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

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

**Agenda Item: 9.14.2**

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

**Title: Summary of** **UE features for NR MIMO Phase 5**

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

# Introduction

This document presents the summary of email discussion [119-R19-UE\_features] during RAN1 #119. According to the Chair’s Notes:

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| [119-R19-UE\_features] Email discussion on Rel-19 UE features – 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 during RAN1 #119 within the scope of [119-R19-UE\_features].

# Summary of Contributions Submitted to RAN1 #119

The following is the moderator’s summary of contributions submitted to RAN1 #119 in this agenda item.

## UE-initiated/event-driven beam management

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| Company | Summary |
| ZTE Corporation/Sanechips [1] | We have the following initial thoughts on UE features for UE-initiated/event-driven beam report:   * For the support of UE-initiated/event-driven beam report, at least taking the follows into account of the basic UE features:   + Event-2   + UEI/ED beam report Mode-A   + Triggering UEI/ED beam report once detecting one event instance * Consequently, the support of the follows can be taken as separate UE features:   + Event-1   + Event-7   + UEI/ED beam report Mode-B   + Triggering event determination via detecting ≥M (M>1) event instances within a time window * Besides, the support of cross-CC beam measurement/report can be taken as separate UE feature when compared to the case of single-CC. |
| Huawei/HiSilicon [2] | Mode A beam reporting as well as the beam report based on one event instance should be parts of the basic UE capability, that is, all UEs supporting UE-initiated/event-driven beam reporting should support these two features. Further, other components in the basic UE capability should include the maximum number of the configured RS(s) for new beam in the RS resource set. Regarding trigger-event, event-2 has been agreed and all subsequent detailed designs in this AI were based on event-2. In RAN1#118, a WA was reached to additionally support event-1 and event-7 which states that these additional events use the same design as event-2 and have a lower priority. We think the support of event-2 should be a component of the basic UE capability for this AI while the support of event-1 and event-7 can be other optional features. For event-7, the supported values of Q are subject of UE capability. Given above discussion, we have the following proposals:  ***Proposal 2.1: For UE initiated/event-driven beam management, define the basic UE capability with the following components:***   * ***Support of Mode A based beam report.*** * ***Support of beam report based on one event instance*** * ***The maximum number of the configured RS(s) for new beam in the RS resource set*** * ***Support of event-2 based measurement and report.***   ***Proposal 2.2: For UE initiated/event-driven beam management, define a UE capability to support event-1 based measurement and report.***  ***Proposal 2.3: For UE initiated/event-driven beam management, define a UE capability to support event-7 based measurement and report. The supported value(s) of Q is a component of this UE capability.***  For Mode B based beam reporting, it was further agreed that beam report is carried on a first available transmission occasion of the second UL channel X symbols after sending the last symbol of report notification on the first PUCCH channel. We think the supported values of X should be a component of the corresponding UE capability.  ***Proposal 2.4: For UE initiated/event-driven beam management, define a UE capability to support Mode B based beam report. The supported value(s) of X is a component of this UE capability.***  Additionally, counter/timer-based reporting should also be supported as a UE capability.  ***Proposal 2.5: For UE initiated/event-driven beam management, define a UE capability to support event instance(s) counting per new beam within a time window for triggering event determination.***  Based on the above discussion, the following UE features are proposed:  ***Proposal 2.6****:* ***Introduce the following FGs for UE initiated/event-driven beam management****.*   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | [TBD] | UE-initiated/event-driven beam management | 1. Support of Mode A based beam report. 2. Support of beam report based on one event instance 3. The maximum number of the configured RS(s) for new beam in the RS resource set 4. Support of event-2 based measurement and report. |  | Yes | No | UE-initiated beam report triggered is not supported. | TBD | n/a | FR2 only | n/a | 3. Candidate values {1, 2, … , 64} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | event-1 based measurement and report for UE-initiated/event-driven beam management | 1. Support of event-1 based measurement and report. |  | Yes | No | event-1 based measurement and report is not supported. | TBD | n/a | FR2 only | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | event-7 based measurement and report for UE-initiated/event-driven beam management | 1. Support of event-7 based measurement and report. 2. Supported values of Q |  | Yes | No | event-7 based measurement and report is not supported. | TBD | n/a | FR2 only | n/a | 1. Candidate values {[1,2,…,8]} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | UE-initiated/event-driven beam management Mode B | 1. Support of Mode B for UE-initiated/event-driven beam reporting 2. Supported values of X |  | Yes | No | Mode B for UE-initiated/event-driven beam reporting is not supported. | TBD | n/a | FR2 only | n/a | 2.Candidate values {0,1,…,[N]} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Counter and timer based reporting | 1. Support event instance(s) counting per new beam within a time window for event determination |  | Yes | No | Counter and timer based reporting is not supported | TBD | n/a | FR2 only | n/a |  | Optional with capability signalling | |
| CMCC [3] | Firstly, Mode-A is basic UE capability (i.e. all UE supporting UE-initiated/event-driven beam reporting should support this feature), and Mode-B is a separate UE capability. Secondly, UE initiated beam report once the L1-RSRP of the new beam becomes a threshold value better than the current beam is basic UE capability and UE initiated beam report when detecting ≥ M event instance(s) within a time window is a separate UE capability. Thirdly, cross-CC beam measurement/report should be a separate UE capability.  Based on the above analyses, we suggest taking the following UE feature list as a starting point:  ***Proposal 1: Take the following UE feature list as a starting point for the feature of UE-initiated/event-driven beam management:***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | | 59. NR\_MIMO\_Ph5 | 59-1-1 | UEI/ED beam report | 1. Triggering UEI/ED beam report once once the L1-RSRP of the new beam becomes a threshold value better than the current beam  2. UEI/ED beam report Mode-A | 2-24 | | 59. NR\_MIMO\_Ph5 | 59-1-2 | UEI/ED beam report Mode-B | 1. UEI/ED beam report Mode-B | 59-1-1 | | 59. NR\_MIMO\_Ph5 | 59-1-3 | Triggering event determination via detecting ≥ M event instances within a time window. | 1. Triggering UEI/ED beam report when detecting ≥ M event instance(s) within a time window. | 59-1-1 | | 59. NR\_MIMO\_Ph5 | 59-1-4 | Cross-CC beam measurement/report | 1. Support of cross-CC beam measurement/report | 59-1-1 | |
| Samsung [4] | **UE-initiated/event-driven beam management (UEI/ED BM)**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Prerequisite FGs | Consequence if the feature is not supported by the UE | Type | Need of FR1/FR2 differentiation | Note | Mandatory  /Optional | | X-1-1 | UEI/ED beam reporting | 1. Support of event-2  2. Support of determination of one event-2 instance within a time window  3. Supported candidate value(s) of the threshold for determining an event-2 instance  4. Support of determining event-2 based on determination of one event-2 instance  5. Support of Mode A  6. Supported candidate value(s) of reported beam(s) N in a reporting instance  7. Supported maximum number of candidate beam RS resources in a candidate beam RS resource set  8. Support of Scheme-1 and/or Scheme-2 for determining current beam RS  9. Supported candidate value(s) of time window duration | 2-24 | UEI/ED beam reporting is not supported | Per band | N/A | Component 2: one event-2 instance is determined when a candidate beam becomes a threshold value better than the current beam within a time window  Component 3: candidate value(s) of the threshold is in dB range  Component 6: candidate value(s): {2, 3, 4}  Component 7: candidate value(s): {1, 2, …, 128}  Component 8: {Scheme-1, Scheme-2, both}  Component 9: candidate value(s) is in ms | Optional with capability signalling | | X-1-2 | UEI/ED beam reporting Mode B | 1. Support of event-2.  