**3GPP TSG RAN WG1 #107bis-e R1-200xxxx**

**e-Meeting, January 17th – 25th, 2022**

**Source: Ad-Hoc Chair (AT&T)**

**Title: Session Notes of AI 8.15.1**

**Agenda Item:** **8.15.1**

**Document for:** **Endorsement**



#### 8.15.1 UE features for further enhancements on NR-MIMO

[107bis-e-R17-UE-features-MIMO-01] Email discussion UE features for further enhancements on NR-MIMO – Ralf (AT&T)

* 1st check point: January 20
* Final check point: January 25

**Agreement: Adopt the following changes highlighted in green, while keeping the yellow highlighting as shown**

* The following are the components of the feature “joint TCI for intra-cell operation”

1. Joint DL/UL TCI update with their components: (configuration mechanism, ~~[~~QCL rules,~~]~~ applicable source and target signals, ~~MAC-CE -based TCI]~~ ~~activation~~)
2. Common multi-CC TCI update and activation ~~(involving RRC common TCI state pool)~~
3. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS ~~[for PUCCH, PUSCH, and SRS]~~
4. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS
5. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state]  
   b) ~~[~~MAC-CE+DCI-based TCI state indication (~~including TCI state activation,~~ use of DCI formats 1\_1/1\_2 with ~~and without~~ DL assignment)~~]~~  
   c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)
6. [TCI states pool for configured reference BWP/CC shared by a set of BWP/CC] FFS: (involving RRC common TCI state pool)
7. [Maximum number of CCs configured with BFR]
8. [R17 mechanism reusing R15/16 signalling to indicate R17 TCI for individual DL channel/RS that cannot share the same unified TCI as UE-dedicated PDCCH/PDSCH]
9. [Configuration of both R17 TCI and R15/16 TCI and spatial relation]
10. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination]
11. ~~[~~The maximum number of configured joint TCI states across all BWPs and all CCs in a band~~]~~ [in a band combination]
12. ~~[~~The maximum number of configured joint TCI states per CC ~~[~~in a band~~]]~~ [in a band combination]
13. ~~[~~The maximum number of MAC-CE activated joint TCI states ~~[per BWP per CC/~~across ~~all BWPs and~~ all CCs in a band~~]]~~ in a band combination  
    a) The maximum number of MAC-CE activated joint TCI states per CC in a band in a band combination
14. [Whether a particular DL RS that is a valid target DL RS of a Rel-15/16 TCI state based on the Rel-15/16 QCL rules can be configured as a target DL RS of Rel-17 DL TCI (hence the Rel-17 DL TCI state pool)]
15. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS]
16. [The minimum time gap between the beam indication PDCCH and first slot where beam is applied]

* This list gives no guidance as to how to group these components into FGs. They may be mapped to one or more FGs and one or more of these FGs may be agreed as basic. Specifically, different FGs can be grouped together through notes “a UE supporting this FG must also support FG 23-x-y”. This allows to create “basic” FGs while allowing, e.g., different types for different components/candidate values.

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* The following are the components of the feature “joint TCI for intra-cell operation”

1. Joint DL/UL TCI update with their components: (configuration mechanism, ~~[~~QCL rules,~~]~~ applicable source and target signals, ~~MAC-CE -based TCI]~~ ~~activation~~)
2. Common multi-CC TCI update and activation ~~(involving RRC common TCI state pool)~~
3. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS ~~[for PUCCH, PUSCH, and SRS]~~
4. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS
5. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state]  
   b) ~~[~~MAC-CE+DCI-based TCI state indication (~~including TCI state activation,~~ use of DCI formats 1\_1/1\_2 with ~~and without~~ DL assignment)~~]~~  
   c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment)
6. ~~[TCI states pool for configured~~ Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CC~~]~~Note: agree component, final wording may change (e.g., when this is merged with other components/FGs)
7. ~~[~~Maximum number of CCs configured with BFR~~]~~   
   FFS whether this is a component or just a note in the FG to reuse R16 signaling
8. [R17 mechanism reusing R15/16 signalling to indicate R17 TCI for individual DL channel/RS that cannot share the same unified TCI as UE-dedicated PDCCH/PDSCH]
9. ~~[Configuration of both R17 TCI and R15/16 TCI and spatial relation]~~
10. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination]  
    FFS: Whether to make component 6 a prerequisite or merge with 6
11. [The maximum number of configured joint TCI states across all BWPs and all CCs in a band] [in a band combination]
12. ~~[~~The maximum number of configured joint TCI states [per BWP per CC] [in a band]~~]~~ [in a band combination]
13. ~~[~~The maximum number of MAC-CE activated joint TCI states ~~[per BWP per CC/~~across ~~all BWPs and~~ all CCs [in a band]~~]]~~ [in a band combination]  
    a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination]
14. ~~[Whether a particular DL RS that is a valid target DL RS of a Rel-15/16 TCI state based on the Rel-15/16 QCL rules can be configured as a target DL RS of Rel-17 DL TCI (hence the Rel-17 DL TCI state pool)]~~
15. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS]
16. [The minimum time gap between the beam indication PDCCH and first slot where beam is applied]

