UE FGs structure is proposed in Table 1 . The Release 18 MIMO is discussing technical enhancements in several technical directions, and it is very likely that the main corresponding Release 18 UE features would be independent of each other. These technical categories are:   1. Unified TCI extension for multi-TRP enhancements 2. Two TAs for multi-DCI 3. CSI enhancements 4. DM-RS Reference signals enhancements 5. SRS Reference Signals enhancements 6. UL precoding for Multi-Panel transmission 7. SRI/TPMI enhancements for enabling 8Tx UL transmission   **Proposal: consider at least 7 independent discussion areas related to the UE features for Rel18 MIMO. Dependencies between these technical areas can be considered at the point when technical details are agreed.**   |  |  |  |  | | --- | --- | --- | --- | | FG | FG name | Components | Note | | 40-1-1 | Support unified TCI framework extension for M-DCI based MTRP | * Support up to 4 TCI states that can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation * Support of indication of multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list by the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) * For a serving cell configured with joint DL/UL TCI mode, support one joint TCI state being mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) * For a serving cell configured with separate DL/UL TCI mode, support mapping of a DL TCI state, an UL TCI state, or a pair of DL and UL TCI states to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) * Support association of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) with one coresetPoolIndex value can indicate the joint/DL/UL TCI state(s) specific to the same coresetPoolIndex value | **Agreement** (RAN1#110 Toulouse)  On unified TCI framework extension, ~~at least~~ for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, up to 4 TCI states can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation  **Agreement** (RAN1#110bis-e)  On unified TCI framework extension for M-DCI based MTRP:   * For a serving cell configured with joint DL/UL TCI mode, one joint TCI state can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) * For a serving cell configured with separate DL/UL TCI mode, a DL TCI state, an UL TCI state, or a pair of DL and UL TCI states can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment)   **Agreement** (RAN1#110bis-e)  On unified TCI framework extension for M-DCI based MTRP:   * The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value * The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDSCH scheduled/activated by PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value | | 40-1-2 | Support unified TCI framework extension for S-DCI based MTRP | * Support up to 4 TCI states that can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation * Support indication of multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list by the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) * Support RRC configuration to inform that the UE shall apply the first one, the second one, both, or none of the joint/DL TCI states indicated by DCI/MAC-CE to a CORESET * Support RRC configuration to inform that the UE shall apply the first one, the second one, or both of the indicated joint/UL TCI states to a PUCCH resource/group * Support reception of an indicator field in the DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2 | **Agreement** (RAN1#109e)  On unified TCI framework extension at least for single-DCI based MTRP, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list | | 40-1-2-x | Support PDSCH-CJT with unified TCI framework | * Support 1 or 2 indicated joint TCI states for PDSCH-CJT | **Agreement** (RAN1#110bis-e)  Support of 1 or 2 indicated joint TCI states for PDSCH-CJT is up to **UE capability** | | 40-1-2-x | Support of CSI-RS resource mapping to joint/DL TCI state in S-DCI based MTRP |  | **Agreement**  (RAN1#112bis-e)  On unified TCI framework extension for S-DCI based MTRP, an RRC configuration can be provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTrigger State* for each CSI-RS resource set or for each CSI-RS resource in each aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the CSI-RS resource if the aperiodic CSI-RS resource set for CSI/BM is configured to follow unified TCI state  ‘per CSI-RS resource set’ or ‘per CSI-RS resource’ is up to **UE capability** | | 40-2-1 | Support of Two TAs for multi-DCI multi-TRP, for intra-cell and inter-cell cases | - Support of two TAGs belonging to a serving cell.  - Support of two DL reference timings each associated to a TAG.  - Association of TAG to UL/joint TCI state.  - For intercell case, one additional PRACH configuration is supported for each configured additional PCI  - Support of up to two *n-TimingAdvanceOffset*  - Support RAR-based solution where RAR is only received from a TRP that is associated with Type 1 CSS. | **Agreement** (RAN1#110 Toulouse)  For multi-DCI based multi-TRP operation with two TAs, support configuring two TAGs belonging to a serving cell.  **Agreement** (RAN1#110 Toulouse)  For multi-DCI multi-TRP operation with two TAs, up to two n-TimingAdvanceOffset value per serving cell is supported  **Agreement** (RAN1#110bis-e)  For multi-DCI multi-TRP operation with two TAs in a CC, two DL reference timings are supported where each DL reference timing is associated with one TAG   * baseline assumption is that the Rx timing difference between the two DL reference timings is no larger than CP length * as an optional UE capability, Rx timing difference between the two DL reference timings can be assumed to be larger than CP length   + FFS: the maximum Rx timing difference (could be up to RAN4)   + Other than UE capability details and relevant configuration, no additional RAN1 specification enhancement specific for this case is expected   **Agreement** (RAN1#112 Athens)  For associating TAGs to  target UL channels/signals  for multi-DCI based multi-  TRP operation, support the  following:Associate TAG to TCI-state   * Associate TAG ID with UL/joint TCI state * For UL transmission, the TAG ID associated with the UL/joint TCI state is utilized * A baseline is UE expects that the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESET Pool Index correspond to one TAG * Working Assumption: A UE may report that it supports that the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESETPoolIndex correspond to both TAGs   FFS: on how to handle  association when Rel-  15/16 spatial relation  framework is used for   * PUCCH * DG/CG Type 1/Type 2 PUSCH * AP/SP/P SRS   **Agreement** (RAN1#112 Athens)  Confirm the following working assumption:  For multi-DCI based inter-cell Multi-TRP operation with two TA enhancement, one additional PRACH configuration is supported for each configured additional PCI   * the additional PRACH configuration is used in a RACH procedure triggered by a PDCCH order for the corresponding configured additional PCI | |  | Support of a PDCCH order sent by one TRP triggers RACH procedure (specifically PRACH) towards a different TRP based on CFRA, at least for the inter-cell case. |  | **Agreement** (RAN1#111 Toulouse)  For multi-DCI based  Multi-TRP operation with  two TA enhancement,  support the case where a  PDCCH order sent by one  TRP triggers RACH  procedure towards either  the same TRP or a different  TRP at least for inter-cell  Multi-DCI.  NOTE: This feature provides good benefits and flexibility, especially for the intercell case (to allow a TRP in the serving cell to trigger PRACH towards a TRP in another cell). Better to support it as a mandatory/basic feature for UEs supporting the corresponding scenario.  Pre-requisite: 40-2-1 | |  | Support of Rx timing difference between the two DL reference timings that can be assumed to be larger than CP length. |  | **Agreement** (RAN1#110bis-e)  • For multi-DCI multi-TRP operation with two TAs in a CC, two DL reference timings are supported where each DL reference timing is associated with one TAG: • baseline assumption is that the Rx timing difference between the two DL reference timings is no larger than CP length  • as an **optional UE capability**, Rx timing difference between the two DL reference timings can be assumed to be larger than CP length | | 40-3-1 | Support of Rel-16 based Type-II-CJT |  | The work scope of Type-II codebook refinement for CJT mTRP includes refinement of the following codebooks:   * Rel-16 eType-II regular codebook | | 40-3-1a |  |  |  | | 40-3-2 | Support of Rel-17 based Type-II-CJT |  | The work scope of Type-II codebook refinement for CJT mTRP includes refinement of the following codebooks:   * Rel-17 FeType-II port selection (PS) codebook | | 40-3-3 | Support of Rel-16 based Type-II-Doppler |  | The Rel-18 Type-II codebook refinement for high/medium velocities comprises refinement of the following codebooks:   * Refinement of the Rel-16 eType-II regular codebook, with N4>=1 | | 40-3-4 | Support of Rel-17 based Type-II-Doppler for |  | The Rel-18 Type-II codebook refinement for high/medium velocities comprises refinement of the following codebooks:   * Refinement of the Rel-17 FeType-II port selection (PS) codebook, based on the common design with the Refinement of the Rel-16 eType-II regular codebook, except for the supported set of parameter combinations, with N4=1   + Time-/Doppler-domain reciprocity is not assumed | | 40-3-5 | Support of TRS-based aperiodic TDCP reporting |  | For aiding gNB determination of codebook switching and SRS periodicity with the Rel-18 TRS -based TDCP reporting, support reporting quantized wideband normalized amplitude/phase of the time-domain correlation profile with Y≥1 delay(s) as follows:   * Basic feature: Y=1 with delay≤ Dbasic symbols, only wideband quantized normalized amplitude is reported * Optional feature: Y=1 with delay>Dbasic symbols and Y≥1, wideband quantized normalized amplitude and phase for each delay are reported   + For Y>1, the phase can be configured to be absent for all the Y delays   For the Rel-18 TRS-based TDCP reporting, there is no consensus in supporting periodic, semi-persistent, and event-triggered/UE-initiated TDCP reporting. | | 40- 4-1 | Enhanced DM-RS type support for PUSCH | 1.support of FD-OCC4 DMRS for PUSCH  Tansmission of Cyclic shift based FD-OCC 4 sequence. | **Agreement** (RAN1#112 Athens)  For enhanced FD-OCC length for DMRS of PDSCH/PUSCH for Rel.18 eType 1 DMRS, support  Opt.1-2: Length 4 FD-OCC is applied to 4 REs of DMRS within a PRB or across consecutive PRBs within an CDM group  **Agreement** (RAN1#111 Toulouse) – 38.211  For FD-OCC length 4 for PDSCH/PUSCH, select the following:   * Opt.1-1 (Walsh matrix) for PDSCH * Opt.1-2 (Cyclic shift) for PUSCH | | 40-4-2 | Enhanced DM-RS type support for PDSCH | 1.support of FD-OCC4 DMRS for PUSCH  Reception of Walsh based FD-OCC4 seqeunce.  2. support of skipping scheduling restriction | **Agreement** (RAN1#112 Athens)  For enhanced FD-OCC length for DMRS of PDSCH/PUSCH for Rel.18 eType 1 DMRS, support   * Opt.1-2: Length 4 FD-OCC is applied to 4 REs of DMRS within a PRB or across consecutive PRBs within an CDM group   **Agreement** (RAN1#110bis-e)  For FD-OCC length 4 in Rel.18 eType 1 DMRS for PDSCH, support the following:   * Introduce UE capability to report whether UE can be scheduled PDSCH without the scheduling restriction for FD-OCC length 4 in Rel.18 eType 1 DMRS.   + If this capability is not supported by the UE, UE expects that gNB shall apply the scheduling restriction for PDSCH for FD-OCC length 4 in Rel.18 eType 1 DMRS. | | 40-4-3 | DMRS for 8TX UL support | 1.Support of 8TX UL for Rel-18 DMRS  2. Support of PTRS for 8TX UL | **Agreement** (RAN1#111 Toulouse)  For > 4 layers PUSCH, support new antenna ports tables for rank = 5,6,7,8 for both single-symbol/double-symbol DMRS.   * For Type 1/Type 2 Rel.15 DMRS ports, new antenna ports tables are the following:   + The same DMRS port combination(s) as that for rank = 5,6,7,8 for PDSCH is reused at least for full or non-coherent UL codebook. * For Rel.18 eType1/eType2 DMRS ports,   + New antenna ports tables with new DMRS port combinations are used for rank = 5,6,7,8 (FFS: details). | |  |  |  |  | | 40-5-1 | 8 port SRS for codebook | 1.support of 8 port SRS for codebook based UL  2.support of TDM operation of 8 port SRS  3.the number of TDM subset s  {n1(default), n2, [n4],[n8]} | **Agreement** (RAN1#110bis-e)  For one single SRS resource in a SRS resource set with usage ‘codebook’ for 8Tx PUSCH, when the SRS resource is configured with n ports (n <= 8) and m OFDM symbols (m >= 1), at least support the n ports mapped onto each of the m OFDM symbols using legacy schemes (repetition, frequency hopping, partial sounding, or a combination thereof).   * n can be 8 * m takes the legacy values, i.e., 1,2,4,8,10,12,14.   **Agreement** (RAN1#112 Athens)  For an 8-port SRS resource in a SRS resource set with usage ‘codebook’ or ‘antennaSwitching’ and resource mapping based on TDM onto m ≥ 2 OFDM symbols in a slot and with TDM factor s, support the 8 ports equally partitioned into s subsets with each subset having 8/s different ports.   * At least s = 2. | | 40-5-2 | 8 port SRS for antenna switching | 1.support of 8 port SRS for antenna switching  2.support of TDM operation of 8 port SRS  3.the number of TDM subset s  {n1(default), n2, [n4],[n8]} | **Agreement** (RAN1#110 Toulouse)  For an 8-port SRS resource in an SRS resource set with usage antennaSwitching (i.e., for 8T8R antenna switching), the 8-port SRS resource is transmitted in at least one OFDM symbol.  **Agreement** (RAN1#112 Athens)  For an 8-port SRS resource in a SRS resource set with usage ‘codebook’ or ‘antennaSwitching’ and resource mapping based on TDM onto m ≥ 2 OFDM symbols in a slot and with TDM factor s, support the 8 ports equally partitioned into s subsets with each subset having 8/s different ports.   * At least s = 2. | | 40-5-3 | SRS for 8TX operation for non-codebook PUSCH | 1. support of upto 8 single port SRS resources in a SRS resource sert for non-codebook PUSCH  2. maximum number of SRS resources in a SRS resource set | **Agreement** (RAN1#110 Toulouse)  For SRS resource set(s) with usage ‘nonCodebook’ support 8 1-port SRS resources in one or multiple OFDM symbols.   * Note: The maximum number of simultaneous SRS resources is determined via UE-capability signalling. | | 40-5-4 | SRS cyclic shift hopping and comb offset hopping | 1.support of SRS cyclic shift hopping and comb offset hopping | **Agreement** (RAN1#112 Athens)  For SRS interference randomization, support:   * Opt. 3: Both cyclic shift hopping and comb offset hopping.   + At least the two features can be separately configured   + FFS: Combined cyclic shift hopping and comb offset hopping for a UE   + FFS: Separate or combined with SRS sequence group hopping / sequence hopping   + FFS: Associated UE capability | | 40-5-4a | Time domain behavior for comb offset hopping with repeition | 1. Support of comb offset hopping at every symbol or at every SRS repetition. | **Agreement**  (RAN1#112bis-e)  For a SRS resource configured with comb offset hopping, if the repetition factor R > 1, within a slot, the time-domain hopping behavior depends on the OFDM symbol index l' of each symbol or the first symbol across the R repetitions based on RRC configuration, and FFS configuration details.   * UE can indicate whether it supports one or both the options. Details to be discussed in UE feature. | | 40-6-1 | Support of single- DCI based STxMP PUSCH transmission | Support the following schemes for s-DCI based PUSCH:   * SDM * SFN | **Agreement** (RAN1#110bis-e)  Support the following scheme for STxMP PUSCH transmission in single-DCI based mTRP system in Rel-18:   * SDM * SFN * Support DCI-based dynamic switching between SFN scheme of single-DCI based STxMP PUSCH and sTRP transmission * The DCI field “SRS resource set indicator” is used to indicate the switching between SFN scheme and sTRP transmission   **Agreement** (RAN1#112 Athens)   * Dynamic switching between sTRP and mTRP with SRS resource set indicator * Support the following scheme for STxMP PUSCH transmission in single-DCI based mTRP system in Rel-18: * SDM scheme with one CW   **Agreement** (RAN1#112 Athens)   * On dynamic switching between STxMP SFN scheme and sTRP transmission: * The legacy maxRank/Lmax is applied to sTRP transmission * For configuration of SFN,   + Alt2: Configure a separate parameter for the maximal number of layers for STxMP SFN | | 40-6-1a | Support indication of DMRS ports in different CDM groups for s-DCI based PUSCH | * Layer combination {1+2}: new entry {0, 2, 3} in DMRS table | * This is optional UE capability for UE that supports sDCI based STxMP SDM | | 40-6-1b | Support of switching between s-DCI based SDM/SFN and Rel-17 mTRP PUSCH TDM scheme | -RRC based switching between SDM/SFN and Rel-17 mTRP PUSCH TDM | **Agreement** (RAN1#110bis-e)  Support RRC-based switching between SDM scheme of single-DCI based STxMP PUSCH and Rel-17 mTRP PUSCH TDM scheme  **Conclusion** (RAN1#112 Athens)  There is no consensus to support dynamic switching between STxMP SDM/SFN scheme and Rel-17 mTRP PUSCH TDM scheme | | 40-6-1-2 | Support of single DCI based STxMP PUCCH transmission | Support SFN scheme for s-DCI based PUCCH: | **Agreement** (RAN1#111 Toulouse)  Support the SFN scheme for single-DCI based STxMP PUCCH transmission | | 40-6-2 | Support of multi- DCI based STxMP PUSCH transmission | * Two independent PUSCHs associated with different TRPs can be transmitted by a UE simultaneously in same active BWP. * The total number of layers of these two PUSCHs is up to 4.   + Maximum number of layers of each PUSCH overlapping in time can be 1 or 2 s.t. UE capability * PUSCH+PUSCH transmission supports fully/partially/non-overlapping in frequency domain and fully/partially overlapping in time domain   + DG-PUSCH+DG-PUSCH   + CG-PUSCH + DG-PUSCH   + CG PUSCH + CG PUSCH | **Agreement** (RAN1#110bis-e)  Support STxMP PUSCH+PUSCH transmission in multi-DCI based system in Rel-18.  **Agreement** (RAN1#110bis-e)  Multi-DCI based STxMP PUSCH+PUSCH transmission supports the following PUSCH combinations:   * DG-PUSCH+DG-PUSCH * CG-PUSCH+DG-PUSCH * CG-PUSCH+CG-PUSCH   **Agreement** (RAN1#110bis-e)  The multi-DCI based STxMP PUSCH+PUSCH transmission supports fully/partially/non-overlapping in frequency domain and fully/partially overlapping in time domain  **Agreement** (RAN1#112bis-e)   * For STxMP PUSCH+PUSCH transmission in multi-DCI based system: * The maximal number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain can be 1 or 2 subject to UE capability | | 40-7-1 | Support for SRI/TPMI enhancements for enabling 8Tx UL transmission | Number of Antenna groups Ng  1, 2, 4, 8 | Support the following cases for codebook design for 8TX precoders   * Full coherent precoders with Ng=1   + FFS: Full coherent precoders with Ng=2, Ng=4 * Partial coherent precoders with Ng=2 and Ng=4   + This does not imply any relation with the number of TPMI indications for 8TX precoder * Non-coherent precoders | | 40-7-2 | Support for SRI/TPMI enhancements for enabling 8Tx UL transmission | Extension Max layer to 8, over existing layers (up to 4): {4, 8} | Support up to X layers for codebook and non-codebook UL transmission for 8TX UE where X=4, 8 is determined based on **separate UE capability**   * For uplink transmission with rank<=4, single CW is supported * For uplink transmission with rank>4, whether single or dual CW is used will be decided in RAN1 meeting #110b-e | | 40-7-2a | Support for SRI/TPMI enhancements for enabling 8Tx UL transmission | Support of two antenna configurations  (N, N1)=(4,1) or  (2,2) | For fully coherent uplink precoding by an 8TX UE, based on NR Rel-15 single panel DL Type I codebook, the following pairs of (N1, N2) values are supported,   * (N1, N2) = (4, 1) * (N1, N2) = (2, 2)`   A pair of (N1, N2) can be configured with subject to **UE capability.** | | 40-7-2b | Support for SRI/TPMI enhancements for enabling 8Tx UL transmission | 8Tx full Tx mode  Mode {0, 1, 2} | **Agreement**  Framework for full power PUSCH transmission by an 8TX UE   * To support full power transmission with Mode0, Rel-16 Mode0 (fullPower ) is re-used.   + FFS if any change is required in the specifications. * **Working Assumption** To support full power transmission with Mode1, Rel-16 Mode1 (fullPowerMode1) is re-used.   + FFS if more than one of the 8TX full coherent precoders is used ~~per rank~~. * **Working Assumption** To support full power transmission with Mode2, Rel-16 Mode2 (fullPowerMode2) is re-used.   + FFS definition of precoder groups (G0, G1, …)   + FFS enhancements for SRS configuration | |
| Huawei/HiSilicon [10] | **UE feature for <Multi-TRP enhancement>**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Unified TCI for Multi-TRP | 1. Granularity of TCI state selection configuration for aperiodic CSI-RS in sDCI based Multi-TRP | 23-1-1 | Yes |  | Unified TCI for multi-TRP is not supported | Per band | n/a | n/a | n/a | 1.candidate values {per resource, per resource set} | Optional with capability signalling | |  |  | Support of two TCI states for PDSCH-CJT transmission | 1. Support of two indicated joint TCI states that can be applied for PDSCH-CJT. |  | Yes |  | Two indicated joint TCI states is not supported for PDSCH-CJT | Per band | n/a | n/a | n/a |  | Optional with capability signalling | |  |  | Two TAs for Uplink Multi-TRP transmission | 1.Difference between the two DL reference timings can be larger than CP length |  | Yes |  | UE cannot maintain two DL timing with a difference larger than CP length | Per UE | n/a | n/a | n/a | 1.candidate values {support} | Optional with capability signalling |   **UE feature for <CSI enhancement>**  For CJT CSI enhancement  For CJT CSI codebook, similar to legacy Type I single panel codebook in FG 2-36, Type I multi panel codebook in FG 2-40, Type II codebook in FG 2-41 and etc., a list of supported combinations where each combination contains {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CC should be introduced. The gNB can configure multiple CSI measurement according to the above listed combinations. For example, if UE reports {16, 8, 128}, then gNB can configure CSI report #1 and CSI report #2 based on {16, 4, 64} and {16, 4, 64}, respectively; or the gNB can configure CSI report #1, CSI report #2, CSI report #3, and CSI report #4 based on {16, 2, 64}, {16, 2, 64}, {16, 2, 64} and {16, 2, 64}, respectively; or the gNB can configure CSI report #1, CSI report #2, and CSI report #3 based on {16, 2, 64}, {16, 2, 64}, {16, 4, 64}, respectively. However, it is quite complicated for UE preforming CJT CSI measurement on 4 CSI-RS resources than 2 CSI-RS resources. Therefore, to avoid the configuration of the base station exceeding UE capacity, a list of supported combinations where each combination contains {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement should be introduced.  Besides, two codebook mode are supported, e.g., mode-1 and mode-2. Mode-2 can be considered as a special case of codebook mode 1, where mode-1 needs additional computational complexity of calculating the frequency offset. Besides, it was agreed in RAN#110bis that the selection of N out of NTRP CSI-RS resources is UE optional.  ***Proposal 2-1: Introduce following FGs:***   1. ***A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously*** 2. ***A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement*** 3. ***Support codebook modes for CJT CSI*** 4. ***CJT CSI measurement schemes***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Support of Rel-16-based CJT measurement | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously 2. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement 3. Supported codebook modes for CJT CSI 4. CJT CSI measurement schemes 5. Support R=1 6. Support NL=1 |  |  |  |  |  |  |  |  | Component 3 candidate value {mode-2, both mode-1 and mode-2}  Component 4 candidate value {N=NTRP, both N=NTRP and selection of N out of NTRP} | Optional with capability signalling | |  |  | FD basis selection offset mode for Rel-16-based CJT codebook with mode1 | Supported FD basis selection offset modes for mode1 codebook |  |  |  |  |  |  |  |  | Candidate value {integer-mode, both integer-mode and fractiona-mod} | Optional with capability signalling | |  |  | Support R=2 for Rel-16-based CJT codebook | 1. Support R=2 for Rel-16-based CJT codebook 2. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously to support R=2 for Rel-16-based CJT codebook 3. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement to support R=2 for Rel-16-based CJT codebook |  |  |  |  |  |  |  |  |  |  | |  |  | Support pv={1/2,1/2,1/2,1/2} and beta=1/2 for Rel-16-based CJT codebook | Support pv={1/2,1/2,1/2,1/2} and beta=1/2 for Rel-16-based CJT codebook |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support of Rel-17-based CJT measurement | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously 2. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement 3. Supported codebook modes for CJT CSI 4. CJT CSI measurement schemes 5. Support R=1 and M=1 6. Support NL=1 7. Support parameter combinations with M=1 |  |  |  |  |  |  |  |  | Component 3 candidate value {mode-2, both mode-1 and mode-2}  Component 4 candidate value {N=NTRP, both N=NTRP and selection of N out of NTRP} | Optional with capability signalling | |  |  | FD basis selection offset mode for Rel-17-based CJT codebook with mode1 | Supported FD basis selection offset modes for mode1 codebook |  |  |  |  |  |  |  |  | Candidate value {integer-mode, both integer-mode and fractiona-mod} | Optional with capability signalling | |  |  | Support of M=2 and R=1 for Rel-17-based CJT codebook | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously to support M=2 and R=1 for Rel-17-based CJT codebook 2. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement to support M=2 and R=1 for Rel-17-based CJT codebook 3. Support parameter combinations with M=2 |  |  |  |  |  |  |  |  |  |  | |  |  | Support R=2 for Rel-17-based CJT codebook | 1. Support R=2 for Rel-17-based CJT codebook 2. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously to support R=2 for Rel-17-based CJT codebook 3. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement to support R=2 for Rel-17-based CJT codebook |  |  |  |  |  |  |  |  |  |  |   The selection of N out of NTRP CSI-RS resources needs additional computational complexity. Thus, it is preferred to introduce separate combinations. We have the following proposal:  ***Proposal 2-2: Introduce following UE capability:***   * ***For dynamic TRP selection by N out of NTRP***  1. ***A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously*** 2. ***A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one CJT CSI measurement***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | For CJT measurement, support selection of N TRPs out of NTRP TRPs |  |  |  |  |  |  |  |  |  |  | Optional with capability signalling |   For CSI enhancement for mobility  Agreement (RAN1#111, 202211)  For the Type-II codebook refinement for high/medium velocities, regarding the parameter *N*4 (length of DFT vector, unit-less), support 8 as an additional candidate value.   * FFS (by RAN1#112): Whether any of the following additional candidate values are supported: 3, 5, 16, 32. * The candidate values supported by UE are reported via UE capability (details can be discussed in UE feature).   **Agreement** (RAN1#112, 202302)  For the Rel-18 Type-II codebook refinement for high/medium velocities, regarding the time instance and/or PMI(s) in which a CQI is associated with, given the CSI reporting window *WCSI* (in slots), *as well as* the number of CQIs (=X) in one sub-band and one CSI reporting instance, support only the following:   * Basic feature: X=1 and the CQI is associated with the first/earliest slot of the CSI reporting window and the first/earliest of the *N*4 **W**2 matrices * Optional features:   + X=1 and the CQI is associated with:     - the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - the last slot of the CSI reporting window (slot *l*+*WCSI*–1) and the *N*4-th**W**2 matrix   + X=2 and     - The 1st CQI is associated with the first/earliest slot of the CSI reporting window (slot *l*) and the first/earliest of the *N*4 **W**2 matrices, and     - The 2nd CQI is associated with the middle slot of the CSI reporting window (slot *l*+*WCSI*/2) and the (*N*4 /2)-th**W**2 matrix     - FFS: Whether/how to include CQI overhead reduction for X=2   For doppler CSI codebook, multiple CSI-RS occasions measurement, UE-side prediction and PMI calculation in three dimensions would be performed, which increase calculation complexity and the requirement of UE memory. Obviously, the value of N4 affects the calculation complexity of the UE. Therefore, the value of N4 needs to be added to the combination and a list of supported combinations where each combination contains {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CC should be introduced. The gNB can configure multiple CSI measurement according to the above listed combinations.  Besides, the UE capability of CQI report with X=1/2 and associated with different slot should be indicated.  ***Proposal 2-3: Introduce FGs with following components:***   1. ***A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously*** 2. ***A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one doppler CSI measurement*** 3. ***The UE capability of CQI report with X=1/2 and associated with different slot***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Support of Rel-16-based doppler measurement | 1. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously 2. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one doppler CSI measurement 3. Support R=1 4. Support X=1 CQI, and the CQI is associated with the first/earliest slot of the CSI reporting window and the first/earliest of the N4 W2 matrices |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support R=2 for Rel-16-based doppler codebook | 1. Support R=2 for Rel-16-based doppler codebook 2. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously to support R=2 for Rel-16-based doppler codebook 3. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one doppler CSI measurement to support R=2 for Rel-16-based doppler codebook 4. Support X=1 CQI, and the CQI is associated with the first/earliest slot of the CSI reporting window and the first/earliest of the N4 W2 matrices |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support X=1 and X=2 CQI for Rel-16-based doppler codebook | 1. Support X=1 CQI, CQI is associated with:the first/earliest slot of the CSI reporting window (slot l) and the first/earliest of the N4 W2 matrices, and the last slot of the CSI reporting window (slot l+WCSI–1) and the N4-thW2 matrix 2. Support X=2 and the 1st CQI is associated with the first/earliest slot of the CSI reporting window (slot l) and the first/earliest of the N4 W2 matrices, and the 2nd CQI is associated with the middle slot of the CSI reporting window (slot l+WCSI/2) and the (N4 /2)-thW2 matrix |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support of Rel-17-based doppler measurement | 1. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously 2. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one doppler CSI measurement 3. Support R=1 and M=1 4. Support parameter combinations with M=1 |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support of M=2 and R=1 for Rel-17-based doppler codebook | 1. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously to support M=2 and R=1 for Rel-17-based doppler codebook 2. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one doppler CSI measurement to support M=2 and R=1 for Rel-17-based doppler codebook 3. Support parameter combinations with M=2 |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support R=2 for Rel-17-based doppler codebook | 1. Support R=2 for Rel-17-based doppler codebook 2. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously to support R=2 for Rel-17-based doppler codebook 3. A list of supported combinations, each combination is {Max # of time unit, Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} for one doppler CSI measurement to support R=2 for Rel-17-based doppler codebook |  |  |  |  |  |  |  |  |  | Optional with capability signalling |   **UE feature for <Reference signal enhancement>**  Increased number of orthogonal DMRS ports  Considering the higher channel estimation complexity brought by length-4-FD-OCC-based Rel.18 DMRS, the support of the combination of Rel.18 DMRS and other features with high timing requirement/channel estimation complexity should be enabled by separate UE features if supported.  First, for PDSCH processing time, there are two capabilities defined in current spec., i.e., capability 1 and capability 2. Capability 2 with higher timing requirement is mainly used for URLLC scenario, which requires higher robustness and lower latency compared with eMBB scenario, while Rel.18 DMRS targets at supporting higher MU-MIMO layers under eMBB scenario. Furthermore, both the lower channel estimation performance and higher channel estimation complexity of length-4 FD-OCC makes Rel.18 DMRS inappropriate under URLLC scenario. As a result, PDSCH processing capability 2 should not be simultaneously supported with Rel.18 DMRS.  Next, to enable different DMRS-related capability reporting for Rel.15 and Rel.18 DMRS, several Rel.18-DMRS-related UE features similar to following Rel.15-DMRS-related ones should be introduced: FG 2-5 (Basic downlink DMRS for scheduling type A), FG 2-6 (Basic downlink DMRS for scheduling type B), FG 2-6a (oneFL-DMRS-TwoAdditionalDMRS-DL), FG 2-7 (twoFL-DMRS), FG 2-8 (twoFL-DMRS-TwoAdditionalDMRS-DL), FG 2-9 (oneFL-DMRS-ThreeAdditionalDMRS-DL) and FG 2-10 (supportedDMRS-TypeDL). Specially, for FG 2-5 3), it mandates UE to support 1 FL DMRS and 2 additional DMRS symbols for at least one port, which mainly applies to medium/high mobility scenario and contradicts with the target scenario of Rel.18 DMRS. Besides that, the higher channel estimation complexity of Rel.18 DMRS and more than 1 additional DMRS symbol makes their combination unacceptable. As a result, even if supported, the Rel.18 ‘FG 2-5 3)’ should be a non-basic feature.  Then, due to the high complexity of multi-CDM-group channel estimation, a UE capability indicating the simultaneous support of Rel.18 DMRS and cross-CDM-group DMRS port combination for rank=2~4 should be introduced. By similar logic, a UE capability indicating the simultaneous support of Rel.18 DMRS and single-DCI NCJT, the DMRS port combinations enabling which always take up 2 CDM groups, is also needed.  Similarly, a UE capability indicating the simultaneous support of Rel.18 DMRS and 8Rx should be introduced.  ***Proposal 3-1: Following Rel.18-DMRS-related UE capabilities should be introduced:***   * ***UE capability 1: indicate whether UE can simultaneously support Rel.18 DMRS and processing time capability 2.