2. Support of determination of one event-2 instance within a time window  3. Supported candidate value(s) of the threshold for determining an event-2 instance  4. Support of determining event-2 based on determination of one event instance  5. Supported candidate value(s) of reported beam(s) N in a reporting instance  6. Supported candidate value(s) of reported beam(s) in a reporting instance that satisfies the event-2 condition(s)  7. Supported maximum number of candidate beam RS resources in a candidate beam RS resource set  8. Supported candidate value(s) of X  9. Support of Scheme-1 and/or Scheme-2 for determining current beam RS  10. Supported candidate value(s) of time window duration | X-1-1 | UEI/ED beam reporting Mode B is not supported | Per band | N/A | Component 2: one event-2 instance is determined when a candidate beam becomes a threshold value better than the current beam within a time window  Component 3: candidate value(s) of the threshold is in dB range  Component 5: candidate value(s): {2, 3, 4}  Component 6: candidate value(s): {1, 2, 3, 4}  Component 7: candidate value(s): {1, 2, …, 128}  Component 8: candidate value(s): {1, 2, …} symbols  Note: UEI beam report is carried on a first available transmission occasion of the second UL channel X symbols after sending the last symbol of report notification on the first PUCCH channel  Component 9: {Scheme-1, Scheme-2, both}  Component 10: candidate value(s) is in ms | Optional with capability signalling | | X-1-3 | Determination of event-2 based on more than one event-2 instances | 1. Support of determining event-2 based on determination of M1 event-2 instances within a time window  2. Supported candidate value(s) of M  3. Support of per candidate beam event instance(s) counting | X-1-1 | UEI/ED beam reporting based on determination of more than one event-2 instances is not supported | Per band | N/A | Component 2: candidate value(s): { 2, 3, …} | Optional with capability signalling | | X-1-4 | Cross-CC beam measurement and report | 1. Support of cross-CC beam measurement and report for Mode A and/or Mode B | X-1-1 | Cross-CC beam measurement and report for UEI/ED beam reporting is not supported | Per band | N/A |  | Optional with capability signalling | | X-1-5 (subject to confirming the WA) | Additional events to event-2 | 1. Support of event-1 and event-7  2. Supported candidate value(s) of Q (i.e., the activated TCI state with the Q-th best quality) | X-1-1 | Additional events to event-2 for UEI/ED beam reporting are not supported | Per band | N/A | Component 1: candidate value(s): {event-1, event-7, both}  Note: event-1 is when quality of the current beam is worse than a certain threshold.  Note: event-7 is when quality of at least one new beam, such as L1-RSRP, becomes a threshold value better than the RS derived from the activated TCI state with the Q-th best quality.  Component 2: candidate value(s): {1, 2, 3, 4} | Optional with capability signalling | |
| Samsung (Moderator) [5] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | UEI/ED beam report | 1. Triggering UEI/ED beam report once detecting one event instance.  2. Event-2  3. UEI/ED beam report Mode-A | 2-24 | yes | n/a | UEI/ED beam report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-2 | UEI/ED beam report Mode-B | 1. UEI/ED beam report Mode-B | 59-1-1 | yes | n/a | UEI/ED beam report Mode-B is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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. | 1. Triggering UEI/ED beam report procedure via detecting ≥ M event instance(s) within a time window. | 59-1-1 | yes | n/a | Triggering event determination via detecting ≥ M event instances within a time window is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-4 | Event-1 | 1. Support of triggering event-1 | 59-1-1 | yes | n/a | Event-1 is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-5 | Event-7 | 1. Candidate value(s) of Q (i.e., the activated TCI state with the Q-th best quality) [= {1, 2, …, 8}] | 59-1-1 | yes | n/a | Event-7 is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-6 | Cross-CC beam measurement/report | 1. Support of cross-CC beam measurement/report | 59-1-1 | yes | n/a | Cross-CC beam measurement/report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | |
| vivo [6] | **Enhancements for UE-initiated/event-driven beam management**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  | Components | Pre-requisite |  |  |  |  |  |  |  |  |  | | x. NR\_MIMO\_Phase 5 | x-1-1 | Support of UEIBM |  |  |  |  |  |  |  |  |  | The UE supporting this feature shall support UEIBM mode A | optional | | x. NR\_MIMO\_Phase 5 | x-1-2 | Support of UEIBM mode A |  | x-1-1 |  |  |  |  |  |  |  |  | optional | | x. NR\_MIMO\_Phase 5 | x-1-3 | Support of UEIBM mode B |  | x-1-1 |  |  |  |  |  |  |  |  | optional | | x. NR\_MIMO\_Phase 5 | x-1-4 | Support of Event-2 |  | x-1-2 or x-1-3 |  |  |  |  |  |  |  | The UE supporting UEIBM shall support this feature | Optional | | x. NR\_MIMO\_Phase 5 | x-1-5 | UEIBM report after M instances of event-2 within a time window |  | x-1-4 |  |  |  |  |  |  |  |  | Optional | |
| Nokia [7] | |  |  |  |  | | --- | --- | --- | --- | | FG | FG name | Components | Note | | MIMO-1-1 | UE-initiated/event driven beam reporting – Mode A | * Event-2, [Event-1 and Event-7] based reporting * N ≥ 1 beam(s) are reported in the report instance * support one-bit indication in the first PUCCH channel to request a resource for a second UL channel to carry beam report * [dedicated SR for first PUCCH] * The UL-grant DCI format at least comprises DCI format 0\_1/0\_2 * Once the L1-RSRP of the new beam becomes a threshold value better than the current beam, UE initiated beam report occurs * maximum number of the configured RS(s) in the RS resource set | • We base our analysis on the potential outcome that the first PUCCH would be signaled differently for Modes A and B  • We also note that if more events are supported, it is a very likely outcome that they become separate UE capabilities, at least this would be the starting point of the discussion.  **(RAN1 #116bis Changsha)**  On beam report transmission procedure for UE-initiated/event-driven beam reporting  **(RAN1 #117 Fukuoka)**  On UE-initiated/event-driven beam reporting, regarding UL signaling content(s) of L1-RSRP report depending on Event-2, in a report instance, at least Option-3 is supported  **Working Assumption (RAN1 #117 Fukuoka)**  On beam report transmission procedure for UE-initiated/event-driven beam reporting  **(RAN1 #117 Fukuoka)**  On beam report transmission procedure for UE-initiated/event-driven beam reporting, regarding Mode-A, the DCI format in Step-2 comprises UL-grant DCI format, and the second channel in Step-3 is at least PUSCH.  **(RAN1 #117 Fukuoka)**  Regarding the triggering event determination for Event 2:  **(RAN1 #118 Maastricht)**  Regarding explicit RS configuration for new beam measurement for Event 2, at least Option-1 is supported  **Working Assumption (RAN1 #118 Maastricht)**  On UE-initiated/event-driven beam reporting, regarding trigger events, besides for Event-2, Event-1 and Event-7 are both supported. | | MIMO 1-2 | UE-initiated/event driven beam reporting – Mode B | * Event-2, [Event-1 and Event-7] based reporting * N ≥ 1 beam(s) are reported in the report instance * support one-bit indication in the first PUCCH channel to notify a second UL channel to carry beam report. * [new UCI type for first PUCCH channel] * Once the L1-RSRP of the new beam becomes a threshold value better than the current beam, UE initiated beam report occurs * pre-configured resource(s) for the second channel in Step-2 is at least type 1 CG-PUSCH * maximum number of the configured RS(s) in the RS resource set | **(RAN1 #116bis Changsha)**  On beam report transmission procedure for UE-initiated/event-driven beam reporting  **(RAN1 #117 Fukuoka)**  On UE-initiated/event-driven beam reporting, regarding UL signaling content(s) of L1-RSRP report depending on Event-2, in a report instance, at least Option-3 is supported  **Working Assumption (RAN1 #117 Fukuoka)**  On beam report transmission procedure for UE-initiated/event-driven beam reporting  **(RAN1 #117 Fukuoka)**  Regarding the triggering event determination for Event 2:  **(RAN1 #118 Maastricht)**  On beam report transmission procedure for UE-initiated/event-driven beam reporting, for regarding Mode-B, the pre-configured resource(s) for the second channel in Step-2 is at least type 1 CG-PUSCH.  **(RAN1 #118 Maastricht)**  Regarding explicit RS configuration for new beam measurement for Event 2, at least Option-1 is supported  **Working Assumption (RAN1 #118 Maastricht)**  On UE-initiated/event-driven beam reporting, regarding trigger events, besides for Event-2, Event-1 and Event-7 are both supported. | | MIMO 1-3 | RS measurement for the current beam - Scheme-1 | * RS for current beam is the QCL RS in the indicated TCI state | **(RAN1 #117 Fukuoka)**  Regarding RS measurement for the current beam for Event 2, for Option-2a, support the both schemes as follows. | | MIMO 1-4 | RS measurement for the current beam - Scheme-2 | * the RS for current beam is the SSB which is QCLed with the QCL RS in the indicated TCI state. | **(RAN1 #117 Fukuoka)**  Regarding RS measurement for the current beam for Event 2, for Option-2a, support the both schemes as follows. | | MIMO 1-5 | UE initiated beam report based on number of Event-2 instances within a time window | * Time window duration | **(RAN1 #117 Fukuoka)**  Regarding the triggering event determination for Event 2: | |