* This list gives no guidance as to how to group these components into FGs. They may be mapped to one or more FGs and one or more of these FGs may be agreed as basic. Specifically, different FGs can be grouped together through notes “a UE supporting this FG must also support FG 23-x-y”. This allows to create “basic” FGs while allowing, e.g., different types for different components/candidate values.

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

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| 23. NR\_FeMIMO | 23-2-1 | ~~[Multi-TRP]~~ PDCCH repetition | 1. Support of intra-slot PDCCH repetition ~~(~~based on two linked SS sets associated with corresponding CORESETs~~)~~ [with [non-SFN scheme] TDM and FDM] [(except FR2)] [including PDCCH repetition for Type 3 CSS]  2. Support of reporting one ~~[or more]~~ number~~(s)~~ as required number of BDs for the two PDCCH candidates  ~~3. [If 3 or {2, 3} is reported in component 2,] support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET [for the case that the linked PDCCH candidates is 3 BDs] [If 2 or {2,3} is reported in component 2, the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs.]~~  FFS: ~~4~~3. Support max number of overlaps when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate per scheduled component carrier |  |  |  |  |  |  |  |  | ~~Component 1 details FFS~~  Component 2 candidate values: ~~details FFS~~ 2 or 3  ~~Component 3 candidate values: details FFS {monitored, not monitored}~~  Component 4 candidate values: [{0,1,2,3}] ~~details FFS~~  [Note: UE supports PDCCH repetition for the following (basic) PDCCH monitoring capability: For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot]  Note: for component4, if N PDCCH candidates are overlapped, the number of overlaps is counted as one. | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-2-1a | Monitoring of individual candidates | Support of monitoring of individual candidates when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET | [23-2-1] |  |  |  |  |  |  |  | [Note: [If 2 is reported in component 2 of FG 23-2-1,] the individual candidate is monitored when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET for the case that the linked PDCCH candidates is 2 BDs. If 3 is reported in component 2, support of whether the individual candidate is monitored or not when one of the linked PDCCH candidates uses the same set of CCEs as an individual (unlinked) PDCCH candidate, and they both are associated with the same DCI size, scrambling, and CORESET] | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-3-1 | Multi-TRP PUSCH repetition (type A)[-CB] | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A) [for CB]  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions]  ~~[2. Support of cyclic mapping when the number of repetitions is larger than 2 for single DCI based M-TRP PUSCH repetition Type A]~~  ~~[3. Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2]~~  ~~[4. Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.) ]~~  ~~[5. Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.) ]~~  ~~[6. support of sequential mapping for single for single DCI based M-TRP PUSCH repetition Type A]~~  [7. The maximum number of PHR reporting across all CCs (including those related to M-TRP PUSCH repetition and the legacy Rel-15/16 PUSCH transmission)]  ~~[8. Support of A-CSI report on two PUSCH repetitions]~~  ~~[9. Support of SP-CSI report on two PUSCH repetitions]~~  [2. Support dynamic switching between multi-TRP PUSCH scheme and single-TRP PUSCH transmission]  FFS: ~~[11.~~ Support PUSCH operations: CB based and NCB based and corresponding parameters including number of SRS resources~~]~~ |  |  |  |  |  |  |  |  | [Candidate component values: {CB, non-CB, both}] | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1a | Cyclic mapping | Support of cyclic mapping when the number of repetitions is larger than 2 for single DCI based M-TRP PUSCH repetition Type A |  |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1b | Second TPC field | Support of second TPC field for per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2 |  |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1c | Two PHR reporting | Support of PHR reporting related to M-TRP PUSCH repetition (calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.) |  |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1e | A-CSI report | Support of A-CSI report on two PUSCH repetitions |  |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1f | SP-CSI report | Support of SP-CSI report on two PUSCH repetitions |  |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-1g | CG PUSCH transmission | Support of CG PUSCH transmission towards M-TRPs using a single CG configuration (Use same beam mapping principals as dynamic grant PUSCH repetition scheme.) |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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

