**3GPP TSG RAN WG1 #119 R1-24nnnnn**

**Orlando, US, November 18th – 22nd, 2024**

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

**Title: Session Notes of AI 9.14.2**

**Agenda Item: 9.14.2**

**Document for: Endorsement**

### 9.14.2 UE features for NR MIMO Phase 5

*For RAN1#119, in addition to individual company/organization/university tdocs, the rapporteurs are to provide initial input on UE features for Rel-19 MIMO.*

**Agreement: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 59. NR\_MIMO\_Ph5 | 59-1-1 | UE-initiated/event-driven beam management [at least] for Mode A | 1. Support of UE-initiated/event-driven beam report based on one event instance [with M=1]2. Support of Event-2 based measurement and report 3. Support of Mode A UE-initiated/event-driven beam report[4. Maximum number of the configured RS(s) for new beam in the RS resource set][5. Support of current beam measurement by using QCL RS in the indicated TCI state and the corresponding QCL SSB for Scheme-1 and Scheme-2, respectively] | FFS | yes | n/a | UEI/ED beam report is not supported [for Event-2 and Mode A] | FFS | FFS | FFS | FFS | [Component 4 candidate values: {1, 2, … , 64}]FFS: Further partitioning of this FG based one existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-1-2 | UE-initiated/event-driven beam management Mode B | [1.Support of UE-initiated/event-driven beam report [based on one event instance]][2. Support of Event-2 based measurement and report]3. Support of Mode B UE-initiated/event-driven beam report[4. Maximum number of the configured RS(s) for new beam in the RS resource set][5. Support of current beam measurement by using QCL RS in the indicated TCI state and the corresponding QCL SSB for Scheme-1 and Scheme-2, respectively][6. Supported values of X] | FFS | yes | n/a | UEI/ED beam report Mode-B is not supported for Event | FFS | FFS | FFS | FFS | [Component 2 candidate values: {0,1,…,[N]}]FFS: whether to combine FG 59-1-1 and FG 59-1-2FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-1-3 | Triggering event determination via detecting ≥ M event instances within a time window. | Triggering UEI/ED beam report procedure via detecting ≥ M event instance(s) within a time window [with M>1 per one new beam] | FFS | yes | n/a | Triggering event determination via detecting ≥ M event instances within a time window is not supported | FFS | FFS | FFS | FFS | FFS: whether to merge FG 59-1-1 and FG 59-1-3FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |

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| **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** |
| 59. NR\_MIMO\_Ph5 | 59-2-1-1 | Enhanced Type-I SP codebook | [Support of enhanced Type-I SP codebook] | FFS | yes | n/a | Enhanced Type-I SP codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements (e.g., Scheme-A and Scheme-B separation, number of ports, …) | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-2 | Enhanced Type-I MP codebook  | [Support of enhanced Type-I MP codebook] | FFS | yes | n/a | Enhanced Type-I MP codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements (e.g., Scheme-A and Scheme-B separation, number of ports, …) | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-3 | Extended Rel-16 eType-II codebook | [Support of extended Rel-16 eType-II codebook] | FFS | yes | n/a | Extended Rel-16 eType-II codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements (e.g., Scheme-A and Scheme-B separation, number of ports, …) | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-4 | Extended Rel-17 FeType-II codebook | [Support of extended Rel-17 FeType-II codebook] | FFS | yes | n/a | Extended Rel-17 FeType-II codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements (e.g., Scheme-A and Scheme-B separation, number of ports, …) | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-5 | Extended Rel-18 eType-II Doppler codebook  | [Support of extended Rel-18 Type-II Doppler codebook] | FFS | yes | n/a | Extended Rel-18 Type-II Doppler codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements (e.g., Scheme-A and Scheme-B separation, number of ports, …) | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-6 | 2-slot CSI-RS resource aggregation | [Support of 2-slot CSI-RS resource aggregation] | FFS | yes | n/a | 2-slot resource aggregation is not supported | FFS | FFS | FFS | FFS | [1-slot resource aggregation is a basic feature and incorporated in 59-2-1-1, 2, 3, 4, 5] | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-7 | Group-specific 3-bit scaling factors for up to 128 ports | 1. Support of group-specific 3-bit scaling factors  | FFS | yes | n/a | Group-specific 3-bit scaling factors is not supported | FFS | FFS | FFS | FFS | [Candidate values: {’rank 1’, ‘rank 1 and 2’}]FFS: Further partitioning of this FG based on existing and future agreements, e.g, separate FGs for RI=1 and RI=2 | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-1-8 | SRS Port Grouping | Support of SRS port grouping | FFS | yes | n/a | SRS Port Grouping is not supported | FFS | FFS | FFS | FFS | [Only applicable for reportQuantity = ‘cri-RI-CQI’]FFS: Further partitioning of this FG based on existing and future agreements, e.g., separate SRS port group for xT6R and xT8R related SRS antenna switching | Optional with capability signalling |