| Apple [8] | **Enhancements for UE-initiated/event-driven beam management**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | Support of UE initiated beam report | 1. Support UE initiated beam report 2. Support event for UE initiated beam report |  | Yes | n/a | UE initiated beam report is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values {Mode A, Mode A and Mode B}  Component 2 candidate value bitmap {event 1, event 2, event 7}  Note: the event definition  Event 1: Quality of the current beam is worse than a certain threshold.  Event 2: Quality of at least one new beam, such as L1-RSRP, becomes a threshold value better than the current beam.  Event 7: Quality of at least one new beam, such as L1-RSRP, becomes a threshold value better than the RS derived from the activated TCI state with the Q-th best quality. | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1a | Measurement resource for UE initiated beam report | Per slot limitations:   1. The max number of SSB/CSI-RS (1Tx) resources (sum of aperiodic/periodic/semi-persistent) across all CCs configured to measure L1-RSRP within a slot for UE initiated beam report 2. The max number of CSI-RS (2Tx) resources (sum of aperiodic/periodic/semi-persistent) across all CCs configured to measure L1-RSRP within a slot for UE initiated beam report   Memory limitations:   1. The max number of CSI-RS resources across all CCs configured for UE initiated beam report 2. The max number of aperiodic CSI-RS resources across all CCs configured for UE initiated beam report 3. The max number of CSI-RS resources in a CSI-RS resource set configured for new beam for UE initiated beam report   Other limitations:   1. Supported density of CSI-RS (CMR) | 59-1-1 | Yes | n/a | UE initiated beam report is not supported | Per band | n/a | n/a | n/a | Component 1: Candidate values {8, 16, 32, 64}  Component 2: Candidate values {0, 4, 8, 16, 32, 64}  Component 3: Candidate values {8, 16, 32, 64, 128}  Component 4: Candidate values {0, 2, 4, 8, 16, 32, 64}  Component 5: Candidate values {2, 4, 8, 16, 32, 64}  Component 6: Candidate values {'1 only', '3 only', '1 and 3'}  Note: The reference slot duration is the shortest slot duration defined for the FR where the reported band belongs  Note: For component 3, 4, 5  the configured CSI-RS resources for both active and inactive BWPs are counted  Note: For components 1, 2, a SSB/CSI-RS resource is counted within the duration of a reference slot in which the corresponding reference signals are transmitted | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1b | Maximum N for UE initiated beam report | Support of UE initiated beam report with maximum N L1-RSRP values | 59-1-1 | Yes | n/a | Maximum N=1 | Per band | n/a | n/a | n/a | Candidate values {1, 2, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1c | Configuration that current beam is always reported for UE initiated beam report | Support RRC to configure that current beam is always reported for UE initiated beam report | 59-1-1 | Yes | n/a | RRC to configure that current beam is always reported for UE initiated beam report is not supported | Per band | n/a | n/a | n/a | Note: The reported current beam, if configured, is not counted in the N reported beams | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1d | Support of event triggering when the number of event 2 instance(s) for at least one same new beam is greater than or equal to a configurable number M | Support event triggering when the number of event 2 instance(s) for at least one same new beam is greater than or equal to a configurable number M | 59-1-1 | Yes | n/a | Once the L1-RSRP of the new beam becomes a threshold value better than the current beam, UE initiated beam report occurs | Per band | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1e | Beam reporting timing for Mode B UE initiated beam report | For Mode B UE initiated beam report, the minimum number of symbols, X, between the last symbol of report notification on the first PUCCH channel and the first symbol of the second UL channel carrying the UE initiated beam report | 59-1-1 | Yes | n/a |  | Per band | n/a | n/a | n/a | Candidate values: different X in symbols can be reported for different SCS  15kHz SCS: {2, 4, 8}  30kHz SCS: {4, 8, 14, 28}  60kHz SCS: {8,14, 28}  120kHz SCS: {14,28, 56}  480kHz SCS: {56, 112, 224}  960kHz SCS: {112, 224, 448} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1f | Q-th best quality for UE initiated beam report event 7 | For event 7, quality of at least one new beam becomes a threshold value better than the RS derived from the activated TCI state with the Q-th best quality. | 59-1-1 | Yes | n/a |  | Per band | n/a | n/a | n/a | Candidate values: {best, worst, both} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-1-1g | Different PUCCH group for the first PUCCH and second PUSCH | Support the first PUCCH and the second PUSCH from different PUCCH group for both Mode A and Mode B | 59-1-1 | Yes | n/a | The first PUCCH and the second PUSCH must be configured from the same PUCCH group for both Mode A and Mode B | Per BC | n/a | n/a | n/a |  | Optional with capability signalling | |
| CATT [9] | **UEIBM**  In RAN #102 meeting [1], enhancements for UE-initiated/event-driven beam management was specified. In this section, UE features of UEIBM are discussed.  On beam report transmission procedure for UEIBM, transmission Mode A and Mode B have been supported. Transmission mode A supports dynamically scheduling UCI by gNB and has been supported as a basic UE capability. Transmission mode B supports UCI in pre-configured resource(s) for second UL channel. Since UE can work in Mode B independently whatever Mode A exists or not. Mode B can also be supported as a basic feature separately from Mode A.  **Proposal 1: Support beam report transmission Mode B as a basic UE feature separately from Mode A.** |
| OPPO [10] | **UE feature for UE-initiated/event-driven beam management**  First of all, event-2 based UEI beam reporting shall be a UE capability. As agreed, the mode-A is the basic UE feature.  Supporting mode-B shall be optional UE feature and it is subject to UE capability reporting.  Regarding the new beam RS configuration, maximal number of RSs in the new beam RS set shall be UE capability. The maximal number of reported beams in each beam reporting shall be UE capability too.  Whether to report the measurement of current beam shall be UE capability.  Regarding Event-1 and Event-7: they are only WA now and the confirmation on them are still pending. So we propose not to include them in UE capability for now.  ***Proposal 1a: Support the following UE features for UEI beam reporting of Rel-19:***   * ***Supporting Event-2 based UEI beam reporting is UE capability*** * ***Supporting Mode-A for event-2 based UEI beam reporting is basic UE capability.*** * ***Supporting Mode-B for event-2 based UEI beam reporting is UE capability*** * ***The maximal number of new beam RS of one CC and the maximal number of new beam RS of all CCs are UE capability*** * ***The maximal number of reported new beam RSs in one UEI beam reporting is UE capability*** * ***Supporting reporting measurement of current beam is UE capability***   ***Proposal 1b: Do not include Event-1 and Event-2 in UE capability for now.*** |
| Ericsson [11] |  |
| Qualcomm Incorporated [12] | **Enhancements for UE-initiated/event-driven beam management**  The UE capabilities for UE-initiated/event-driven beam management encompass three main areas:   1. Event definitions and measurement resources 2. Reporting contents and formats 3. Reporting procedures and channels   As agreed in previous RAN1 meetings, it is desirable to maintain a consistent design across different events, and consequently, for the associated capabilities. Additionally, certain capabilities, such as the configuration of measurement resources, can be shared with legacy beam reporting.