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| 23. NR\_FeMIMO | 23-5-1 | Group based L1-RSRP reporting enhancements | 1. Max number N of beam groups (M=2 beams per beam group) in ~~Support~~ a single L1-RSRP reporting instance ~~consisting of N beam groups and M=2 beams per [pair/group]~~ ~~[in one report instance]~~ based on measurement on two CMR resource sets  ~~2. [Support of enhanced group-based reporting for Rel-17 M-TRP]~~  [2~~3.~~ Maximum number of SSB and CSI-RS resources for measurement in both CMR sets within a slot across all CCs]  [3~~4.~~ Maximum number of configured SSB and CSI-RS resources for measurement in both CMR sets across all CCs]  ~~5. [Support beam measurement on two CMR resource sets]~~  ~~6. [Support of enhanced group-based reporting for Rel-17 intra-cell and inter-cell mTRP]~~ |  |  |  |  |  |  |  |  | Component 1 candidate values: {1,2,3,4}  Component 2 candidate values: FFS  Component 3 candidate values: FFS  FFS: If FG 23-5-a is not introduced, the relationship of this FG with FG 16-1g/16-1g-1 needs to be further clarified | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-5-1a | Resources [for beam management , PL measurement, BFD, RLM, and new beam identification] | Note: Strive to align the final implementation of FG 23-5-1a with related R15/16 implementations  If 23-5-1a ends up being identical to one or more of Rel.15/ 16 FGs this row will be deleted |  |  |  |  |  |  |  |  | Component 1 candidate values: FFS | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-5-2 | MTRP BFR enhancements | 1. Support of the maximum number of BFD-RS resources per set  [2. Support of Rel-17 M-TRP BFR based on two BFD-RS sets]  ~~3. [Maximum number of CSI-RS resources of both BFR-RS sets across all CCs]~~  ~~4. [Maximal number of different SSBs of both BFD-RS sets across all CCs]~~  ~~5. [Maximal number of different CSI-RS and/or SSB resources of both NBI-RS sets across all CCs]~~  [3. [Support of one ~~up to two~~ PUCCH-SR resource~~s~~ for MTRP BFRQ]  4~~7~~. ~~[~~Supported maximum number of BFD-RS resources across two BFD-RS sets per BWP~~]~~  ~~8. [Support of [single DCI/multi-DCI] based BFR enhancement]~~ |  |  |  |  |  |  |  |  | [Candidate values: {1, 2,…}] | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-5-2a | PUCCH-SR resources for MTRP BFRQ | 1. Max number of PUCCH-SR resources for MTRP BFRQ  [2. Association between BFD-RS resource set on sPCell and a PUCCH SR resource (if component candidate value equals 2)] |  |  |  |  |  |  |  |  | Component candidate values: {[0,1], 2} | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-7-1 | Basic Features of CSI Enhancement for Multi-TRP | 1. Support ~~Maximum number~~ of NZP CSI-RS resource pairs used as CMR (channel measurement resource) pairs for NCJT measurement hypothesis: Support of N~~max~~=1 2. ~~FFS:~~ Maximum number of NZP CSI-RS resources in one CSI-RS resource set: Ks,max 3. CSI report mode [selection] of mode 1 with X=0 [and/or] mode 2 4. ~~Maximum value of numberOfSingleTRP-CSI-Mode1~~ 5. A list of [supported combinations, up to 16, across all CCs simultaneously, where each combination is]    * 1. [Maximum number of Tx ports in one NZP CSI-RS resource associated with a single-TRP measurement hypothesis]      2. Maximum number of Tx ports in one NZP CSI-RS resource associated with an NCJT measurement hypothesis      