*** * ***UE capabilities 2~8: introduce Rel.18-DMRS-related UE features similar to FG 2-5, FG 2-6, 2-6a, FG 2-7, FG 2-8, FG 2-9 and FG 2-10.***   + ***Rel.18-DMRS-related UE features similar to FG 2-5 3) should be a non-basic feature.*** * ***UE capability 9: indicate whether UE can simultaneously support Rel.18 DMRS and cross-CDM-group DMRS port combination.*** * ***UE capability 10: indicate whether UE can simultaneously support Rel.18 DMRS and single-DCI NCJT.*** * ***UE capability 11: indicate whether UE can simultaneously support Rel.18 DMRS and 8Rx.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Basic downlink DMRS for scheduling type A | 1) Support 1 symbol FL DMRS without additional symbol(s)  2) Support 1 symbol FL DMRS and 1 additional DMRS symbol |  |  |  |  |  |  |  |  |  | Mandatory with capability signalling | |  |  | Basic downlink DMRS for scheduling type B | 1) Support 1 symbol FL DMRS without additional symbol(s)  2) Support 1 symbol FL DMRS and 1 additional DMRS symbol |  |  |  |  |  |  |  |  |  |  | |  |  | Support 1+2 DMRS (downlink) | Support 1 symbol front-loaded DMRS and 2 additional DMRS symbols. |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Supported 2 symbols front-loaded DMRS (downlink) | Support 2 symbols FL-DMRS |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Supported 2 symbols front-loaded + 2 symbols additional DMRS (downlink) | Support 2-symbol FL DMRS + one additional 2-symbols DMRS |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support 1+3 DMRS symbols(downlink) | Support 1 symbol FL DMRS and 3 additional DMRS symbols |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support DMRS type (downlink) | Support DMRS {etype 1, both etype 1 and etype 2} |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support Rel-18 DMRS and processing time capability 2 | Support Rel-18 DMRS and processing time capability 2 |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | Support Rel-18 DMRS and 8Rx | Support Rel-18 DMRS and 8Rx |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | support Rel.18 DMRS and cross-CDM-group DMRS port combination | support Rel.18 DMRS and cross-CDM-group DMRS port combination |  |  |  |  |  |  |  |  |  | Optional with capability signalling | |  |  | support Rel.18 DMRS and NCJT transmission | support Rel.18 DMRS and NCJT transmission |  |  |  |  |  |  |  |  |  | Optional with capability signalling |   SRS enhancement targeting TDD CJT and 8 TX operation  In last meeting, for the time domain behaviour for comb offset hopping, it has been agreed that:  Agreement  For a SRS resource configured with comb offset hopping, if the repetition factor R > 1, within a slot, the time-domain hopping behavior depends on the OFDM symbol index *l*' of each symbol or the first symbol across the R repetitions based on RRC configuration, and FFS configuration details.   * UE can indicate whether it supports one or both the options. Details to be discussed in UE feature.   Given that whether to support the time-domain hopping behavior for comb offset hopping depends on the OFDM symbol index l' of each symbol (per symbol hopping) or the first symbol across the R repetitions (per R hopping) has no impact on UE complexity. Actually, the time-domain hopping behavior has some impact on SRS measurement implementation for gNB, so it should depend on gNB configuration instead of UE capability reporting.  Note that, for CS hopping, it has been agreed that the time-domain hopping behavior is per symbol hopping. In this case, per symbol hopping should be the default configuration for comb offset hopping.  ***Proposal 3-2: The time-domain behavior for comb offset hopping should be gNB configuration instead of UE capability reporting.***  **UE feature for <Uplink transmission enhancement>**  UL precoding indication for multi-panel transmission  In Rel-18, single-DCI based SDM/SFN scheme and multi-DCI based STxMP are supported for PUSCH and single-DCI based SFN scheme is supported for PUCCH. We think that separate FGs should be defined for each of these four schemes.  ***Proposal 4-1: Define the following FGs to support STxMP schemes:***  ***FG 1:*** ***Indicate the support for single-DCI based SDM scheme for PUSCH***  ***FG 2: Indicate the support for single-DCI based SFN scheme for PUSCH***  ***FG 3: indicate the support for multi-DCI based scheme for PUSCH***  ***FG 4: indicate the support for single-DCI based SFN scheme for PUCCH***  Since the new entry {0, 2, 3} is only optionally supported for a UE that supports SDM PUSCH, it should be defined in a new FG whose pre-requisite is the FG for SDM PUSCH support.  ***Proposal 4-2: Define an FG for the support of DMRS entry {0,2,3} for single-DCI based SDM scheme for PUSCH. The FG is pre-requisited by the FG that indicates the support for single-DCI based SDM scheme for PUSCH.***  It was agreed in RAN#112bis that maximal number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain can be 1 or 2 subject to UE capability is reported as UE capability.  With above analysis, we propose the following:  ***Proposal 4-3: Include the following component in the FG that indicates the support for multi-DCI based scheme for PUSCH :***   * ***The maximal number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain with the candidate values {1,2}.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Single-DCI based SDM scheme of PUSCH | Support of single-DCI based SDM scheme |  |  |  |  |  |  |  |  | Candidate value {‘support’} | Optional with capability signalling | |  |  | single-DCI based SFN scheme of PUSCH | Support of single-DCI based SFN scheme |  |  |  |  |  |  |  |  | Candidate value {‘support’} | Optional with capability signalling | |  |  | multi-DCI based PUSCH scheme | 1. Support of multi-DCI based PUSCH scheme 2. The maximal number of layers of each PUSCH of PUSCH+PUSCH overlapping in time domain |  |  |  |  |  |  |  |  | Component 1 candidate value {‘support’}  Component 2 candidate value {1,2} | Optional with capability signalling | |  |  | single-DCI based SFN scheme of PUCCH | Support of single-DCI based SFN scheme |  |  |  |  |  |  |  |  | Candidate value {‘support’} | Optional with capability signalling | |  |  | new DMRS port entry {0, 2, 3} | Support of new DMRS port entry {0, 2, 3} for DCI based SDM scheme of PUSCH | Single-DCI based SDM scheme of PUSCH |  |  |  |  |  |  |  | Candidate value {‘support’} | Optional with capability signalling |   SRI/TPMI enhancement for enabling 8 TX UL transmission  ***Proposal 4-3: Following Rel.18-8TX-related UE capabilities should be introduced:***  ***UE capability 1: indicate whether UE can support up to 8 transmission layers of PUSCH***  ***UE capability 2: indicate the layout of UE is (N1, N2) = (4, 1) or (N1, N2) = (2, 2)***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Support of 8TX PUSCH | The maximal number of transmission layers of PUSCH |  |  |  |  |  |  |  |  | Candidate value {4,8} | Optional with capability signalling | |  |  | Support of (N1, N2) for fully coherent precoding | Support of (N1, N2) |  |  |  |  |  |  |  |  | Candidate value {(4, 1), (2, 2), both (4,1) and (2,2)} | Optional with capability signalling | |
| Samsung [11] | **Multi-TRP enhancement**  Unified TCI framework extension for multi-TRP  **Maximum number of configured or activated TCI states**  In Rel-17, following UE capabilities are defined to share UE’s capability on number of supported TCI state:   * ***unifiedJointTCI-r17*** * *maxConfiguredJointTCI-r17*  :indicates the maximum number of configured joint TCI states per BWP per CC in a band * *maxActivatedTCIAcrossCC-r17  :*indicates the maximum number of MAC-CE activated joint TCI states across all CC(s) in a band * ***unifiedSeparateTCI-r17*** * *maxConfiguredDL-TCI-r17  :indicates the maximum number of configured DL TCI states per BWP per CC* * *maxConfiguredUL-TCI-r17 : indicates the maximum number of configured UL TCI states per BWP per CC* * *maxActivatedDL-TCIAcrossCC-r17 : indicates the maximum number of MAC-CE activated DL TCI states across all CC(s) in a band* * *maxActivatedUL-TCIAcrossCC-r17 : indicates the maximum number of MAC-CE activated UL TCI states across all CC(s) in a band*   The parameters above define the number of TCI state UE supports when UE is connected in sTRP mode. Though RAN1 did not make final decision yet on supported number unified TCI state for mTRP mode operation, it should be a common sense that UE may need more of TCI states to be activated and possibly to be configured. But it should be noted that the enhanced number of TCI state does not necessitate UE to support more of TCI state per connected TRP.  **Observation 2-1-1:**Support of mTRP oepration via unfied TCI framework may request UE to support more of TCI state in total, but would not request to support more TCI states per TRP.  There should be two different way of defining total number of supported TCI states based on Rel-17 capability. First, the total number of supported TCI state of UE is informed as UE capability and network should define number of configured or activated TCI states per TRP separately. Or as second approach, network assumed the reported UE capability is a number of TCI states supported per TRP. The 1st approach may need more cooperation between TRPs in case of MDCI based operation. We prefer 2nd approach more than 1st one, or we are also open to define new UE capability informing number of supported TCI states with clear notification whether the number is a total or per TRP.  **Proposal 2-1-1:**RAN1 discuss how the maximum number of configured/activated TCI state is defined for UE, e.g., per TRP or in total  **Beam application latency**  In Rel-18 design, UE has two of indicated beam, 1st TCI state and 2nd TCI state. In case of MPUE, UE has one indicated TCI state per panel, and application of indicated TCI state may mean switching of UE panel, not changing of UE shaped beam. In that sense, the latency at UE beam application ordered by Rel-18 eUTCI could be different with the case ordered by Rel-17 UTCI. Based on this observation, there were discussion whether to introduce new timing threshold defining UE beam switching latency. But as captured above, the actual latency should depends on required UE operation which could be sometime blinded to gNB. Therefore, we propose not to define new UE capability on UE beam switching or UE panel switching latency  **Proposal 2-1-2:**RAN1 does not define new UE capability for Re-18 UE beam switching latency or panel switching latency.  **Application of TCI state for CSI-RS**  As agreed, it is up to UE capability whether applicable TCI state is configured per CSI-RS resource or CSI-RS resource set. In our perspective, per resource is more general way actually covering per resource set, and pre resource set is allowed to release more simplified UE operation. So we propose to define per resource set as default mode of UE operation claying easier UE operation:  **Proposal 2-1-3:**As a default, applicable TCI state is defined per CSI-RS resource set.  **Application of TCI state for CSI-RS**  **Proposal 2-1-4:**Define UE capability support of Rel-18 CJT including number of supported TCI states for CJT   * If number of supported TCI state is not reported, network assumes 2 TCI states as UE’s support   Though RAN1 keeps discussion for the down-selection of the alternative above, it seems companies still have diverse preference. As a compromise, RAN1 may support all of the alternatives as UE’s capability, and discuss whether one of the alternative is defined as a default UE capability.  **Proposal 2-1-5:**Support all of 3 listed alternatives on how UE applies QCL of indicated two TCI states for CJT operation but depends on UE capability  Two TAs for multi-DCI  **Reference timing**  Therefore, we do not see there is a UE supporting only one reference timing while supporting multiple TA for serving cell. We propose not to define separated UE capability on supported number of reference timing.  **Proposal 2-2-1:**RAN1 does not define separated UE capability on number of supported reference timing   * Network assumes two reference timing is supported for a UE reporting capability of multiple TA/TAG for serving cell.   As aligned approach with another agreement, we propose to define a new capability of supporting timing difference larger than CP. We also propose to define a default UE capability of not supporting timing difference large than CP.  **Proposal 2-2-2:**Define a new UE capability of supporting Rx timing difference larger than CP   * As a default, Rx timing difference larger than CP is not supported, if parameter is not reported   **Reference signal enhancement**  Increased number of orthogonal DMRS ports (Including increasing orthogonal DMRS ports for UL/DL MU-MIMO and 8 Tx UL SU-MIMO)  **Basic structure on Rel-18 DMRS eType-I/II**  Regarding increased number of orthogonal DMRS ports for UL/DL MU-MIMO, our view is that the basic structure of UE features for Rel-18 DMRS eType-I/II could be started from the structure of Rel-15 DMRS Type-I/II considering pre-requisite, report granularity, the number of front-loaded DMRS symbols, the number of additional DMRS symbols, and/or supported DMRS types as follows.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Index** | **Feature group** | **Components** | **Pre-requisite** | **Reporting granularity** | **Note** | **Mandatory/Optional** | | 2-5 | Basic downlink DMRS  for scheduling type A | 1) Support 1 symbol FL DMRS without additional symbol(s)  2) Support 1 symbol FL DMRS and 1 additional DMRS symbol  3) Support 1 symbol FL DMRS and 2 additional DMRS symbols for at least one port. | 2-1 |  | conditioned to whether PDSCH scheduling type A is supported | Mandatory without capability signalling (condition to scheduling capability) | | 2-6 | Basic downlink DMRS  for scheduling type B | 1) Support 1 symbol FL DMRS without additional symbol(s)  2) Support 1 symbol FL DMRS and 1 additional DMRS symbol |  |  | conditioned to whether PDSCH scheduling type B is supported | Mandatory without capability signalling (condition to scheduling capability) | | 2-6a | Support 1+2 DMRS (downlink) | Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port | 2-5 | *FeatureSetDownlink-v1540* |  | Mandatory with capability signalling | | 2-6b | Support alternative additional DMRS location | Support alternative additional DMRS position for co-existence with LTE CRS | 2-5 and 5-28 | *FeatureSetDownlink-v1540* | This FG applies to FR1 only and 15kHz SCS. This applies to one additional DMRS case only | Optional with capability signalling | | 2-7 | Supported 2 symbols front-loaded DMRS (downlink) | Support 2 symbols FL-DMRS | 2-5 | *Phy-ParametersFRX-Diff* |  | Optional with capability signalling | | 2-8 | Supported 2 symbols front-loaded +2 symbols additional DMRS (downlink) | Support 2-symbol FL DMRS + one additional 2-symbols DMRS | 2-5 | *FeatureSetDownlink-v1540* |  | Optional with capability signalling | | 2-9 | Support 1+3 DMRS symbols(downlink) | Support 1 symbol FL DMRS and 3 additional DMRS symbols | 2-5 | *FeatureSetDownlink-v1540* |  | Optional with capability signalling | | 2-10 | Support DMRS type (downlink) | Support DMRS {type 1, both type 1 and type 2} |  | *Phy-ParametersFRX-Diff* |  | Type 1 is mandatory with capability signalling.    Type 2 is optional with capability signalling |   **Proposal 3-1-1:** Support the basic structure of Rel-18 DMRS eType-I/II, by re-using the structure of Rel-15 DMRS Type-I/II as much as possible.  In addition to the basic structure of Rel-18 DMRS eType-I/II, based on UE feature structure for Rel-15 DMRS, we think that at least the following UE features would be defined.  **Handling orphan RE problem for Rel-18 DMRS eType-I**  Since the expression “orphan RE” is used for a discussion purpose, we utilize the expression like “scheduling restriction”. Hence, we propose to have the corresponding UE capability as follows.  **Proposal 3-1-2:** Support the FG whether a UE can handle orphan RE problem or not.   * Feature group name: Rel-18 DMRS eType-I without scheduling restriction for frequency domain resource allocation * Pre-requisite: Basic feature of Rel-18 DMRS eType-I. * Reporting granurality: per band * Note: If this FG is not reported, UE expects that gNB shall apply the following scheduling restrictions for PDSCH for Rel-18 DMRS eType-I.   + The number of consecutively scheduled PRBs for PDSCH is even.   + The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) is even.   Also, since single-DCI based multi-TRP scheme is also scheduled by using Rel-18 DMRS eType-I/II, we can define additional scheduling restriction for single-DCI based multi-TRP PDSCH transmission with FDM scheme A or B by extending such scheduling restrictions as per each of TRPs or each of indicated TCI states. Since pre-requisite FG would be different, if this extension on single-DCI based multi-TRP with FDM scheme A or B, then  **Proposal 3-1-3:** Support the FG whether a UE can handle orphan RE problem or not, when the UE is scheduled as single-DCI based multi-TRP PDSCH transmission with FDM scheme A or B, based on Rel-18 DMRS eType-I.   * Feature group name: Rel-18 DMRS eType-I without scheduling restriction for frequency domain resource allocation scheduled with S-DCI based M-TRP PDSCH transmission with FDMSchemeA or FDMSchemeB. * Pre-requisite: Basic feature of Rel-18 DMRS eType-I, FG 16-2b-2 and/or FG 16-2b-3 * Reporting granurality: per band * Note: If this FG is not reported, UE expects that gNB shall apply the following scheduling restrictions for PDSCH for Rel.18 eType 1 DMRS.   + The number of consecutively scheduled PRBs per TCI state for PDSCH is even.   + The number of PRBs offset of scheduled PDSCH from point A (common resource block 0) per TCI state is even.   **Additional row in DMRS port indication table for S-DCI based M-TRP**  In RAN1#112 [4] and RAN1#112b-e [5], one additional row including DMRS ports as {0, 2, 3}, and number of DMRS CDM group(s) without data as {2} in DMRS port indication table was agreed for Rel-18 DMRS eType-I with *maxLength* = 1 and 2, and eType-II with *maxLength* = 1 and 2. Since the related FG including the exact same combination of DMRS ports was agreed for Rel-16 single-DCI based multi-TRP as in FG 16-2b-1b as follows.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Pre-requisite | Reporting granularity | Note | Mandatory/Optional | | 16-2b-1b | Single-DCI based SDM scheme – Support of new DMRS port entry | 1. Support of new DMRS port entry {0, 2, 3} | 16-2b-1 | Per band |  | Optional with capability signaling |   Our view is that if two different FGs are reported from a UE, then it does not imply that the combined functionality of the two FGs from the UE is always supported. Hence, we think that a dedicate FG supporting certain combinations of DMRS ports at least including DMRS ports {0, 2, 3} for Rel-18 DMRS eType-I/II. Since additional rows for S-DCI based M-TRP are still discussing, we can merge in a single FG supporting additional rows for S-DCI based M-TRP based on Rel-18 DMRS eType-I/II.  **Proposal 3-1-4:** Support a UE capability introducing additional rows of Rel-18 DMRS eType-I/II for single-DCI based multi-TRP PDSCH scheme, at least including row for indicating DMRS ports {0, 2, 3}.  **The maximum number of different DMRS types for all DCI formats**  Since Rel-18 DMRS eType-I/II are introduced, there are 4 different types of DMRSs: Rel-15 DMRS Type-I/II, and Rel-18 DMRS eType-I/II. Given supportable types of DMRS for each different DCI format defined in NR, a UE shall prepare up to 4 different DMRS types whenever the UE receives same or different DCI formats, which could be burden to UE. Hence, our view is that defining the maximum number of different DMRS types considering for all DCI formats as a UE capability could inform to gNB the processing limit of the UE.  **Proposal 3-1-5:** Support a UE capability introducing the maximum number of different DMRS types considering for all DCI formats.   * Pre-requisite: Basic feature of Rel-18 DMRS eType-I or II * Component: the maximum number of different DMRS types for all DCI formats (candidate value: one of 2, 3, or 4) * Reporting granurality: per UE or per band   **DMRS for UL 8TX**  For DMRS up to 8 layers for supporting UL 8TX, since supported DMRS type is one of parts for supporting UL 8TX, this could be required with having pre-requisite of a basic feature of supporting UL 8TX, which could be discussed and defined in AI 9.1.4.2. Since a UE supporting Rel-18 DMRS types could be indicated with either Rel-15 or Rel-18 DMRS types, and a UE not supporting Rel-18 DMRS types could be indicated Rel-15 DMRS types only, our view is that a new FG supporting Rel-15 DMRS types with up to 8 layers could be defined as a basic feature for UL 8TX DMRS and can be reported by the UE. On top of that, Rel-18 DMRS types could be additionally reported from the UE, then gNB can indicate either of Rel-15 or Rel-18 DMRS types for supporting up to 8 layers for the UE.  By the way, it was agreed that Rel-18 DMRS types are defined for supporting more number of MU-MIMO layers for PUSCH as well. Hence, we think that a FG supporting Rel-18 DMRS types with at least up to 4 layers could be separately defined and it shall not be required with having pre-requisite of a basic feature of supporting UL 8TX.  **Proposal 3-1-6:** Define a FG supporting Rel-15 DMRS types with up to 8 layers.   * Pre-requisite: Basic feature of UL 8TX PUSCH   **Proposal 3-1-7:** Define a FG supporting Rel-18 DMRS types with up to 8 layers.   * Pre-requisite: Basic feature of UL 8TX PUSCH   **Proposal 3-1-8:** Define a FG supporting Rel-18 DMRS types with up to 4 layers.   * Pre-requisite is not needed.   SRS enhancement targeting TDD CJT and 8 TX operation  **Cyclic shift hopping and Comb-offset hopping**  For supporting SRS cyclic shift hopping and comb-offset hopping, we think that separate FG for each hopping scheme, or a single FG with component selecting one of two hopping schemes or both hopping schemes would be required. Since cyclic shift hopping and comb-offset hopping have similarity on the functionality, we think that different components in a single FG could indicate whether to support cyclic shift and/or comb-offset hopping. Note that the applicable SRS is for periodic and semi-persistent SRS with usage of antenna switching. Also, basic feature for SRS as FG 2-52 is needed as a pre-requisite.  **Proposal 3-2-1:** Define a FG supporting SRS cyclic shift hopping and comb-offset hopping by using separate FG for each hopping scheme, or a single FG with component selecting one of two hopping schemes or both hopping schemes.   * Pre-requisite: FG 2-52 * (If one FG is supported) Component: supported hopping scheme(s)   + Candidate value: cyclic shift hopping only, comb-offset hopping only, both cyclic shift hopping and comb-offset hopping * Note: The applicable SRS is for periodic and semi-persistent SRS with usage of antenna switching   In RAN1#112b-e [5], it was agreed the UE behavior of comb-offset hopping within R symbols if repetition factor R>1 is configured, as follows. The intention of the agreement was compromise of two alternatives by RRC configuration.   * Hopping behavior 1: depends on the OFDM symbol index l' of each symbol * Hopping behavior 2: depends on the first symbol across the R repetitions   In legacy SRS, since frequency domain resources are maintained during R symbols if repetition factor R>1 is configured, we think that the UE feature design shall reflect such legacy UE behavior. In other words, the Hopping behavior 2 above (depends on the first symbol across the R repetitions) can be a default hopping behaviour of comb-offset hopping by a UE, and on top of this, the UE can additionally support Hopping behaviour 1. Hence, we can define a UE feature indicating whether Hopping behavior 2 is only supported, or both Hopping behaviour 1 and 2 can be supported.  **Proposal 3-2-2:** Define a FG supporting hopping behavior of comb-offset hopping with repetition factor R>1   * Pre-requisite: Basic feature of SRS comb-offset hopping * Component: Supported hopping behavior   + Candidate value: Hopping behavior 2 only (depends on the first symbol across the R repetitions), or both Hopping behavior 1 (depends on the OFDM symbol index l' of each symbol) and 2.   **8-port SRS considering port mapping method**  In Rel-18 SRS discussion, we adopted two SRS port mapping method: non-TDMed port mapping and TDMed port mapping. We think that two port mappings could be supported by separate FGs. Also, for 8-port SRS with non-TDMed port mapping, the applicable SRS usage could be codebook, non-codebook and antenna switching, and for 8-port SRS with TDMed port mapping, the applicable SRS usage could be codebook and antenna switching.  **Proposal 3-2-3:** Define separate FGs for two port mapping methods: 8-port SRS with non-TDMed port mapping, and 8-port SRS with TDMed port mapping  **Enhanced uplink transmission**  UL precoding indication for multi-panel transmission  **STxMP PUSCH transmission**  In our view, separate UE feature groups for sDCI based STxMP PUSCH schemes and mDCI based STxMP PUSCH should be defined because it requires different UE capability to support each scheme. In addition, if the UE can support sDCI based STxMP PUSCH schemes and/or mDCI based PUSCH STxMP, separate UE feature groups are needed to distinguish UE’s capability to indicate whether to support ‘codebook’ based PUSCH STxMP and/or ‘nonCodebook’ based PUSCH STxMP like Rel-17 sDCI based mTRP PUSCH repetition schemes. In those separate UE feature groups according to scheduling DCI (sDCI vs mDCI) and codebook type (codebook vs non-codebook), the followings can be defined as basic component(s) (or can be defined as separate UE FGs) considering the below RAN1 agreements [2][3]:   * UE can support two SRS resource sets with the usage set to ‘codebook’ or ‘nonCodebook’ * UE can support how many SRS resources in a SRS resource set * UE can support simultaneous transmission with different QCL Type-D * UE can support fully overlapping in frequency and time   **Proposal 4-1-1:** Support separate UE feature groups to support the following systems:   * sDCI based uplink multi-panel transmission (UL STxMP) PUSCH schemes or, * mDCI based UL STxMP PUSCH schemes.   **Proposal 4-1-2:** For either sDCI based STxMP PUSCH schemes or mDCI based STxMP PUSCH schemes, define separate UE feature groups for ‘codebook’ based PUSCH or ‘nonCodebook’ based PUSCH like Rel-17 sDCI based mTRP PUSCH repetition schemes.  **Proposal 4-1-3:** Followings can be considered as basic feature(s) for both sDCI based UL STxMP PUSCH schemes and mDCI based UL STxMP PUSCH schemes:   * Support two SRS resource sets with the usage set to ‘codebook’ or ‘nonCodebook’ * UE can support how many SRS resources in a SRS resource set * Support simultaneous transmission with different QCL Type-D * UE can support fully overlapping in frequency and time   Based on the previous basic UE feature groups, each the multi-panel based transmission schemes can be justified, e.g. sDCI based SDM STxMP PUSCH and sDCI based SFN STxMP PUSCH. As component in the feature group, the UE can indicate the maximum supported number of layers for STxMP (i.e. it can be used for the gNB to configured maxRank or Lmax).  **Proposal 4-1-4:** Define separate UE feature groups for each sDCI based UL STxMP PUSCH scheme(s)   * Define the independent UE feature group for sDCI based SDM STxMP PUSCH scheme   + UE can indicate the maximum supported number of layers for sDCI based SDM STxMP scheme * Define the independent UE feature group for sDCI based SFN STxMP PUSCH scheme   + UE can indicate the maximum supported number of layers for sDCI based SFN STxMP scheme   For mDCI based STxMP PUSCH, it can require further enhanced UE capability to support partially overlapped case rather than fully overlapped case in frequency and time domain. Therefore, independent UE feature group should be justified to support partially overlapped case like Rel-16 mDCI based mTRP PDSCH reception. In our understanding, the UE can support the part(s) of the above combinations and the possible combination(s) could be reported as UE capability. Therefore, the related UE feature group or component in the UE feature group could be defined.  **Proposal 4-1-5:** Define additional UE feature group(s) or component(s) of UE feature group.   * Whether to support two partially overlapping PUSCHs in frequency and time domain * Whether to support the possible overlapping combination(s) among followings:   + DG-PUSCH + DG-PUSCH   + CG-PUSCH + DG-PUSCH   + CG-PUSCH + CG-PUSCH   **STxMP PUCCH transmission**  **Proposal 4-1-6:** Define the UE feature group for sDCI based SFN STxMP PUCCH scheme  **Group-based beam reporting for UL STxMP**  To support all types of multi-panel based UL STxMP schemes, the adequate beam reporting is required because the gNB does not know which beam pair could be proper to support uplink simultaneous transmission. New UE feature group or new component(s) in a UE feature group to support the enhanced group based beam reporting for UL STxMP should be specified in Rel-18.  **Proposal 4-1-7:** Define the UE feature group or component(s) to support for the enhanced group based beam reporting which can be used to report possible beam pair(s) for UL STxMP.  SRI/TPMI enhancement for enabling 8 TX UL transmission  In Rel.15 NR MIMO, the following UE feature groups (FGs) are supported regarding PUSCH transmission from a UE with 1, 2, or 4 antenna ports.   * FG 2-12: Basic PUSCH transmission   + single port codebook-based PUSCH transmission * FG 2-13: PUSCH codebook coherency subset   + one of non-coherent, partial/non-coherent, full/partial/non-coherent * FG 2-14: Codebook based PUSCH MIMO transmission   + maximum number of supported layers from {1,2,4}   + maximum number of SRS resource per set (with usage = codebook) from {1,2} * FG 2-15: Non-codebook based PUSCH transmission   + maximum number of supported layers from {1,2,4}   + maximum number of SRS resource per set (with usage = non-codebook) from {1,2,3,4}   + Maximum number of simultaneous transmitted SRS resources at one symbol from {1,2,3,4}   In Rel.16 eNR MIMO, the following UE feature groups (FGs) are specified regarding full power transmission for non-coherent or partial-coherent precoders.   * FG 16-5a: UL full power transmission mode of fullpower   + Support for full power based on all full-rated PAs * FG 16-5b: UL full power transmission fullpowerMode1   + Support of full power based on a full-coherent precoder * FG 16-5c: UL full power transmission fullpowerMode2   + Support of full power based on SRS virtualization or full power TPMI groups * FG 16-5c-2: UL full power transmission fullpowerMode2 – SRS resources   + Support of full power based on virtualized SRS ports (combing PAs before SRS transmission) * FG 16-5c-3: UL full power transmission fullpowerMode2 – full power TPMI groups   + Support of full power based on TPMIs that can achieve full using at least one (but not all) full-rated PA or all non-full-power PAs   For 8Tx PUSCH transmission, the UE features can be similar to the legacy (above-mentioned) FGs. Based on the agreements and working assumptions that far, the UE features as shown in Table 1 can be supported, wherein a brief explanation of each feature is as follows.   * Basic: support of 8Tx PUSCH transmission * Optional 1: support of codebook-based PUSCH transmission including component 1 for the supported codebook parameter(s) , component 2 for the maximum number of supported layers, and component 3 for the maximum number of SRS resources in a set * Optional 2: support of non-codebook-based PUSCH transmission including component 1 for the maximum number of supported layers, component 2 for the maximum number of SRS resources in a set, and component for the maximum number of simultaneously transmitted SRS resources at one symbol * Optional 3: support for a maximum of 8 layers including component 2 for one or both of the codebook-based and non-codebook-based transmission schemes * Optional 4: support for full power (mode0) for 8Tx * (working assumption) Optional 5: support for full power mode1 for 8Tx * (working assumption) Optional 6: support for full power mode2 for 8Tx * (if working assumption is confirmed) Optional 7: support of a first sub-feature of mode2 that is based on SRS virtualization * (if working assumption is confirmed) Optional 8: support of a second sub-feature of mode2 that is based on full power TPMI group(s)   **Table 1**   |  |  |  | | --- | --- | --- | | **UE features** | **Description** | **Component values** | | Basic | 1. Support 8Tx PUSCH transmission |  | | Optional 1:  Codebook-based 8Tx PUSCH | 1. one or multiple values of {(Ng, N1, N2)  2. Supported codebook based 8Tx PUSCH MIMO with maximal number of supported layers  3. Supported max number of SRS resource per set (SRS set use is configured as for codebook). | Component 1: (1,4,1), (1,2,2), (2,-,-), (4,-,-), (8,-,-)  Component-2:  Candidate value: {1, 2, 4}  Component-3  Candidate value: {1, 2} | | Optional 2:  Non-Codebook-based 8Tx PUSCH | 1. Maximal number of supported layers (non-codebook transmission scheme)  2. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook transmission).  3. Maximum number of simultaneous transmitted SRS resources at one symbol | Optional with UE capability  Component-1 candidate values: {1, 2, 4}  Component-2  Candidate value: {1,2,3,4,5,6,7,8}  Component-3  Candidate value: TBD (legacy {1,2,3,4}) | | Optional 3:  Support for up to 8 layers | 1. Maximum number of supported layers = 8  2. Supported transmission scheme | Candidate value-2: {codebook-based, non-codebook, both} | | Optional 4:  UL full power transmission mode of 8Txfullpower | 1. Supported UL full power transmission mode of 8Txfullpower |  | | working assumption  Optional 5:  UL full power transmission 8TxfullpowerMode1 | 1.Supported UL full power transmission 8TxfullpowerMode1 |  | | working assumption  Optional 6:  UL full power transmission 8TxfullpowerMode2 | 1.The maximum number of SRS resources in one SRS resource set with usage set to 'codebook' for Mode 2: {1, 2, 4} |  | | TBD (if WA is confirmed)  Optional 7:  UL full power transmission 8TxfullpowerMode2 – SRS resources | 1. The SRS configuration with different number of antenna ports per SRS resource for Mode 2 | Component 1: TBD | | TBD (if WA is confirmed)  Optional 8:  UL full power transmission 8TxfullpowerMode2 – full power TPMI groups | 1. TPMI group(s) which delivers full power | Component 1: TBD |   **Proposal 4-2-1:**for 8Tx PUSCH transmission, support feature groups as shown in Table 1   * support feature groups based on simple extension of legacy (Rel.15 and 16) FGs * support a separate FG for a maximum of up to 8 layers PUSCH transmission * support including a component in the FG for codebook-based PUSCH transmission that reports one or multiple values of the codebook parameter |