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-1-1 | UE-initiated/event-driven beam reporting event evaluation according to Event-2 | Support UE-initiated/event-driven beam reporting Event-2  1) Maximum length of Event-2 evaluation window  2) Maximum number of Event-2 instances within the window | 2-24, and 23-1-1 or 23-10-1 | YES | N/A | UE\_initiated/event-driven beam reporting according to Event-2 is not supported | Per Band | NO | YES | N/A |  | Optional with capability signalling  Component-1:  candidate values: FFS  UE is mandated to support at least 1  Component-2: candidate values: FFS  UE is mandated to support at least 1 | | XX. NR MIMO phase 5 | XX-1-2 | UE-initiated/event-driven beam reporting event evaluation according to Event-1 | Support UE-initiated/event-driven beam reporting Event-1  1) Maximum length of Event-1 evaluation window  2) Maximum number of Event-1 instances within the window | 2-24, and 23-1-1 or 23-10-1 | YES | N/A | UE\_initiated/event-driven beam reporting according to Event-1 is not supported | Per Band | NO | YES | N/A |  | Optional with capability signalling  Component-1:  candidate values: FFS  UE is mandated to support at least 1  Component-2: candidate values: FFS  UE is mandated to support at least 1 | | XX. NR MIMO phase 5 | XX-1-3 | UE-initiated/event-driven beam reporting event evaluation according to Event-7 | Support UE-initiated/event-driven beam reporting Event-7  1) Maximum length of Event-7 evaluation window  2) Maximum number of Event-7 instances within the window  3) Maximum number of activated TCI states for Event-7 evaluation | 2-24, and 23-1-1 or 23-10-1 | YES | N/A | UE\_initiated/event-driven beam reporting according to Event-7 is not supported | Per Band | NO | YES | N/A |  | Optional with capability signalling  Component-1:  candidate values: FFS  UE is mandated to support at least 1  Component-2: candidate values: FFS  UE is mandated to support at least 1  Component-3: candidate value: {from 1 to 8} | | XX. NR MIMO phase 5 | XX-1-4 | Implicit selection of the serving beam RS Scheme-1 | Support QCL RS in the indicated TCI state as the serving beam RS | XX-1-1, XX-1-2, or XX-1-3, and 23-1-1 or 23-10-1 | YES | N/A | CSI-RS as the serving beam RS for UE\_initiated/event-driven beam reporting is not supported | Per Band | NO | YES | N/A | Conditioned on the support of UE-initiated/event-driven beam reporting | Optional with capability signalling  If UE supports UE-initiated/event-driven beam reporting, UE is mandated to report this capability | | XX. NR MIMO phase 5 | XX-1-4a | Implicit selection of the serving beam RS Scheme-2 | Support SSB which is QCLed with the QCL RS in the indicated TCI state as the serving beam RS | XX-1-1, XX-1-2, or XX-1-3, and 23-1-1 or 23-10-1 | YES | N/A | SSB as the serving beam RS for UE\_initiated/event-driven beam reporting is not supported | Per Band | NO | YES | N/A | Conditioned on the support of UE-initiated/event-driven beam reporting | Optional with capability signalling | | XX. NR MIMO phase 5 | XX-1-5 | UE-initiated/event-driven beam reporting Mode-A | Support UE-requested and network-scheduled UE-initiated/event-driven beam reporting | XX-1-1, XX-1-2, or XX-1-3, and 2-32, 2-35 | YES | N/A | UE-initiated/event-drivem beam reporting Mode-A is not supported | Per Band | NO | YES | N/A | Conditioned on the support of UE-initiated/event-driven beam reporting | Optional with capability signalling  If UE supports UE-initiated/event-driven beam reporting, UE is mandated to report this capability | |  | XX-1-5a | UE-initiated/event-driven beam reporting Mode-B | Support UE-notified and pre-configured UE-initiated/event-driven beam reporting  1) Minimum number of symbols X between the first and second UL channels  2) Support for different periodicities between the first and second UL channels | XX-1-1, XX-1-2, or XX-1-3, and [2-32b] | YES | N/A | UE-initiated/event-drivem beam reporting Mode-B is not supported | Per Band | NO | YES | N/A | Conditioned on the support of UE-initiated/event-driven beam reporting | Optional with capability signalling | |

## CSI enhancements for up to 128 ports

|  |  |
| --- | --- |
| Company | Summary |
| ZTE Corporation/Sanechips [1] | At least the following FGs of CSI enhancement should be supported:   * Rel-19 SP Type-I codebook   + Component 1: Codebook scheme     - Candidates: {Scheme-A, Scheme-B}   + Component 2: Number of antenna ports     - Candidates: {48 (optional), 64 (basic), 128 (optional)} * Rel-19 MP Type-I codebook   + Component 1: Number of antenna ports     - Candidates: {48 (optional), 64 (basic), 128 (optional)} * Rel-19 eType-II codebook   + Component 1: Number of antenna ports     - Candidates: {48 (optional), 64 (basic), 128 (optional)} * Rel-19 FeType-II codebook   + Component 1: Number of antenna ports     - Candidates: {48 (optional), 64 (basic), 128 (optional)} * Rel-19 eType-II Doppler codebook   + Component 1: Number of antenna ports     - Candidates: {48 (optional), 64 (basic), 128 (optional)} * Timeline, CPU occupation, and active resource counting for Rel-19 Type-I/Type-II codebooks   + Component 1: Capability 1   + Component 2: Capability 2 * 3-bit soft scaling for Rel-19 SP Type-I codebook   + Component 1: Support of the 3-bit scaling factor for RI = 1   + Component 1: Support of the 3-bit scaling factor for RI = 2 * CSI-RS resource aggregation within one or two slots   + Component 1: CSI-RS resource aggregation within one slot (basic)   + Component 2: CSI-RS resource aggregation within two consecutive slots (optional) * SRS port grouping   + Component 1: xT6R   + Component 2: xT8R * CRIs-based CSI reporting (HBF) with Rel-15 Type-I codebook   + Component 1: Maximum number of reported CRI(s) M     - Candidates: {1, 2, 3, 4}   + Component 2: Maximum number of configured CSI-RS resources Ks     - Candidates: {1, 2, …, 8} * CRIs-based CSI reporting (HBF) with Rel-16 eType-II codebook   + Component 1: Maximum number of reported CRI(s) M     - Candidates: {1, 2}   + Component 2: Maximum number of configured CSI-RS resources Ks     - Candidates: {1, 2, 3, 4} * UE always report MR configured CRI(s)   + Component 1: MR for Rel-15 Type-I codebook     - Candidates: {1, 2}   + Component 2: MR for Rel-16 eType-II codebook     - Candidates: {1} * CJT Dd report   + Component 1: X for CPU occupation * CJT FO report   + Component 1: X for CPU occupation * CJT PO report   + Component 1: Subband FO report   + Component 2: Wideband FO report   + Component 3: X for CPU occupation * Joint CJT Dd and FO report   + Component 1: X for CPU occupation * New QCL assumptions for CJT PDSCH   + Component 1: Scheme-C   + Component 2: Scheme-D   + Component 3: Scheme-E * Linkage between CJT Dd report and CJT Type-II report   + Component 1: Joint triggering and reporting   + Component 2: Separate triggering and reporting     - Candidates: {Separate triggering and reporting with a 1-bit indicator, Separate triggering and reporting without a 1-bit indicator} |
| Huawei/HiSilicon [2] | The following UE features are proposed:  ***Proposal 3.1****:* ***Introduce the following FGs for CSI enhancement for up to 128 ports.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | [TBD] | Rel-19 Type-I codebook refinement for up to 128 ports | 1. Rel-19 Type-I codebook refinement for 64 ports  2. Rel-19 Type-I codebook refinement for 48 and 128 ports  3. Supported codebooks |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 2 Candidate values: {none, 48, 128, 48 and 128}  Component 3 candidate values:  {SchemeA RI=1-4, SchemeB RI=1-4, SchemeA RI=5-8, SchemeB RI=5-8} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Rel-19 eType-II Doppler codebook refinement for up to 128 ports | 1. Rel-19 eType-II codebook refinement for 64 ports  2. Rel-19 eType-II codebook refinement for 48 and 128 ports |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 2 Candidate values {none, 48, 128, 48 and 128} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Rel-19 eType-II Doppler codebook refinement for up to 128 ports | 1. Rel-19 eType-II Doppler codebook refinement for 64 ports  2. Rel-19 eType-II Doppler codebook refinement for 48 and 128 ports |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 2 Candidate values {none, 48, 128, 48 and 128} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Rel-19 FeType-II PS codebook refinement for up to 128 ports | 1. Rel-19 FeType-II PS codebook refinement for 64 ports  2. Rel-19 FeType-II PS r codebook refinement for 48 and 128 ports |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 2 Candidate values {none, 48, 128, 48 and 128} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Resources for up to 128 ports | 1. Suppot CSI-RS resources for up to 128 ports |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 1 candidate values {’within 1 slot’, ‘within 1 or 2 slots’} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Timelines for for up to 128 ports | 1. the timeline for up to 128 ports. |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 1 candidate values: {Capability1, Capability 2}  Note 1: capability 1 is the legacy Z/Z’  Not 2: legacy Z/Z’ multiplied by ceil(P/32), where P is the total number of ports across all the aggregated CSI-RS resources | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | CPU occupations for up to 128 ports | 1. CPU occupations for up to 128 ports |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 1 Candidate values: {Capability1, Capability 2}  Note 1: Capability 1 is OCPU = ceil(P/32), where P is the total number of ports across all the K aggregated CSI-RS resources.  Note 2: OCPU =1 | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Support group-specific 3-bit scaling factors for up to 128 ports | 1. Support group-specific 3-bit scaling factors |  | Yes | No |  | TBD | n/a | n/a | n/a | Component 1 Candidate values: {’rank 1’, ‘rank 1 and 2’} | Optional with capability signalling |   Only Rel-15 Type I single panel codebook and Rel-16 eType II codebook are supported for CRIs based CSI reporting, thus two separate features can be defined similar that in the legacy spec, and Rel-15 Type I single panel codebook should be taken as a basic feature. Additionally a feature can be defined for *MR* selected resources for each codebook. Based on the above discussions, the following UE features are proposed:  ***Proposal 3.2: For CRIs based CSI reporting, define the following UE capabilities:***   * ***Support of Type I single panel codebook (basic feature).