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| 59. NR\_MIMO\_Ph5 | 59-2-2-1 | Hybrid BF (CRI-based) with Rel-15 Type-I SP codebook | [1. M={1,2,3,4}][2. KS={1,2, …, 8}] | FFS | yes | n/a | Hybrid BF (CRI-based) with Rel-15 Type-I SP codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-2-2 | Hybrid BF (CRI-based) with Rel-16 eType-II codebook | [1. M={1,2}][2. KS={1,2,3,4}] | FFS | yes | n/a | Hybrid BF (CRI-based) with Rel-16 eType-II codebook is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-2-3 | Configuration of MR always-reported resources | [1. For Rel-15 Type-I SP, MR={1,2}][2. For Rel-16 eType-II, MR={1}] | FFS | yes | n/a | Configuration of MR always-reported resources is not supported, i.e. MR=0 | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |

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| 59. NR\_MIMO\_Ph5 | 59-2-3-1 | CJTC Dd report | [1. AD={0.5CP, CP}][2. MD={32, 64, 128, 256}] | FFS | yes | n/a | CJTC Dd report is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-2 | CJTC FO report | [1. AF={0.1ppm, 0.2ppm}][2. MF={16, 32, 256}] | FFS | yes | n/a | CJTC FO report is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-3 | CJTC wideband PO report | [1. Mphi= {16, 32}] | FFS | yes | n/a | CJTC PO report is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-4 | CJTC subband PO report | [1. Mphi= {16, 32}][2. Subband size= {1, 2, 4, 8, 16} RB] | FFS | yes | n/a | CJTC subband PO report is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-5 | CJTC Dd+FO report | [1. AD={0.5CP, CP}][2. MD={32, 64, 128, 256}][3. AF={0.1ppm, 0.2ppm}][4. MF={16, 32, 256}] | FFS | yes | n/a | CJTC Dd+FO report is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-6 | New CJT QCL assumptions for PDSCH pre-compensation | [1. Scheme-C][2. Scheme-D][3. Scheme-E] | FFS | yes | n/a | New QCL assumptions for PDSCH pre-compensation is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-7 | Linkage of CJTC Dd and Rel-18 eType-II CJT | [1. Joint triggering][2. Separate triggering w/o delay offset compensation (DOC) indication][3. Separate triggering w/ delay offset compensation (DOC) indication] | FFS | yes | n/a | Linkage of CJTC Dd and Rel-18 eType-II CJT is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-2-3-8 | Separate triggering with configuration of 1-bit indicator per CSI trigger state | Support of 1 bit indicate per trigger state for separate triggering of linked DO reporting and Type II CJT reporting | FFS | yes | n/a | Separate triggering with configuration of 1-bit indicator per CSI trigger state is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |

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| 59. NR\_MIMO\_Ph5 | 59-3-1 | Non-codebook based PUSCH transmission for 3TX for single TRP | 1. ~~Maximal number of supported~~ Support of 3 layers (non-codebook transmission scheme)[2. Maximum 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][4. Association between CSI-RS and SRS for non-codebook-based 3Tx PUSCH] | FFS | yes | n/a | Non-codebook based PUSCH transmission for 3TX is not suported | FFS | FFS | FFS | FFS | [Component 1 candidate values: {1, 2, 3,4}][Component 2 candidate values: {1,2,3}][Component 3 candidate values: {1,2,3}]FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-3-2 | Codebook based PUSCH transmission for 3TX for single TRP | 1. ~~Maximal number of~~ Support of 3 PUSCH MIMO layers for codebook-based PUSCH2. Maximum number of 4-port SRS resources per SRS resource set with usage set to 'codebook’ for codebook-based 3Tx PUSCH[3. Maximum number of simultaneous transmitted SRS resources at one symbol with usage set to 'codebook’ for codebook-based 3Tx PUSCH] | FFS | yes | n/a | Codebook based PUSCH transmission for 3TX is not suported | FFS | FFS | FFS | FFS | [Component 1 candidate values: {1, 2}][Component 2 candidate values: {1,2,3}][Component 3 candidate values: {1,2,3}][Note: Codebook based PUSCH transmission with port 1003 disabled when 4 port SRS resources with port 1003 disabled are configured to the UE]FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-3-3 | 3T6R antenna switching | 1. Support of 3T6R SRS Tx port switching[2. Support of reporting whether the uplink TX switching impact to downlink receiving in a band][3. Support of reporting whether the UL Tx is switched together with UL Tx in another band] | FFS | yes | n/a | 3TX 3T6R antenna switching is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-3-3a | 3T3R antenna switching | 1. Support of 3T3R SRS Tx port switching[2. Support of reporting whether the uplink TX switching impact to downlink receiving in a band][3. Support of reporting whether the UL Tx is switched together with UL Tx in another band][4. Maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching][5. Downgrade antenna switching configurations for 3T6R] | FFS | yes | n/a | 3TX 3T3R antenna switching is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-4 | M-TRP PUSCH repetition (type A) of 3-antenna-port PUSCH transmission – codebook based | 1. Support of M-TRP PUSCH repetition for 3-antenna-port PUSCH transmission with type A for codebook based- sequential mapping for repetitions larger than 2- cyclic mapping for 2 repetitions2. Support of two SRS resource sets with usage set to 'codebook' 3. Supported number of SRS resources in one SRS resource set (values can be 1 or 2, since UL FPTx is not defined)[4. Maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching][5. Downgrade antenna switching configurations for 3T3R] | FFS | yes | n/a | M-TRP PUSCH repetition is not supported for 3TX PUSCH transmission with type A for codebook based | FFS | FFS | FFS | FFS | Note: Two linked PDCCH candidates are not expected to be associated with different CORESETPoolIndex valuesFFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-4a | M-TRP PUSCH repetition (type A) of 3-antenna-port PUSCH transmission – non-codebook based | Support of M-TRP PUSCH repetition for 3-antenna-port PUSCH transmission with type A for non-codebook based- sequential mapping for repetitions larger than 2- cyclic mapping for 2 repetitions2. Support of two SRS resource sets with usage set to 'non-codebook' 3. Supported number of SRS resources in one SRS resource set (values can be 1 or 2, since UL FPTx is not defined) | FFS | yes | n/a | M-TRP PUSCH repetition is not supported for 3TX PUSCH transmission with type A for non-codebook based | FFS | FFS | FFS | FFS | Note: Two linked PDCCH candidates are not expected to be associated with different CORESETPoolIndex valuesFFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-5 | M-TRP PUSCH repetition (type B) of 3-antenna-port PUSCH transmission – codebook based | Support of M-TRP PUSCH repetition for 3-antenna-port PUSCH transmission with type B for codebook based- sequential mapping for repetitions larger than 2- cyclic mapping for 2 repetitions2. Support of two SRS resource sets with usage set to 'codebook' 3. Supported number of SRS resources in one SRS resource set (values can be 1 or 2, since UL FPTx is not defined) | FFS | yes | n/a | M-TRP PUSCH repetition is not supported for 3TX PUSCH transmission with type B for codebook based | FFS | FFS | FFS | FFS | Note: Two linked PDCCH candidates are not expected to be associated with different CORESETPoolIndex valuesFFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-5a | M-TRP PUSCH repetition (type B) of 3-antenna-port PUSCH transmission – non-codebook based | Support of M-TRP PUSCH repetition for 3-antenna-port PUSCH transmission with type B for non-codebook based- sequential mapping for repetitions larger than 2- cyclic mapping for 2 repetitions2. Support of two SRS resource sets with usage set to 'non-codebook' 3. Supported number of SRS resources in one SRS resource set (values can be 1 or 2, since UL FPTx is not defined) | FFS | yes | n/a | M-TRP PUSCH repetition is not supported for 3TX PUSCH transmission with type B for non-codebook based | FFS | FFS | FFS | FFS | Note: Two linked PDCCH candidates are not expected to be associated with different CORESETPoolIndex valuesFFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-6 | PTRS of 3-antenna-port PUSCH transmission | Number of supported PTRS ports for PUSCH transmission | FFS | yes | n/a | PTRS is not supported for 3TX PUSCH transmission | FFS | FFS | FFS | FFS | [Candidate values: {1,2}]FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-7 | Support of full-power Mode 0 for codebook-based~~UL full power transmission mode of~~ *~~fullpower~~* | UL full power transmission mode of *fullpower* ~~Support of full-power Mode 0 for codebook-based~~ | FFS | yes | n/a | UL full power transmission mode of *fullpower* is not supported for 3 Tx operation | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |

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| 59. NR\_MIMO\_Ph5 | 59-4-1 | PL offset for PUCCH/PUSCH/SRS power control | Support of applying PL offset for PUCCH/PUSCH/SRS power controls | FFS | yes | n/a | PL offset for PUCCH/PUSCH/SRS power control is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements (e.g., joint DL/UL TCI(s) and separate UL TCI(s)) | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-4-2 | Path Loss offset on PDCCH-order PRACH | Support of applying PL on PDCCH-order PRACH | FFS | yes | n/a | Applying PL offset on PDCCH-order PRACH is not supported | FFS | FFS | FR1 only | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-4-3 | Two SRS CLPS adjustment states separatefrom PUSCH ~~SRS closed loop indices~~ | Support of two sepatate SRS closed loop indices separate from PUSCH | FFS | yes | n/a | Two separate SRS closed loop indexes is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-4-4 | Extended value range of starting bit of DCI format 2\_3 for asymmetric DL sTRP/UL mTRP scenarios | Support of the extended value range of starting bit of DCI format 2\_3 | FFS | yes | n/a | The extended value range of starting bit of DCI format 2\_3 is not supported | FFS | FFS | FFS | FFS | Note: The starting bit of value range extends to X=45 for operations in FR1 in shared spectrum or FR2-2 and X = 43 otherwiseFFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-4-5 | DCI format 1\_1 to indicate TPC for separate SRS closed loop index(es) for asymmetric DL sTRP/UL mTRP scenarios | Support of DCI format 1\_1 to indicate TPC for separate SRS closed loop index(es) | FFS | yes | n/a | DCI 1\_1 indicating TPC command for separate SRS closed loop index(es) is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements, e.g., one FG is “DCI format 1\_1 for TPC command indicatinon for a separate SRS CLPC adjustment state” and another is “DCI format 1\_1 for TPC command indication for two separate SRS CLPC adjustment states” | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-4-6 | Support two TAs enhancement | Support of two TAs [without the restriction of multi-DCI based multi-TRP operation] | FFS | yes | n/a | 2 TAs for asymmetric DL sTRP/UL mTRP is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-4-7 | Overlapping UL transmission reduction | Support of reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions when the UE is with two TA enhancement | FFS | yes | n/a | Reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions is not supported | FFS | FFS | FFS | FFS | Note: If UE does not support this feature, UE does not expect the two UL transmissions to overlap ~~(i.e., scheduling restriction is applied to avoid overlap between the two UL transmissions)~~FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-4-8 | MAC-CE update of PL offset value(s) for asymmetric DL sTRP/UL mTRP deployment scenario  | Support of MAC-CE update of the configured PL offset value(s) | FFS | yes | n/a | MAC-CE update of the configured PL offset value(s) is not supported | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |

R1-2409382 Discussion on UE features for NR MIMO Phase 5 ZTE Corporation, Sanechips

R1-2409431 UE features for NR MIMO Phase 5 Huawei, HiSilicon

R1-2409533 "Discussion on UE features for NR MIMO Phase 5" CMCC

R1-2409620 UE features for NR MIMO Phase 5 Samsung

R1-2409621 Initial list of UE features for Rel-19 MIMO Ph5 Samsung (Moderator)

R1-2409704 Discussion on Rel-19 MIMO UE features vivo

R1-2409768 Initial views on UE features NR MIMO Phase 5 WI Nokia

R1-2409829 Views on UE features for NR MIMO Phase 5 Apple

R1-2409932 On UE features for NR MIMO Phase 5 CATT

R1-2410112 UE features for NR MIMO Phase 5 OPPO

R1-2410342 UE features for NR MIMO Phase 5 Ericsson

R1-2410501 UE features for NR MIMO phase 5 Qualcomm Incorporated