# Discussion Items during RAN1 #113 — First Checkpoint

After review of contributions submitted to RAN1 #113 in this agenda item, the following topics were identified by the moderator for discussion during RAN1 #113.

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: Multi-TRP enhancement

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

|  |  |  |
| --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1 | Unified TCI with joint DL/UL TCI update for single-DCI based multi-TRP with single activated TCI codepoint per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-1a | Unified TCI with joint DL/UL TCI update for single-DCI based multi-TRP with multiple activated TCI codepoints per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-2 | Unified TCI with separate DL/UL TCI update for single-DCI based multi-TRP with single activated TCI codepoint per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-2a | Unified TCI with separate DL/UL TCI update for single-DCI based multi-TRP with multiple activated TCI codepoints per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-3 | TCI selection for aperiodic CSI-RS in S-DCI based MTRP |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-4 | CJT Tx scheme for PDSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-5 | TRP-specific BFR with unified TCI framework |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-6 | Two default beams for single-DCI based multi-TRP |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-7 | Unified TCI with joint DL/UL TCI update for multi-DCI based multi-TRP with single activated TCI codepoint per CORESETPoolIndex per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-8 | Unified TCI with joint DL/UL TCI update for multi-DCI based multi-TRP with multiple activated TCI codepoints per CORESETPoolIndex per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-9 | Unified TCI with separate DL/UL TCI update for multi-DCI based multi-TRP with single activated TCI codepoint per CORESETPoolIndex per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-10 | Unified TCI with separate DL/UL TCI update for multi-DCI based multi-TRP with multiple activated TCI codepoints per CORESETPoolIndex per CC |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-1-11 | Two default beams for multi-DCI based multi-TRP |

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| Company | Comments/Questions/Suggestions |
| QC | Suggest to add the following FGs, which have been agreed and should be optional as in R17   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40-1-12 | Common multi-CC TCI state ID update and activation for single-DCI based multi-TRP | Common multi-CC TCI state ID update and activation | 40-1-1, 40-1-2 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 40-1-13 | Common multi-CC TCI state ID update and activation for multi-DCI based multi-TRP | Common multi-CC TCI state ID update and activation | 40-1-7, 40-1-9 | Yes |  |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling |   Agreement  On unified TCI framework extension, support the following cases for CA operation:  A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in S-DCI based MTRP  A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in M-DCI based MTRP  FFS: A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in S-DCI based MTRP   * + FFS: How to support common TCI state ID activation/update for this case   FFS: A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in M-DCI based MTRP   * + FFS: How to support common TCI state ID activation/update for this case   FFS: A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in S-DCI based MTRP and CC(s) operating in M-DCI based MTRP   * + FFS: How to support common TCI state ID activation/update for this case   FFS: A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP, CC(s) operating in S-DCI based MTRP, and CC(s) operating in M-DCI based MTRP   * + FFS: How to support common TCI state ID activation/update for this case |
| Apple | The problem is actually on the details of the components, in our view, the following things are not clear   * How to separate intra-cell and inter-cell multi-TRP * How to control the memory and UE processing complexity related to uTCI extension to mTRP * Beam mismatch between indicated TCI state and SRS used for PUSCH scheduling * Unified TCI framework for Single-DCI Multi-TRP, DCI format 1\_1/1\_2 configured without the [TCI selection field] |
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# Issue 2: Two TAs for multi-DCI

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

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| --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-1 | Basic feature for multi-DCI based intra-cell Multi-TRP operation with two TA enhancement |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-2 | Basic feature for multi-DCI based inter-cell Multi-TRP operation with two TA enhancement |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-3 | Basic feature for multi-DCI based intra-cell Multi-TRP operation with two TA enhancement—separate DL/UL TCI states |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-4 | Basic feature for multi-DCI based inter-cell Multi-TRP operation with two TA enhancement—separate DL/UL TCI states |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-5 | Two TAs for multi-DCI based STxMP PUSCH+PUSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-6 | Support of a PDCCH order sent by one TRP triggers RACH procedure (specifically PRACH) towards a different TRP based on CFRA, at least for the inter-cell case. |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-7 | TCI states of one CORESET Pool associated to both TAGs |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-8 | TCI states of one CORESET Pool associated to both TAGs—separate DL/UL TCI states |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-2-9 | Rx timing difference larger than CP length |

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| Company | Comments/Questions/Suggestions |
| Apple | * Based on the description: FG40-2-1/FG40-2-2/FG40-2-7 can be clarified as “- joint TCI states”? * We miss seberal UE complexity related   + “Maximum number of n-TimingAdvanceOffset value per serving cell”   + “The maximum number of TAGs all CCs” |
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# Issue 3: CJT CSI enhancement

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

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| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-1 | Support of Rel-16-based CJT measurement |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-2 | FD basis selection offset mode for Rel-16-based CJT codebook with mode1 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-3 | Support R=2 for Rel-16-based CJT codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-4 | Support pv={1/2,1/2,1/2,1/2} and beta=1/2 for Rel-16-based CJT codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-5 | Support of Rel-17-based CJT measurement |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-6 | FD basis selection offset mode for Rel-17-based CJT codebook with mode1 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-7 | Support of M=2 and R=1 for Rel-17-based CJT codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-8 | Support R=2 for Rel-17-based CJT codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-9 | 2NN1N2 >32 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-1-10 | dynamic selection of N<N\_TRP |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | In our view, we are generally fine to have the above listed FGs, and some main essential or missed ones are:  For Rel-16-based,   * Support of Rank 3,4 * Support of ParamCombos other than basic PCs depending on value of NTRP, , and/or {pv,beta} (FFS) * Timeline (still under discussion in this 113 meeting) * OCPU (still under discussion in this 113 meeting)   For Rel-17-based,   * Support of Rank 3,4 * Support of ParamCombos other than basic PCs, depending on value of NTRP, , and/or beta (FFS) * Timeline (still under discussion in this 113 meeting) * OCPU (still under discussion in this 113 meeting)   For a mixed,  Active CSI-RS resources and ports for mixed Type-II-CJT codebook types in any slot (analogous to 23-9-5) |
| Apple | For Rel-16 based, miss the following feature   * “Support of L=6” * “Support of Rank 3, 4” * “Active CSI-RS resources and ports in the presence of multi-TRP NCJ eType-II regular”, i.e., concurrent codebook   For Rel-17 based, miss the following feature   * “Support of Rank 3, 4” * “Active CSI-RS resources and ports in the presence of multi-TRP NCJ FeType-II port selection”, i.e., concurrent codebook. * “Unequal number of spatial basis selection for multi-TRP CJT” |
| Samsung | We are fine with the above as the starting point with the following revision:   * 40-3-1-1: Support of Rel-16-based CJT measurement (including the support for mode2) * 40-3-1-2: Additional support for FD basis selection offset mode for Rel-16-based CJT codebook with mode1 * 40-3-1-3: Additional support for R=2 for Rel-16-based CJT codebook * 40-3-1-4: Additional support pv={1/2,1/2,1/2,1/2} and beta=1/2 for Rel-16-based CJT codebook * 40-3-1-5: Support of Rel-17-based CJT measurement (including the support for mode2) * 40-3-1-6: Additional support for FD basis selection offset mode for Rel-17-based CJT codebook with mode1 * 40-3-1-7: Additional support of M=2 and R=1 for Rel-17-based CJT codebook * 40-3-1-8: Additional support R=2 for Rel-17-based CJT codebook * 40-3-1-9: Additional support for 2NN1N2 >32 (conditioned upon support for 40-3-1-1 and/or 40-3-1-2) * 40-3-1-10: Additional support for dynamic selection of N<N\_TRP (conditioned upon support for 40-3-1-1 and/or 40-3-1-2) |

# Issue 4: Rel-18 Type-II-Doppler CSI

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

|  |  |  |
| --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-1 | Support of Rel-16-based doppler measurement |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-2 | Support R=2 for Rel-16-based doppler codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-3 | Support X=1 CQI for Rel-16-based doppler codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-3 | Support X=2 CQI for Rel-16-based doppler codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-4 | Support of Rel-17-based doppler measurement |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-5 | Support of M=2 and R=1 for Rel-17-based doppler codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-6 | Support R=2 for Rel-17-based doppler codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-2-7 | support of l = (n – nCSI,ref ) for CSI reference slot |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | Some clarifications to 40-3-2-3  “Support X=1 CQI based on averaging first and last slot of WCSI, for Rel-16-based doppler codebook”  We are generally fine to have the above listed FGs, and some main essential or missed ones are:  For Rel-16-based,   * Support of Rank 3,4 * Support of ParamCombos with L=6 * Timeline (still under discussion in this 113 meeting) * OCPU (still under discussion in this 113 meeting)   For Rel-17-based,   * Support of Rank 3,4 * Timeline (still under discussion in this 113 meeting) * OCPU (still under discussion in this 113 meeting)   For a mixed,  Active CSI-RS resources and ports for mixed Type-II-CJT codebook types in any slot (analogous to 23-9-5) |
| Apple | For Rel-16 based, miss the following feature   * “Support of L=6” * “Support of Rank 3, 4” * “Active CSI-RS resources and ports in the presence of multi-TRP NCJ eType-II regular”, i.e., concurrent codebook   For Rel-17 based, miss the following feature   * “Support of Rank 3, 4” * “Active CSI-RS resources and ports in the presence of multi-TRP NCJ FeType-II port selection”, i.e., concurrent codebook.   General, miss the following feature   * “CSI reference resource as time domain location for CSI prediction” |
| Samsung | FGs can based on simple extension of legacy (Rel.16,17) FGs:  40-3-2-1: Support of Rel-16-based doppler measurement, including components   * Support X=1 CQI based on one slot * Support R=1 * Support parameter combinations with L=2,4 * Support for rank = 1,2   40-3-2-2: Support R=2 for Rel-16-based doppler codebook  ~~4~~0-3-2-3: Suppor X = 1 CQI based on 2 slots for Rel-16-based doppler codebook  40-3-2-3: Support X=2 CQI for Rel-16-based doppler codebook  40-3-2-3B: Support parameter combination with L=6 (L=6 is a separate capability in legacy)  40-3-2-4: Support of Rel-17-based doppler measurement, including component   * Support of M = 1 * Support for rank = 1,2   40-3-2-8: Support rank = 3-4 applicable to 40-3-2-1 and 40-3-2-4 (rank 3-4 is a separate capability inlegacy Rel.16/17)  40-3-2-9: Support for K=12 aperiodic NZP CSI-RS resouces (applicable to 40-3-2-1 and 40-3-2-4) |

# Issue 5: TDCP

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

|  |  |  |  |
| --- | --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-1 | TDCP (Time Domain Channel Properties) report | 1. Support of Y=1 delay value for TDCP report 2. Support of delay<=D\_basic symbols  3. Support of amplitude report |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-2 | Number of delay values | Number Y>1 of delay values |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-3 | Delay value | Supported delay value >D\_basic |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-3-3-4 | Phase report | Support of phase report |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | We are generally fine to have the above listed FGs, and we think the following one FG is essential for UE cost (buffer):  Number of CSI-RS resources for TD: Per-CC, across all CCs, and, simultaneous across all CCs (analogous to 2-33 or 16-1g) |
| Apple | In general, we are fine, it depends on the components discussion |

# Issue 6: DMRS enhancements

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

|  |  |  |
| --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1 | Basic feature of Rel.18 enhanced DMRS ports for PDSCH for scheduling type A |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-1a | Basic feature of Rel.18 enhanced DMRS ports for PDSCH for scheduling type B |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-2 | Additional support of eType2 DMRS for PDSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-3 | Additional support of maxLength = 2 for enhanced DMRS for PDSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-4 | Reception of PDSCH without the scheduling restriction for Rel.18 eType1 DMRS ports |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-5 | Additional row(s) of Rel.18 DMRS ports for single-DCI based M-TRP |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-6 | Basic feature of Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-7 | Additional support of eType2 DMRS for PUSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-8 | Additional support of maxLength = 2 for enhanced DMRS for PUSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-9 | UL PTRS RE mapping for Rel.18 enhanced DMRS ports for PUSCH with rank 1-4 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-10 | Rel.15 DMRS ports for PUSCH with rank 5-8 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-11 | Rel.18 enhanced DMRS ports for PUSCH with rank 5-8 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-12 | UL PTRS for PUSCH with rank 5-8 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-4-13 | Orphan RE handling |