*** * ***Support of selected resources for Type I single panel codebook*** * ***Support of regular eType II codebook.*** * ***Support of selected resources for regular eType II codebook***   ***Proposal 3.3****:* ***Introduce the following four FGs for CRIs based CSI reporting****.*   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | Z1 | CRI(s) based reporting | 1) Support of Type I single panel codebook  2) A list of supported combinations, each combination is {maximum # of Tx ports in one resource, maximum # of resources Ks,max, maximum total # of Tx ports, and the maximum # of reporting CRI(s) Mmax } in one CSI-RS resource set. | 2-35, 2-36 | Yes | N/A | CRI(s) based reporting for Type I single panel codebook is not supported, and the performance of UE may be degraded in a network with HBF (multi-beams) | Per UE | No | No | Yes | Max # of Tx ports in one resource: {4,8,12,16,24,32}  Ks,max: {2 to 8}  Max # total ports: {8 to 128}  Mmax: {1 to 4} | Optional with capability signalling | | NR MIMO Phase 5 | Z2 | Selected resources for Type I single panel codebook for CRI(s) based reporting | 1) The maximum # of configured resources selected by gNB for CRI(s) based reporting for Type I single panel codebook, MRmax. | Z1 | Yes | N/A | All the reported CRIs are selected by UE, and the performance of UE may be degraded in a network with HBF (multi-beams) | Per UE | No | No | Yes | MRmax: {1, 2} | Optional with capability signalling | | NR MIMO Phase 5 | Z3 | Regular eType II codebook for CRI(s) based reporting | 1) A list of supported combinations, each combination is {maximum # of Tx ports in one resource, maximum # of resources Ks,max, maximum total # of Tx ports, and the maximum # of reporting CRI(s) of Mmax } in one CSI-RS resource set for R=1. | 2-35, 16-3a | Yes | N/A | CRI(s) based reporting for regular eType II codebook is not supported, and the performance of UE may be degraded in a network with HBF (multi-beams) | Per UE | No | No | Yes | Max # of Tx ports in one resource: {4,8,12,16,24,32}  Ks,max: {2 to 4}  Max # total ports: {8 to 128}  Mmax: {1 to 2} | Optional with capability signalling | | NR MIMO Phase 5 | Z4 | Selected resources for Regular eType II codebook for CRI(s) based reporting | 1) The maximum # of configured resources selected by gNB for CRI(s) based reporting for regular eType II codebook, MRmax. | Z3 | Yes | N/A | All the reported CRIs are selected by UE, and the performance of UE may be degraded in a network with HBF (multi-beams) | Per UE | No | No | Yes | MRmax: {1} | Optional with capability signalling |   The following UE features are proposed:  ***Proposal 3.4****:* ***Introduce the following FGs for Enhancements for CJT****.*   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | [TBD] | Support of UE feedback of delay offsets between TRPs for CJT | 1. Support of UE feedback of delay offsets between TRPs for CJT |  | Yes | No |  | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Support of UE feedback of frequency offsets between TRPs for CJT | 1. Support of UE feedback of frequency offsets between TRPs for CJT |  | Yes | No |  | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Support of QCL assumption of Scheme C/D for PDSCH | 1. Support Scheme C and Scheme D as two TCI states regarding QCL assumptions for PDSCH for CJT calibration. |  | Yes | No |  | TBD | n/a | n/a | n/a | Note 1: Scheme C: The PDSCH DMRS port(s) are QCLed with the DL-RS associated with the first TCI state with respect to QCL-TypeA and QCLed with the DL-RS in the second TCI state with respect to QCL-TypeA except for {Doppler shift}  Note 2: Scheme D: The PDSCH DMRS port(s) are QCLed with the DL-RS associated with the first TCI state with respect to QCL-TypeA and QCLed with the DL-RS in the second TCI state with respect to QCL-TypeA except for {average delay} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Support of UE feedback of phase offsets of DL/UL reciprocity between TRPs for CJT | 1. Support of UE feedback of wideband phase offsets of DL/UL reciprocity between TRPs for CJT |  | Yes | No |  | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Support sub-band phase reporting for CJT calibration | Support sub-band phase reporting for CJT calibration. |  | Yes | No |  | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Support of delay offset compensation for Rel-18 CJT CSI reporting. | Support of delay offset compensation for Rel-18 CJT CSI reporting |  | Yes | No |  | TBD | n/a | n/a | n/a |  | Optional with capability signalling |   The following UE features are proposed:  ***Proposal 3.5****:* ***Introduce the following FGs for SRS port grouping.***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | [TBD] | SRS port grouping | 1. Support grouping SRS ports into two SRS port groups based on SRS port indexes. |  | Yes | No | SRS port grouping is not support | TBD | n/a | n/a | n/a |  | Optional with capability signalling | |
| CMCC [3] | Based on the agreements related with UE optional feature and considering in previous releases, separate codebook types are usually different UE capabilities, e.g. Type-I SP, Type-I MP, eType-II, we suggest taking the following UE feature list as a starting point:  ***Proposal 2: Take the following UE feature list as a starting point for the feature of Rel-19 Type-I/II codebook refinement for up to 128 CSI-RS port:***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | | NR\_MIMO\_Ph5 | XX-X-1-1 | Enhanced Type-I SP codebook for 64 ports | 1. Support Scheme-A and Scheme-B | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-2 | Enhanced Type-I SP codebook for 48 ports | 1. Support Scheme-A and Scheme-B | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-3 | Enhanced Type-I SP codebook for 128 ports | 1. Support Scheme-A and Scheme-B | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-4 | Enhanced Type-I MP codebook for 64 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-5 | Enhanced Type-I MP codebook for 48 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-6 | Enhanced Type-I MP codebook for 128 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-7 | Extended Rel-16 eType-II codebook for 64 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-8 | Extended Rel-16 eType-II codebook for 48 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-9 | Extended Rel-16 eType-II codebook for 128 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-10 | Extended Rel-17 FeType-II codebook for 64 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-11 | Extended Rel-17 FeType-II codebook for 48 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-12 | Extended Rel-18 Type-II Doppler codebook for 64 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-13 | Extended Rel-18 Type-II Doppler codebook for 48 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-14 | Extended Rel-18 Type-II Doppler codebook for 128 ports |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-15 | 2-slot CSI-RS resource aggregation | UE capability for 2-slot aggregation | XX-X-1-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 | | NR\_MIMO\_Ph5 | XX-X-1-16 | SRS Port Grouping | 1. For xT6R  2. For xT8R | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-17 | Soft scaling for RI=1 |  | 2-35 | | NR\_MIMO\_Ph5 | XX-X-1-18 | Soft scaling for RI=2 |  | 2-35 |   Based on the agreements related with UE optional feature, we suggest taking the following UE feature list as a starting point:  ***Proposal 3: Take the following UE feature list as a starting point for the feature of Rel-19 for CRI based CSI report for hybrid beamforming:***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | | NR\_MIMO\_Ph5 | XX-X-2-1 | Hybrid BF (CRI-based) with Rel-15 Type-I SP codebook | 1. M={1,2,3,4}  2. Ks={1,2, …, 8} | 2-36 | | NR\_MIMO\_Ph5 | XX-X-2-2 | Hybrid BF (CRI-based) with Rel-16 eType-II codebook | 1. M={1,2}  2. Ks={1,2,3,4} | 16-3a | | NR\_MIMO\_Ph5 | XX-X-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} | XX-X-2-1, 2 |   Based on the agreements related with UE optional feature, supporting of different CJTC report quantities can be considered as different UE capabilities. In addition, regarding the new CJT QCL assumptions for PDSCH pre-compensation, i.e., Scheme C, D, E, since it is possible that a UE who supports CJT calibration reporting may help another UE nearby without such CJT calibration capability to achieve the PDSCH pre-compensation with delay offset and/or frequency offset, the three new CJT QCL assumptions for PDSCH pre-compensation can be considered as one UE capability.  Therefore, we suggest taking the following UE feature list as a starting point:  ***Proposal 4: Take the following UE feature list as a starting point for the feature of Rel-19 for UE reporting for CJT calibration:***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | | NR\_MIMO\_Ph5 | XX-X-3-1 | CJTC Dd report | 1. AD = {0.5CP, CP}  2. MD = {32, 64, 128, 256} | 2-35 | | NR\_MIMO\_Ph5 | XX-X-3-2 | CJTC FO report | 1. AF = {0.1ppm, 0.2ppm}  2. MF = {16, 32, 256} | 2-35 | | NR\_MIMO\_Ph5 | XX-X-3-3 | CJTC wideband PO report | 1. M = {16, 32}  2. | 2-35 | | NR\_MIMO\_Ph5 | XX-X-3-4 | CJTC subband PO report | 1. 1. M = {16, 32} 2. 2.   3. Subband size= {1, 2, 4, 8, 16} RB | 2-35 | | NR\_MIMO\_Ph5 | XX-X-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} | 2-35 | | NR\_MIMO\_Ph5 | XX-X-3-6 | Linkage of CJTC Dd and Rel-18 eType-II CJT | 1. Joint triggering  2. Separate triggering | 40-3-1-1, XX-X-3-1 | | NR\_MIMO\_Ph5 | XX-X-3-7 | Separate triggering with configuration of 1-bit indicator per CSI trigger state |  | XX-X-3-6 | | NR\_MIMO\_Ph5 | XX-X-3-8 | New CJT QCL assumptions for PDSCH pre-compensation | 1. Support Scheme-C  2. Support Scheme-D  3. Support Scheme-E | 40-1-4 | |