3. [Maximum total number of CMRs for ~~calculated~~ single-TRP measurement ~~hypotheses~~] [per CC/across all CCs]      4. Maximum total number of CMRs for ~~calculated~~ NCJT measurement ~~hypotheses~~ [per CC/across all CCs]      5. [Maximum total number of Tx ports of NZP CSI-RS resources associated with single-TRP measurement hypotheses] [per CC/across all CCs]      6. Maximum total number of Tx ports of NZP CSI-RS resources associated with NCJT measurement hypotheses [per CC/across all CCs]      7. [Maximum total number of Tx ports of NZP CSI-RS resources associated with one NCJT measurement] 6. [A list of (Y1,Y2): UE can process Y1 NCJT CSI ~~report(s)~~ and Y2 sTRP CSI measurement hypothesis ~~report(s)~~ simultaneously in a CC] 7. [A list of (X1,X2): UE can process X1 NCJT CSI ~~report(s)~~ and X2 sTRP CSI measurement hypothesis ~~report(s)~~ simultaneously across all CCs]   ~~FFS others (supported options; values for X, codebook types, number of ports of CMRs, CMR sharing among NCJT and sTRP measurement hypotheses for FR1, two CMR groups with Ks=K1+K2 CMRs in CSI-RS resource set, reporting of 2 PMIs, 2 RIs and 2 Lis for NCJT measurement hypothesis …)~~ | FFS |  |  |  | [Per band and~~/~~ per BC] |  |  |  | [Component 2 candidate value set: {[0, 2, 3,] 4, 5, 6, 7, 8}]  [Component 3 candidate value set: { mode 1 with X=0, mode 2, both]  ~~Component 4 candidate values: {0, 1, 2}~~  Component 5 candidate values:   1. [{2, 4, 8, 12, 16, 24, 32}] 2. {2, 4, 8, 12, 16[, 24, 32]} 3. [{1,2,3,4 … 64}] 4. {~~1,~~2,3,4 … ~~1~~64} 5. [{4,5,6, …, 256}] 6. {2,3,4, …, 256}   [Component 6: The list can have maximum of 16 pairs.  - Y1: {1 to 4}  - Y2: {1 to 8}]  [Component 7: The list can have maximum of 16 pairs.  - X1: {1 to 16}  - X2: {1 to 32}]  Note: ‘NCJT’ is not used in RAN1 specifications and will be aligned with 38.214 | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-7-1a | Additional CSI report mode 1 selection | Maximum value of numberOfSingleTRP-CSI-Mode1 |  |  |  |  |  |  |  |  | Component 1 candidate value set: { ~~mode 1 with~~ X=1, ~~mode 1 with~~ X=2} | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-4 | IntCell-mTRP | 1. Support of RRC configuration of additional PCI different from serving cell associated with the TCI state and/or QCL-info  [2. The maximum number of configured additional PCIs is X1 when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI]  [3. The maximum number of configured additional PCIs is X2 when the configurations of SSB time domain positions and periodicity of the additional PCIs is different with SSB time domain positions and periodicity of the serving cell PCI]  ~~[2. Support of X>1 (max number of PCIs different from serving cell)]~~  ~~[3. Supported max number of RRC-configured PCIs different from serving cell PCI for [FR1/case1] (X1)] [SSB time domain positions or periodicity of additional PCIs is not exactly the same as serving cell PCI)]~~  ~~[4. Supported max number of RRC-configured PCIs different from serving cell PCI for [FR2/case2] (X2)] [SSB time domain positions and periodicity are exactly the same among the additional PCIs and the same as serving cell PCI]~~  ~~[5. default case to be supported, e.g., case2 with X2=1]~~ |  |  |  |  |  |  |  |  | [Component 2 candidate values: {1,2,3,7}]  [Component 3 candidate values: {0,1,2,3,7}]    [Note: case1 and case2 cannot be enabled simultaneously] | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-6-1 | SFN scheme A (scheme 1) for PDSCH and PDCCH | 1. ~~[~~Support of SFN scheme A for PDCCH~~]~~ scheduling [single TRP/] SFN Scheme A PDSCH ~~and~~ [and default QCL assumption with one or two TCI states for PDCCH]  ~~2. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH]~~ |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-1a | Dynamic switching - scheme A | Support of dynamic switching between single-TRP and ~~SFN~~ PDSCH SFN scheme A by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-1[b]] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-1b | SFN scheme A (scheme 1) for PDSCH only | 1. Support of SFN scheme A for PDSCH [only scheduled by [single TRP/ Scheme A] PDCCH] [and default QCL assumption with one or two TCI states for PDSCH] |  |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-2 | SFN scheme B (TRP based pre-compensation) for PDSCH and PDCCH | 1. ~~[~~Support of SFN scheme B for PDCCH~~]~~ scheduling SFN Scheme B PDSCH [and default QCL assumption with one or two TCI states for PDCCH]  ~~2. Support of SFN scheme B for PDSCH only [and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH]~~ | [23-6-1] |  |  |  | [Per band or per FS or per FSPC] |  | ~~[FR1 only]~~ |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-2a | Dynamic switching - scheme B | Support of dynamic switching between single-TRP and ~~SFN~~ PDSCH SFN scheme B by TCI state field in DCI formats 1\_1, 1\_2 | [23-6-2[b]] |  |  |  | [Per band or per FS or FSPC] |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-2b | SFN scheme B (TRP based pre-compensation) for PDSCH only | 1. Support of SFN scheme B for PDSCH [only and default QCL assumption with two TCI states for PDSCH] [scheduled by [single TRP/Scheme B] PDCCH] | [23-6-1] |  |  |  | [Per band or per FS or per FSPC] |  |  |  |  | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-6-4 | Default DL beam setup ~~[~~for SFN ~~HST]~~ | 1. Support of PDSCH reception using default beam for Rel-17 enhanced SFN scheme when PDSCH is scheduled with offset less than threshold 2. ~~FFS:~~ Support PDSCH reception using default beam for Rel-17 enhanced SFN scheme when TCI field is not present in DCI ~~[~~when PDSCH is scheduled with offset equal or larger than the threshold~~]~~ 3. Support aperiodic CSI-RS reception using default beam for Rel-17 enhanced SFN scheme when scheduling offset is less than threshold   ~~FFS: 4. Support of single-TRP PUCCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured~~  ~~FFS: 5. Support of single-TRP PUSCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured~~  ~~FFS: 6. Support of single-TRP SRS resource transmission using default beam when enhanced SFN PDCCH transmission scheme is configured~~ | [23-6-1, 23-6-2] |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-6-4a | Default UL beam setup for SFN | 1. Support of single-TRP PUCCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  2. Support of single-TRP PUSCH transmission using default beam when enhanced SFN PDCCH transmission scheme is configured  3. Support of single-TRP SRS resource transmission using default beam when enhanced SFN PDCCH transmission scheme is configured | [23-6-1, 23-6-2] |  |  |  | Per band |  | FR2 only |  |  | Optional with capability signalling |