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| Company | Comments/Questions/Suggestions |
| QC | A general comment: to safe effort for the group, we should use Rel-15 DMRS FG structure as a starting point to determine the Rel-18 DMRS FG structure.  Then, we have a few detailed comments as below.  After 40-4-1a, for DL DMRS with single symbol front loaded DMRS, FG “Support 1+2 DMRS (downlink)” and “Support 1+3 DMRS symbols(downlink)” are missed.  For 40-4-3, we need break 40-4-3 into several FGs. We cannot support all FGs of dual symbol DMRS in one package. In Rel-15, we had two FGs “Supported 2 symbols front-loaded DMRS(downlink)” and “Supported 2 symbols front-loaded +2 symbols additional DMRS(downlink)” for dual symbol DMRS. We can follow the same structure for Rel-18.  For 40-4-5, on top of this FG to report the additional row {0,2,3} single-DCI based M-TRP, we need a FG to indicate support the generic feature of single-DCI based M-TRP with Rel-18 DMRS or not. The reason is because they are other rows for single-DCI based M-TRP besides the special row {0,2,3}.  Related to 40-4-5 on M-TRP, we need add another FG for “Support Rel-18 DL DMRS with M-DCI based M-TRP”  For 40-4-6 (Basic feature of Rel.18 enhanced DMRS ports for PUSCH with rank 1-4), we prefer follow Rel-15 to break this into FGs for scheduling type A and type B, and add “Support 1+2 DMRS (uplink)”, “Support 1+3 uplink DMRS symbols(uplink)”.  40-4-8: following Rel-15, this can be break into two FGs of “Supported 2 symbols front-loaded DMRS (uplink)”, “Supported 2 symbols front-loaded +2 symbols additional DMRS (uplink)”.  40-4-13(Orphan RE handling) seems the same functionality as 40-4-4 “Reception of PDSCH without the scheduling restriction for Rel.18 eType1 DMRS ports”. |
| Apple | * We need to clarify that FG40-4-1/1a is for eType 1 DMRS for PDSCH * We miss the MU-MIMO scheduling restriction, at least, need to discuss she following   + “MU-MIMO between Rel.15 DMRS ports and Rel.18 DMRS ports for PDSCH within a CDM group”   + “MU-MIMO with Rel.18 DMRS ports for PDSCH when antenna ports are in more than one CDM group” |
| Samsung | We are fine with the above as the starting point with the following revision:   * 40-4-1 Basic feature of Rel.18 enhanced Type-I DMRS ports for PDSCH for ~~scheduling~~ mapping type A * 40-4-1a Basic feature of Rel.18 enhanced Type-I DMRS ports for PDSCH for ~~scheduling~~ mapping type B * 40-4-2 Additional support of ~~eType2 DMRS for PDSCH~~Rel-18 enhanced Type-II DMRS ports * 40-4-7 Additional support of Rel-18 enhanced Type-II DMRS ports ~~of eType2 DMRS~~ ~~for PUSCH~~ * Remove FG 40-4-1, since FG 40-4-4 is already expressing orphan RE handling in FG 40-4-13. |

# Issue 7: SRS enhancements

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

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| --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-1 | SRS comb offset hopping/cyclic shift hopping |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-2 | Comb offset hopping time-domain behavior when repetition factor R>1 |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-3 | Comb offset hopping combined with one of group / sequence hopping on a SRS resource |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-4 | SRS with 8 Tx ports—antenna switching |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-4a | SRS with 8 Tx ports—codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-4b | SRS with 8 Tx ports—noncodebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-5 | SRS with 8 Tx ports and comb 8—antenna switching |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-5a | SRS with 8 Tx ports and comb 8—codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-5b | SRS with 8 Tx ports and comb 8—noncodebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-5-6 | SRS with TDMed 8 Tx ports |

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| Company | Comments/Questions/Suggestions |
| QC | 40-5-1 needs to be separated into two FGs as comb offset hopping and the cyclic shift hopping are separate and independent features.  40-5-6 (SRS with TDMed 8 Tx ports): This need to break into several FGs. Basically, each above SRS FG with 8 TX ports will need to have a TDM version and a nonTDM version.  40-5-5/40-5-5a/40-5-5b maybe can be absorbed into 40-5-4/40-5-4a/40-5-4b as a component, with candidate value to indicate support or not support comb 8. |
| Apple | This does not make sense   * FG40-5-4b “SRS with 8 Tx ports—noncodebook” * FG40-5-5b “SRS with 8 Tx ports and comb 8—noncodebook” |
| Samsung | We are fine with the above as the starting point. One thing we can argue is that, we don’t see a necessity to divide FGs for SRS with 8TX ports by Comb 8 and by usage. Similar with FG 40-5-6 SRS with TDMed 8TX ports, we can merge into one FG 40-5-4 SRS with non-TDMed 8TX ports including Comb 8 and usage (CB, NCB, AS). |

# Issue 8: STXMP

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

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| --- | --- | --- |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1 | Single-DCI based STx2P SDM scheme for PUSCH—codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1a | Single-DCI based STx2P SDM scheme for PUSCH—noncodebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1-2 | New DMRS port entry for single-DCI based SDM scheme |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-1-3 | 2 PTRS ports for SDM scheme |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2 | Single-DCI based STx2P SFN scheme for PUSCH—codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-2a | Single-DCI based STx2P SFN scheme for PUSCH—noncodebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3 | multi-DCI based STx2P PUSCH+PUSCH—codebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-3a | multi-DCI based STx2P PUSCH+PUSCH—noncodebook |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-4 | Single-DCI based STx2P SFN scheme for PUCCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-6-5 | Support grouped-based beam reporting for STx2P |

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| Company | Comments/Questions/Suggestions |
| QC | For each NCB-based (40-6-1a / 40-6-2a / 40-6-3a), there needs to be another (dependent FG) on “Associated CSI-RS resources”.  Furthermore, for multi-DCI, we suggest the following FGs on overlapping (the basic FGs 40-6-3 and 40-6-3a should be limited to “Support fully overlapping PUSCHs in time and non-overlapping in frequency”)   * Partial-overlapping PUSCHs in time and non-overlapping in frequency * Overlapping PUSCHs in time and fully overlapping in frequency and time * Overlapping PUSCHs in time and partially overlapping in frequency |
| Apple | We miss the following   * Dynamic switching by DCI 0\_1/0\_2 between single-DCI STxMP SDM and sTRP * Dynamic switching by DCI 0\_1/0\_2 between single-DCI STxMP SFN and sTRP * For mult-DCI STxMP, the different overlapping mode   + fully overlapping in both frequency and time.   + fully overlapping in frequency, partially overlapping in time   + partially or non-overlapping in frequency, partially or fully overlapping in time |
| Samsung | In our understanding, ‘Overlapping PUSCHs in time and fully overlapping in frequency and time’ and ‘Overlapping PUSCH in time and partially overlapping in frequency’ can be specified separately like Rel-16 UE feature 16-2a-0 (Overlapping PDSCHs in time and fully overlapping in frequency and time) and 16-2a-1 (Overlapping PDSCHs in time and partially overlapping in frequency)  New feature group to report one or more among followings is needed (e.g. supported grant type for multi-DCI based STx2P PUSCH+PUSCH):   * DG-PUSCH+DG-PUSCH * DG-PUSCH+CG-PUSCH * CG-PUSCH+CG-PUSCH |

# Issue 9: UL 8TX

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Agree the following FGs/rows as baseline for further discussions**

* **All details FFS**

|  |  |  |
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| 40. NR\_MIMO\_evo\_DL\_UL | 40-7-1 | Basic features for Codebook-based 8Tx PUSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-7-2 | Basic features for Non-Codebook-based 8Tx PUSCH |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-7-3 | Support for up to 8 layers |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-7-4 | UL full power transmission modes |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-7-5 | Number of antenna groups (Ng) |
| 40. NR\_MIMO\_evo\_DL\_UL | 40-7-6 | Full-coherent codebook parameters |

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| Company | Comments/Questions/Suggestions |
| QC | 40-7-3: In Rel-15, UE can indicate max # layers separately for codebook and non-codebook based PUSCH. We need break 40-7-3 into two FGs to indicate # layers for codebook and non-codebook based PUSCH. Also, RAN1 had specific agreement to indicate max # layers (i.e., 1,2,3,4,5,6,7,8). It is not just a bit to indicate support up to 8 layer or not. The granularity is we can indicate every number from 1 to 8.  40-7-4: follow Rel-16, we should have separate FGs for full power mode 0, 1, 2, separately.  Another minor comment: we missed a FG on “CBG based PUSCH with rank >4” |
| Apple | We miss the following feature   * “CBG-based re-transmission for UL using CBGTI for 2 CW” * “Supported codebook coherency subset type when UE is configured with 2/4 Tx codebook based PUSCH operation while UE supports 8 Tx. “ |
| Samsung | Since 8Tx UL is a new feature, FGs can based on simple extension of legacy (Rel.15 and 16) FGs:   * 40-7-1: Basic features for Codebook-based 8Tx PUSCH including components   + component 1 for the supported codebook parameter(s) ,   + component 2 for the maximum number of supported layers; values {1,2,4}, and   + component 3 for the maximum number of SRS resources in a set; values {1,2} * 40-7-2: Basic features for Non-Codebook-based 8Tx PUSCH including components   + component 1 for the maximum number of supported layers; values {1,2,4}, and   + component 2 for the maximum number of SRS resources in a set; values {1,2,3,4,5,6,7,8}   + component 3 for the maximum number of simultaneous transmitted SRS resources at one symbol * 40-7-3: Additional Support for up to 8 layers (conditioned upon support for 40-7-1 and/or 40-7-2) * 40-7-4: Additional Support for UL full power transmission mode~~s~~ 0 (conditioned upon support for 40-7-1) * 40-7-5: Additional Support for UL full power transmission mode 1 (conditioned upon support for 40-7-1) * 40-7-6: Additional Support for UL full power transmission mode 2 (conditioned upon support for 40-7-1) * ~~40-7-5: Number of antenna groups (Ng) –~~ This can be included in 40-7-1; no need for separate FS * ~~40-7-6: Full-coherent codebook parameters) –~~ This can be included in 40-7-1; no need for separate FS |

# Discussion Items during RAN1 #113 — 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 Items during RAN1 #113 — 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 #113 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. R1-2304227, Initial RAN1 UE features list for Rel-18 NR after RAN1#112bis-e, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2304401, Discussion on UE features for NR MIMO evolution, ZTE
3. R1-2304507, Discussion on Rel-18 MIMO UE features, vivo
4. R1-2305275, Views on UE features for Rel-18 NR MIMO evolution, Apple
5. R1-2305367, UE features for NR MIMO evolution, Qualcomm Incorporated
6. R1-2305409, UE features for Rel-18 MIMO evolution, OPPO
7. R1-2305542, UE features for Rel-18 MIMO, Rapporteur (Samsung)
8. R1-2305698, Discussion on UE features for Rel18 MIMO, Ericsson
9. R1-2305718, Initial views on UE features for MIMO evolution, Nokia/Nokia Shanghai Bell
10. R1-2305927, UE features for NR MIMO evolution, Huawei/HiSilicon
11. R1-2305955, UE features for Rel-18 MIMO, Samsung