| Samsung [4] | **CSI enhancement**  Although Scheme-A seems to simply follow legacy design, scaling up Rel-15 Type-I single-panel codebook with new (N1, N2) values would introduce significant implementation complexity at UE in addition to small performance gain. Scheme-B, on the other hand, can be implemented effortlessly reusing most of existing components of Rel-16 eType-II at UE, and it is also validated the UPT gain is significant over Scheme-A. Therefore, due to less implementation complexity, more flexibility of Scheme-B, and performance benefit, we propose Scheme-B as the basic feature.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Pre-requisite | Reporting granularity | Note | Mandatory/Optional | | X-2-1 | **Basic Features** of Enhanced Type-I SP codebook | 1) Scheme-B  2) A list of supported combinations, up to 16, across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously, where each combination is  a) Maximum number of Tx ports in one NZP CSI-RS resource  b) Maximum total number of NZP CSI-RS resources aggregated  c) Maximum total number of Tx ports of aggregated NZP CSI-RS resources  3) Support of rank 1,2,3,4 | 2-35 |  | Component 2 candidate values:  2)  a) {16, 32}  b) {[1], 2, 3, 4}  c) {64} | Optional with capability signalling | | X-2-2 | Total number of Tx ports of aggregated NZP CSI-RS resources is 48 for Type-I single-panel | 1) support of maximum total number of Tx ports of aggregated NZP CSI-RS resources is 48 |  |  |  |  | | X-2-3 | Total number of Tx ports of aggregated NZP CSI-RS resources is 128 for Type-I single-panel | 1) support of maximum total number of Tx ports of aggregated NZP CSI-RS resources larger is 128 |  |  |  |  |   CRI-based CSI   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Prerequisite FGs | Consequence if the feature is not supported by the UE | Type | Need of FR1/FR2 differentiation | Note | Mandatory  /Optional | | X-2-4 | CRI based upto 128 ports with Rel-15 Type-I SP codebook | 1. Supported number of CRIs | 2-36 | Hybrid BF (CRI-based) with Rel-15 Type-I SP codebook is not supported | Per Band | N/A | Component 4 candidate value: {1, 2, 3, 4} | Optional with capability signalling | | X-2-5 | CRI based upto 128 ports with Rel-16 eType-II codebook | 1. Supported number of resources(Ks) 2. Supported number of CRIs (M) | 16-3a | Hybrid BF (CRI-based) with Rel-16 eType-II codebook is not supported | Per Band | N/A | Component 1 candidate value: {1, 2, 3, 4}  Component 2 candidate value: {1, 2} | Optional with capability signalling | | X-2-6 | Configuration of MR High priority resources | 1. Supported number of High priority Resources per CSI report with Rel-15 type-I SP codebook 2. Supported number of High priority Resources per CSI report with Rel-16 eType-II codebook | X-2-4, X-2-5 | Configuration of MR High priority resources is not supported | Per Band | N/A | Component 1 candidate value: {1, 2}  Component 1 candidate value: {1} | Optional with capability signalling |   CJT calibration reporting   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Pre-requisite | Reporting granularity | Note | Mandatory/Optional | | X-2-7 | Basic Features of CJT calibration reporting | 1. support of CJT calibration reporting  2. supported report type  3. supported reporting mode  4. supported number of reported offsets  5. cjtc-P is reported wideband  6. value of X for CPU occupation (OCPU= X NTRP) |  |  | component 2  candidate values:  {cjtc-Dd, cjtc-F, cjtc-P, cjtc-Dd-F}  component 3  candidate values:  {TRP selection, offset value, both}  component 4  candidate values:  {2,3,4}  component 6  candidate values:  {1,2} | Optional with capability signalling | | X-2-8 | Joint delay and frequency offset CJT calibration reporting | 1. support of joint delay and frequency offset CJT calibration reporting in one report  2. value of X for CPU occupation (OCPU= X NTRP) |  |  | component 2  candidate values:  {1,2} | Optional with capability signalling | | X-2-9 | Maximum number of TRS resource sets in a report configuration | 1. supported maximum number of TRS resource sets in a report configuration |  |  | component 1  candidate values: {2,3,4} | Optional with capability signalling | | X-2-10 | Sub-band phase offset CJT calibration reporting | 1. support of sub-band phase offset reporting  2. supported number of supported sub-bands in PRBs |  |  | component 2  candidate values:  {1, 2, 4, 8, 16} | Optional with capability signalling | | X-2-11 | Linking CJTC Dd and Rel-18 eType-II CJT CSI reports | 1. support of linking CJTC Dd and Rel-18 eType-II CJT CSI reports  2.supported triggering mode  3. value of X for CPU occupation (OCPU= X NTRP) |  |  | component 2  candidate values:  {separate, joint, both}  component 2  candidate values:  {1,2} | Optional with capability signalling | |
| Samsung (Moderator) [5] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | 1. 48 ports, Scheme-A and Scheme-B  2. 64 ports, Scheme-A and Scheme-B  3. 128 ports, Scheme-A and Scheme-B  4. Soft scaling for RI=1 and 2 | 2-35 | yes | n/a | Enhanced Type-I SP codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements, e.g. component 2 is a basic feature (64 ports).  Note: Possible extension to <=32 ports is still being discussed | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1-2 | Enhanced Type-I MP codebook | 1. 48 ports  2. 64 ports  3. 128 ports | 2-35 | yes | n/a | Enhanced Type-I MP codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements, e.g. component 2 is a basic feature (64 ports) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1-3 | Extended Rel-16 eType-II codebook | 1. 48 ports  2. 64 ports  3. 128 ports | 2-35 | yes | n/a | Extended Rel-16 eType-II codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements, e.g. component 2 is a basic feature (64 ports) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1-4 | Extended Rel-17 FeType-II codebook | 1. 48 ports  2. 64 ports | 2-35 | yes | n/a | Extended Rel-17 FeType-II codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements, e.g. component 2 is a basic feature (64 ports) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1-5 | Extended Rel-18 Type-II Doppler codebook | 1. 48 ports  2. 64 ports  3. 128 ports | 2-35 | yes | n/a | Extended Rel-18 Type-II Doppler codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements, e.g. component 2 is a basic feature (64 ports) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1-6 | 2-slot CSI-RS resource aggregation | UE capability for 2-slot aggregation | 59-2-1-1, 2, 3, 4, 5 | yes | n/a | 2-slot resource aggregation is not supported | Per band | n/a | n/a | n/a | 1-slot resource aggregation is a basic feature and incorporated in 59-2-1-1, 2, 3, 4, 5 | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-2-1-7 | SRS Port Grouping | 1. For xT6R  2. For xT8R | 2-35 | yes | n/a | SRS Port Grouping is not supported | Per band | n/a | n/a | n/a | Only applicable for reportQuantity = ‘cri-RI-CQI’ | Optional with capability signaling | | 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} | 2-36 | yes | n/a | Hybrid BF (CRI-based) with Rel-15 Type-I SP codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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} | 16-3a | yes | n/a | Hybrid BF (CRI-based) with Rel-16 eType-II codebook is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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} | 59-2-2-1, 2 | yes | n/a | Configuration of MR always-reported resources is not supported, i.e. MR=0 | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-3-1 | CJTC Dd report | 1. AD={0.5CP, CP}  2. MD={32, 64, 128, 256} | 2-35 | yes | n/a | CJTC Dd report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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} | 2-35 | yes | n/a | CJTC FO report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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} | 2-35 | yes | n/a | CJTC PO report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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 | 2-35 | yes | n/a | CJTC Dd report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-3-5 | CJTC subband 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} | 2-35 | yes | n/a | CJTC Dd report is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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 | 40-1-4 | yes | n/a | New QCL assumptions for PDSCH pre-compensation is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed 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 DOC indication  3. Separate triggering w/ DOC indication | 40-3-1-1, 59-2-3-1  [40-3-1-a] | yes | n/a | Linkage of CJTC Dd and Rel-18 eType-II CJT is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements  DOC = delay offset compensation | Optional with capability signalling | |