**Agreement: Replace the existing row for FG 23-1-1 with the following row**

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| 23. NR\_FeMIMO | 23-1-1 | Unified TCI [with joint DL/UL TCI update] for ~~[~~intra- [and inter-cell] beam management | 1. Joint DL/UL TCI update with their components: (configuration mechanism, QCL rules, applicable source and target signals)   FFS: whether to include the following components 2-14 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-1 must also support said basic FGs  FFS: basic FGs for UEs supporting CA  FFS: separate FGs for inter/intra/joint/separate   1. Common multi-CC TCI update and activation 2. For PUCCH, PUSCH, and SRS, association between TCI state and UL PC settings except for PL RS 3. The maximum number of configured joint TCI states [per BWP per CC] [in a band] [in a band combination] 4. The maximum number of MAC-CE activated joint TCI states across all CCs [in a band] [in a band combination] a) The maximum number of MAC-CE activated joint TCI states per CC [in a band] [in a band combination] 5. [The minimum beam application time between PUCCH of ACK and the first slot in Y symbols per SCS] 6. Beam misalignment between the DL source RS in the TCI state to provide spatial relation indication and the PL-RS 7. TCI state indication [mode]: update and activation [in case of updates]a) MAC CE based TCI state indication [for one active TCI state] b) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 with DL assignment) c) MAC-CE+DCI-based TCI state indication (use of DCI formats 1\_1/1\_2 without DL assignment) 8. Reference BWP/CC configured with reference TCI state pool shared by a set of BWP/CCNote: agree component, final wording may change (e.g., when this is merged with other components/FGs) 9. Maximum number of CCs configured with BFR FFS whether this is a component or just a note in the FG to reuse R16 signaling 10. ~~[R17 mechanism reusing R15/16 signalling to indicate~~ Support of indication/configuration of R17 TCI ~~for individual DL channel/RS that cannot share the same unified TCI as UE-dedicated~~ states for aperiodic CSI-RS, PDCCH, ~~/~~PDSCH~~]~~ , and SRS reusing the Rel-15/16 signaling/configuration design(s) Note: This has no impact on detail signaling design for SRS TCI indication 11. The maximum number of configured joint TCI state pools across all BWPs and all CCs in a band [in a band combination] FFS: Whether to make component ~~6~~9 a prerequisite or merge with ~~6~~9 12. [Alt. 1: ~~[~~The maximum number of PDSCH-Configs containing ~~configured joint~~ TCI states ~~across all BWPs and all CCs in a band] [in a band combination]~~ that can referred to from a PDSCH-Config without TCI states Alt. 2: Support PDSCH-Config which contains a reference to another CC/BWP, in which the PDSCH-Config contains the TCI state list] 13. [The minimum time gap between the beam indication PDCCH and first slot where beam is applied] |  |  |  |  |  |  |  |  |  | Optional with capability signalling |

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

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

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

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| 23. NR\_FeMIMO | 23-3-2 | Multi-TRP PUCCH repetition-inter-slot | 1. Support of PUCCH repetition scheme 1 (inter-slot repetition)  ~~2. Support of PUCCH repetition scheme 3 (intra-slot repetition)~~  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions ]  [2. Support of up to two PUCCH spatial relation per PUCCH resource]  ~~32. Support of cyclic mapping for beam mapping/power control parameter set mapping [when the number of repetitions is larger than 2] for both PUCCH repetitions scheme 1 and 3 when the number of repetitions is larger than 2~~  ~~43. Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats [1\_0 /] 1\_1 / 1\_2~~ | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-x | Multi-TRP PUCCH repetition-intra-slot | Support of PUCCH repetition scheme 3 (intra-slot repetition)  - sequential mapping for repetitions larger than 2  [- cyclic mapping for 2 repetitions] | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-2b |  | Support of cyclic mapping for beam mapping/power control parameter set mapping for PUCCH repetitions scheme 1 and/or 3 when the number of repetitions is larger than 2 | FFS |  |  |  |  |  |  |  | FFS: candidate values | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-3-2c |  | Support of second TPC field for per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2 | FFS |  |  |  |  |  |  |  |  | Optional with capability signalling |

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| 23. NR\_FeMIMO | 23-9-2 | Support of M=2 and R=1 for FeType-II | ~~[~~1. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support Port-selection FeType-II with M=2 and R=1~~]~~  2. Support parameter combinations with M=2  [3. Support of DFT FD bases of size N] | 23-9-1 |  |  |  | ~~[~~per band and per BC~~]~~ |  |  |  | ~~[~~Component 1 candidate values  - Maximum ~~16~~ 8 triplets  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}~~]~~  [Component 3~~4~~ candidate values: {N=2 only, N=2 and N=4}] | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  ~~[~~2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2~~]~~  [3. Support parameter combinations with Mv=2 and R=2] | 23-9-2 |  |  |  | ~~[~~per band and per BC~~]~~ |  |  |  | Component 2 candidate values:  • Maximum ~~16~~ 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: [{1 to 64}]  • Max # total ports: [{4 to 256}] | Optional with capability signalling |