| vivo [6] | **CSI enhancements**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  | Components | Pre-requisite |  |  |  |  |  |  |  |  |  | | x. NR\_MIMO\_Phase 5 | x-2-1-1 | Type I codebook for 64 ports with Scheme A, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-1a | Type I codebook for 48 ports with Scheme A, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-1 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-1b | Type I codebook for 128 ports with Scheme A, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-1 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-2 | Type I codebook for 64 ports with Scheme B, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-2a | Type I codebook for 48 ports with Scheme B, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-2 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-2b | Type I codebook for 128 ports with Scheme B, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-2 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-3 | 3-bit power scaling for rank 1 |  | x-2-1-1, x-2-1-2 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-4 | 3-bit power scaling for rank 2 |  | x-2-1-3 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-5 | eType II codebook for 64 ports, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-5a | eType II codebook for 48 ports, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-5 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-5b | eType II codebook for 128 ports, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-5 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-6 | FeType II PS codebook for 64 ports, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-6a | FeType II PS codebook for 48 ports, timeline capability 1 | Triplet: { *maxNumberTxPortsPerReport* , *maxNumberTxPortsPerResource* , *maxNumberTotalTxPorts* } | x-2-1-6 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-7 | Support of timeline capability 2 for the above codebooks |  |  |  |  |  |  |  |  |  | This may split into multiple FGs for the above codebooks | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-8 | Support of associated CSI-RS resource set for NCB based UL |  |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-1-9 | Support of SRS port grouping |  |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-2-1 | CRI enhancement for up to 128 ports with Type I codebook | Maximum value of M |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-2-2 | CRI enhancement for up to 128 ports with Type II codebook | Maximum value of M |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-2-3 | Support of MR non-reported CRIs |  | x-2-1-7, x-2-1-8 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-3-1 | Support of DO reporting |  |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-3-1a | Support of linkage between DO reporting and Type II CJT reporting |  | x-2-3-1 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-3-1b | Support of 1 bit indicate per trigger state for separate triggering of linked DO reporting and Type II CJT reporting |  | x-2-3-1a |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-3-2 | Support of FO reporting |  |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-3-3 | Support of WB PO reporting |  |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-2-3-3a | Support of SB PO reporting |  | x-2-3-3 |  |  |  |  |  |  |  |  | Optional | |
| Nokia [7] | |  |  |  |  | | --- | --- | --- | --- | | FG | FG name | Components | Note | | MIMO-2-1 | Type-I codebook enhancement: single panel | * Support for 64 ports is a basic feature, but support for 48 and 128 ports are two separate capabilities * Supported schemes: {Scheme-A, Scheme-A and Scheme-B} * Capability 1: Reuse legacy Z/Z’ values; Capability 2: Scale the legacy Z/Z’ timeline by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources * 3-bit scaling of groups of SD basis vectors for RI=1 * 3-bit scaling of groups of SD basis vectors for RI=2 * For CPU occupation: For Capability 1 timeline: OCPU = ceil(P/32); For Capability 2 timeline: OCPU = 1 * Active resource counting is: For Capability 1 timeline: 1; For Capability 2 timeline: 1 | **(RAN1#116bis)** Port count support capabilities  **(RAN1#116bis)** 2 consecutive slots for CSI-RS resources  **(RAN1#116bis)** Timeline (Z/Z’) capabilities  **(RAN1#117)** 3-bit scaling for RI=1  **(RAN1#117)** CPU occupation  **(RAN1#118bis)** 3-bit scaling for RI=2  **(RAN1#118bis)** Active resource counting  **(RAN1#118bis)** Timeline for the port subset indication for SD network energy savings Type 1  **(RAN1#118bis)** CPU occupation for the port subset indication for the SD network energy savings Type-1  Note: Scheme-A is the basic feature, Scheme-B additional UE capability | | MIMO 2-1-1 | Support of SD NES Type-1 for Type-I SP codebook enhancement | * Timeline for the port subset indication for the SD NES Type-1: Capability 1 timeline: Reuse legacy Z/Z’ values; Capability 2 timeline: Scale the legacy timeline Z/Z’ by * CPU occupation for the port subset indication for the SD NES Type-1; For timeline capability 1 and 2, P-report (L subConfigs) OCPU=L; AP/SP-report (N triggered) OCPU=N |  | | 2-1-2 | Type-I codebook enhancement: multi-panel | * Support for 64 ports is a basic feature, but support for 48 and 128 ports are two separate capabilities * Support rank 1 to 4 * FFS other components |  | | MIMO-2-2 | Rel-16 eTypeII regular codebook enhancement | * Support for 64 ports is a basic feature, but support for 48 and 128 ports are two separate capabilities * For CPU occupation: For Capability 1 timeline: OCPU = ceil(P/32); For Capability 2 timeline: OCPU = 1 * Active resource counting is: For Capability 1 timeline: 1; For Capability 2 timeline: 1 | **(RAN1#116)** Separate feature group for each enhanced codebook Port count support capabilities.  **(RAN1#116bis)** 2 consecutive slots for CSI-RS resources  **(RAN1#116bis)** Timeline (Z/Z’) capabilities  **(RAN1#117)** CPU occupation (except for Type II Doppler)  **(RAN1#118)** CPU occupation (for Type II Doppler)  **(RAN1#118bis)** Active resource counting (except for Type II Doppler) | | MIMO 2-2-1 | Rel-17 feTypeII codebook enhancement (port selection): | * Support for 64 ports is a basic feature, but support for 48 ports is a separate capability * For CPU occupation: For Capability 1 timeline: OCPU = ceil(P/32); For Capability 2 timeline: OCPU = 1 |  | | MIMO 2-2-2 | Rel-18 Type II Doppler codebook enhancement: | * Support for 64 ports is a basic feature, but support for 48 and 128 ports are two separate capabilities * For CPU occupation for Type II Doppler codebook, For Capability 1 timeline: OCPU is the legacy Rel-18 Type-II Doppler OCPU multiplied by ceil(P/32); For Capability 2 timeline: OCPU is the legacy Rel-18 Type-II Doppler OCPU |  | | MIMO 2-2-3 | Configuring K NZP CSI-RS resources within 2 consecutive slots |  |  | | MIMO-2-3 | CRI(s)-based CSI reporting for Rel-15 Type I single panel codebook | * the maximum value of KS= {2,…,8} for 16 ports per resource * the maximum value of KS= {2,3,4} for 32 ports per resource * maximum value of M={1, …, min(4,KS)}, | **(RAN1#116bis)** Maximum value of M for Type I single panel codebook  **(RAN1#116bis)** Maximum value of KS for eType II codebook  **(RAN1#116bis)** Maximum value of M for eType II codebook  **(RAN1#117)** UE capability for configuring MR of KS CSI-RS resources as part of reporting the M quadruplets. | | MIMO 2-3-1 | CRI(s)-based CSI reporting for Rel-16 eType II codebook | * the maximum value of KS= {[1],2,3,4} for 16 ports per resource * the maximum value of KS= {[1],2,3,4} for 32 ports per resource and M=1 * maximum value of M={1,2} | The maximum value of needs to be >1 to be able to support CRI-based reporting | | MIMO 2-3-2 | Network-selected CSI-RS resources for CRI(s)-based CSI reporting (Type I) | * Maximum value MR (<M) of KS CSI-RS resources to be reported as part of reporting the M “quadruplets” = {1,2} |  | | MIMO 2-3-3 | Network-selected CSI-RS resources for CRI(s)-based CSI reporting (Type II) | * Maximum value MR (<M) of KS CSI-RS resources to be reported as part of reporting the M “quadruplets” = 1 |  | | MIMO-2-4 | SRS port grouping | * Indication of feature support | **(RAN1#116bis)** Separate UE capability | | MIMO-3-1 | UE reporting for CJT calibration reporting - delay offset | * The UE is configured with NTRP NZP CSI-RS resources/resource sets via higher-layer (RRC) signalling where **NTRP{1, 2, 3, 4}** * For delay offset, **Dn,offset, is uniformly spaced between 0 and AD** {0.5CP, CP} with **={32, 64,128, 