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

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| 23. NR\_FeMIMO | 23-9-2 | Support of M=2 and R=1 for FeType-II | ~~[~~1. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support Port-selection FeType-II with M=2 and R=1~~]~~  2. Support parameter combinations with M=2  ~~[3. Support of DFT FD bases of size N]~~ | 23-9-1 |  |  |  | ~~[~~per band and per BC~~]~~ |  |  |  | ~~[~~Component 1 candidate values  - Maximum ~~16~~ 8 triplets  - Max # of Tx ports in one resource: {4,8,12,16,24,32}  - Max # resources: {1 to 64}  - Max # total ports: {4 to 256}~~]~~  ~~[Component 34 candidate values: {N=2 only, N=2 and N=4}]~~ | Optional with capability signalling |
| 23. NR\_FeMIMO | 23-9-4 | Support of R = 2 for FeType-II | 1. Support of R = 2 for FeType-II  ~~[~~2. {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support to support Port-selection FeType-II with M=2 and R=2~~]~~  ~~[3. Support parameter combinations with Mv=2 and R=2]~~ | 23-9-2 |  |  |  | ~~[~~per band and per BC~~]~~ |  |  |  | Component 2 candidate values:  • Maximum ~~16~~ 8 triplets  • Max # of Tx ports in one resource: {4,8,12,16,24,32}  • Max # resources: [{1 to 64}]  • Max # total ports: [{4 to 256}] | Optional with capability signalling |

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

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| 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of ~~[~~L1-RSRP~~/beam]~~ measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-17 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs  ~~FFS: basic FGs for UEs supporting CA~~  ~~FFS: separate FGs for inter/intra/joint/separate~~  [2. Support of [L1-RSRP/beam] reporting of Kmax SSBRI-RSRP[,SS-RSRP] [pairs/beams], ~~with~~ where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported [in one report instance]]  [3. The maximum number of [RRC configured/ MAC-CE activated] PCI(s) different from serving cell PCI for [periodic/ semi-persistent] [L1-RSRP/beam] measurement] [in FR1]  [4. The maximum number of [RRC configured/ MAC-CE activated] PCI(s) different from serving cell PCI for [periodic/ semi-persistent] [L1-RSRP/beam] measurement] [in FR2]  [5. The max number of SSB resources configured to measure L1-RSRP within a slot ~~across all~~ with PCI(s) same as or different from serving cell PCI[across all CC]]  [6. The max number of SSB resources configured to measure L1-RSRP ~~across all~~ with PCI(s) same as or different from serving cell PCI [across all CC]]  [7. Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]  [8. The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]  [9. The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]  [10. Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]  [11. Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]  [12. Maximum number of Kmax]  [13. Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]  [14. The number of RRC-configured PCI(s) different from serving cell PCI for aperiodic beam measurement]  [15. The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]  [16. The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]  [17. Support of [L1-SINR/beam] measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI] | [2-24, 2-29] |  |  |  | [per band] |  |  |  | ~~[2. Candidate value of {1,2,3,4}]~~  ~~[3. candidate values {1, 2, 4, 6}]~~  ~~[4. candidate values {1, 2, 4}]~~  ~~[5. candidate values: {2, 4, 8, FFS}]~~  ~~[6. candidate values: {4, 8, 16, 32, 64, FFS}]~~  ~~[7. candidate values {not support}]~~ | Optional with capability signalling |

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

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| 23. NR\_FeMIMO | 23-1-2 | Inter-cell beam measurement and reporting [(for inter-cell BM [and mTRP])] | 1. Support of L1-RSRP measurement and reporting on SSB(s) with PCI(s) different from serving cell PCI  FFS: whether to include the following components 2-13 into this FG or one or more separate FGs  FFS: Whether basic FGs are defined, and if so, which components are basic FGs, i.e., a UE that supports FG 23-1-2 must also support said basic FGs   * 1. Support of up to K[=4] SSBRI-RSRP [pairs/beams] in one report [where at least one [pair/beam] associated with a PCI different from serving cell PCI can be reported] FFS: if K is a component candidate value   2. The maximum number of [RRC configured] PCI(s) different from serving cell PCI for L1-RSRP measurement FFS: whether to split this for FR1 and FR2 FFS: whether/how to capture different values/behaviors for periodic/aperiodic/semi-persistent L1-RSRP measurement   3. [The max number of SSB resources configured to measure L1-RSRP within a slot with PCI(s) same as or different from serving cell PCI [across all CC]]   4. [The max number of SSB resources configured to measure L1-RSRP with PCI(s) same as or different from serving cell PCI [across all CC]]   5. [Support on that SSB(s) with PCI(s) different from serving cell PCI configured for L1 beam measurement and report are not included in SSBs with PCIs configured for L3 mobility measurement]   6. [The maximum number of configured additional PCIs is X1 when time domain positions and periodicity of configured SSBs with additional PCIs are the same as time domain positions and periodicity of the serving cell SSBs]   7. [The maximum number of configured additional PCIs is X2 when time domain positions and periodicity of configured SSBs with additional PCIs are different with time domain positions and periodicity of the serving cell SSBs]   8. [Supported mode inter-cell measurement: {inside SMTC, both inside and outside SMTC}]   9. [Supported mode of measurement over overlapped SSBs: {overlapped, both overlapped and non-overlapped}]   10. [Maximum number of overlapped SSBs in one SSB resource for L1-RSRP measurement]   11. [The maximum total number of SSB/CSI-RS/CSI-IM resources configured to measure within a slot across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)]   12. [The maximum total number of SSB/CSI-RS/CSI-IM resources configured across all CCs in one frequency range for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, RLM and new beam identification for both intra-cell and inter-cell measurement (Similar to FG 16-1g)] | [2-24, 2-29] |  |  |  | [per band] |  |  |  | ~~[2. Candidate value of {1,2,3,4}]~~  ~~[3. candidate values {1, 2, 4, 6}]~~  ~~[4. candidate values {1, 2, 4}]~~  ~~[5. candidate values: {2, 4, 8, FFS}]~~  ~~[6. candidate values: {4, 8, 16, 32, 64, FFS}]~~  ~~[7. candidate values {not support}]~~ | Optional with capability signalling |

[R1-2200031](../../Docs/R1-2200031.zip) Rel-17 UE features for further NR MIMO enhancements Huawei, HiSilicon

[R1-2200057](../../Docs/R1-2200057.zip) UE features for feMIMO ZTE

[R1-2200098](../../Docs/R1-2200098.zip) Discussion on Rel-17 MIMO UE features vivo

[R1-2200136](../../Docs/R1-2200136.zip) UE features for Rel-17 FeMIMO CATT

[R1-2200216](../../Docs/R1-2200216.zip) UE features for further enhancements on NR-MIMO Samsung

[R1-2200246](../../Docs/R1-2200246.zip) Discussion on Rel.17 FeMIMO UE features NTT DOCOMO, INC.

[R1-2200285](../../Docs/R1-2200285.zip) Discussion on UE features for FeMIMO Spreadtrum Communications

[R1-2200311](../../Docs/R1-2200311.zip) Discussion on FeMIMO UE features Qualcomm Incorporated

[R1-2200341](../../Docs/R1-2200341.zip) UE features for further enhancements on NR-MIMO OPPO

[R1-2200389](../../Docs/R1-2200389.zip) UE Features for FeMIMO Intel Corporation

[R1-2200430](../../Docs/R1-2200430.zip) Views on Rel-17 FeMIMO UE features Apple

[R1-2200445](../../Docs/R1-2200445.zip) MIMO Rel-17 UE features FUTUREWEI

[R1-2200454](../../Docs/R1-2200454.zip) Discussion on UE features for FeMIMO xiaomi

[R1-2200493](../../Docs/R1-2200493.zip) Discussion on Rel-17 UE feature for NR FeMIMO LG Electronics

[R1-2200535](../../Docs/R1-2200535.zip) Discussion on UE features for FeMIMO Lenovo, Motorola Mobility

[R1-2200536](../../Docs/R1-2200536.zip) Discussion on UE features for FeMIMO Ericsson

[R1-2200544](../../Docs/R1-2200544.zip) UE Features for further enhancements on NR MIMO MediaTek Inc.

[R1-2200599](../../Docs/R1-2200599.zip) Discussion on FeMIMO UE features CMCC

[R1-2200622](../../Docs/R1-2200622.zip) On UE features for further enhancements on NR-MIMO Nokia, Nokia Shanghai Bell