256}** quantization steps. * CPU occupation X, where X multiples NTRP to give the number of CPUs | (RAN1#116)  For the Rel-19 aperiodic standalone CJT calibration reporting,  (RAN1#116bis)  For the Rel-19 aperiodic standalone CJT calibration reporting of {(Dn,offset, dn), n=0, 1, …, NTRP – 1, n≠nref}, regarding the interval which Dn,offset falls into, is uniformly spaced between 0 and AD, i.e. , with and represent ‘out-of-range’  (RAN1#116bis)  For the Rel-19 aperiodic standalone CJT calibration reporting, the dynamic range and resolution parameters for delay offset reporting Dn,offset, i.e. (AD, MD), are NW-configured via higher-layer (RRC) signalling  (RAN1#117)  For the Rel-19 aperiodic standalone CJT calibration reporting, regarding the dynamic range for delay offset reporting Dn,offset, i.e. AD, at least support the following values: {0.5CP, CP}  (RAN1#118)  For the Rel-19 aperiodic standalone CJT calibration reporting, regarding the resolution for delay offset reporting Dn,offset, additionally support MD = {128, 256}  (RAN1#116bis)  For the Rel-19 aperiodic standalone CJT calibration reporting of {FOn , n=0, 1, …, NTRP – 1, n≠nref}, the value of FOn indicates a uniformly quantized frequency offset between 0 and AFO  (RAN1#116bis)  For the Rel-19 aperiodic standalone CJT calibration reporting, regarding frequency offset reporting, and represents an ‘invalid’ state  (RAN1#116bis)  For the Rel-19 aperiodic standalone CJT calibration reporting, the dynamic range and resolution parameters for frequency offset reporting FOn, i.e. (AFO, MFO), are NW-configured via higher-layer (RRC) signalling from the following candidate values:  (RAN1#117)  For the Rel-19 aperiodic standalone CJT calibration reporting, regarding the dynamic range for frequency offset reporting FOn, i.e. AFO, at least support the following values: {0.1ppm, 0.2ppm}  **(RAN1#118)**  For the Rel-19 aperiodic standalone CJT calibration reporting, regarding the resolution for frequency offset reporting FOn, additionally support MFO = 256  (RAN1#117)  For the Rel-19 aperiodic standalone CJT calibration reporting, when ReportQuantity is ‘cjtc-P’ (DL/UL phase offset), =1 only (agreed in RAN1#116bis) implies that the measured/reported phase offsets {n,, n=0, 1, …, NTRP – 1, n≠nref} are associated with the entire configured CSI reporting band (i.e. ‘wideband’)  (RAN1#116bis)  For the Rel-19 aperiodic standalone CJT calibration reporting, the resolution parameters for n, i.e. M, are NW-configured via higher-layer (RRC) signalling from the candidate values {16, 32}, where .  **(RAN1#118)**  For the Rel-19 aperiodic standalone CJT calibration reporting, when ReportQuantity is ‘cjtc-P’ (DL/UL phase offset), regarding the support of sub-band reporting (S>1) {(Fn,0, Fn,1, ..., Fn,NSB-P -1), n=0, 1, …, NTRP – 1, n≠nref}:  (RAN1#118)  For the Rel-19 aperiodic standalone CJT calibration reporting, when ReportQuantity is ‘cjtc-P’ (DL/UL phase offset), the selection of PSRS=1 SRS port corresponding to the ‘reference UE antenna port’ (out of available port(s)) is NW-configured via higher-layer (RRC) signalling  **(RAN1#118bis)**  For the Rel-19 aperiodic standalone CJT calibration reporting, when ReportQuantity is ‘cjtc-P’ (DL/UL phase offset), the selection of PSRS=1 SRS port (corresponding to the ‘reference UE antenna port’) out of the y available SRS ports (from an xTyR SRS resource for antenna switching) can be configured per CSI reporting setting. | | MIMO 3-2 | UE reporting for CJT calibration reporting - frequency offset | * The UE is configured with NTRP NZP CSI-RS resources/resource sets via higher-layer (RRC) signalling where **NTRP{1, 2, 3, 4}** * For frequency offset, the value of FOn indicates a uniformly quantized frequency offset between 0 and **AFO** **{0.1ppm, 0.2ppm}** with **MFO = {16, 32, 256}** quantization steps. * CPU occupation X, where X multiplies NTRP to give the number of CPUs |  | | MIMO 3-3 | UE reporting for CJT calibration reporting - phase offset | * The UE is configured with NTRP NZP CSI-RS resources/resource sets via higher-layer (RRC) signalling where **NTRP{1, 2, 3, 4}** * For phase offset, a single antenna port PSRS=1 is selectable out of the y available SRS ports (from an xTyR SRS resource for antenna switching) and can be configured per CSI reporting setting. * Maximum number of subbands {1, 2, 4, 8, 16} * CPU occupation X, where X multiplies NTRP to give the number of CPUs |  | | MIMO 3-4 | UE reporting for CJT calibration reporting – joint delay and frequency offset | * The UE is configured with NTRP NZP CSI-RS resources/resource sets via higher-layer (RRC) signalling where **NTRP{1, 2, 3, 4}** * CPU occupation X, where X multiplies NTRP to give the number of CPUs |  | | MIMO 3-5 | UE reporting for CJT calibration reporting - delay offset and CJT CSI | * **Type of triggers for reporting delay offset and CJT CSI: {joint, joint and separate}** * CPU occupation X, where X multiplies NTRP to give the number of CPUs | **Agreement**(RAN1#118bis)  For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with two separate triggers, support to include an indicator in the trigger for a Rel-18 eType-II CJT CSI, which indicates whether the UE should perform delay offset (DO) compensation based on the linked CJTC Dd report when calculating the Rel-18 Type-II CJT CSI or not.  This feature is a separate UE capability | |
| Apple [8] | **CSI enhancements**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports | 1. Support 64 ports 2. Additionally supported number of aggregated ports 3. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously 4. Supported maximum rank 5. Supported codebook scheme(s) 6. Max # of CSI-RS resource in a resource set 7. Supported processing capability |  | Yes | n/a | Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values bitmap {48 ports, 128 ports}  Component 3 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256}  Component 4 candidate value {4, 5, 6, 7, 8}  Component 5 candidate value {scheme-A, scheme-B, scheme-A and scheme-B}  Component 6 candidate value {1:8}  Component 7 candidate value {Capability 1, Capability 2}  Note: For component of processing capability  Capability 1:  Reuse legacy Z/Z’ values  OCPU = ceil(P/32)  Capability 2:  Scale the legacy timeline Z/Z’ by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources  OCPU = ceil(P/32) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1a | CBSR for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports | Support CBSR for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports | 59-2-1 | Yes | n/a | CBSR for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1b | 3-bit SD basis scaling factor for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports | 1. Support 3-bit SD basis scaling factor for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports 2. Supported maximum rank | 59-2-1 | Yes | n/a | 3-bit SD basis scaling factor for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values bitmap {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1c | Spatial domain NES Type-I for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports | 1. Support spatial domain NES Type-I for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports by extending the bitmap (i.e., port-subsetIndicator) 2. Processing timeline | 59-2-1 | Yes | n/a | Spatial domain NES Type-I for Rel-15 Type-I SP (single panel) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate value {Capability 1, Capability 2}  Note: For component of processing timeline  Capability 1 timeline: Reuse legacy Z/Z’ values (i.e., Z2 and Z’2)  Capability 2 timeline: Scale the legacy timeline Z/Z’ (i.e., Z2 and Z’2) by where M is the number of sub-configurations that refer to the any of the K aggregated CSI-RS resources | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1d | CSI-RS port mapping for Type-I and Type II codebook enhancement for up to 128 ports | Supported CSI-RS port mapping schemes for Type-I and Type II codebook enhancement for up to 128 ports | At least one of {59-2-1, 59-2-2, 59-2-3, 59-2-4, 59-2-5} | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Candidate value {Mapping method 1, Mapping method 2, Mapping method 3}  Note: The CSI-RS port mapping applies to all of the following, FG59-2-1, FG59-2-2, FG59-2-3, FG59-2-4, FG59-2-5 | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1e | CSI-RS resource time domain restriction for Type-I and Type II codebook enhancement for up to 128 ports | Maximum number of slots the K CSI-RS resources shall be configured within for Type-I and Type II codebook enhancement for up to 128 ports | At least one of {59-2-1, 59-2-2, 59-2-3, 59-2-4, 59-2-5} | Yes | n/a | No time domain restriction for K CSI-RS resources | Per band and Per BC | n/a | n/a | n/a | Candidate value {1 slot, 2 slots}  Note: The supported CSI-RS resource time domain restriction applies to all of the following, FG59-2-1, FG59-2-2, FG59-2-3, FG59-2-4, FG59-2-5 | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-1f | Per CS-RS resource slot offset configuration for Type-I and Type II codebook enhancement for up to 128 ports | Except for codebook refinement based on Rel-18 Type-II Doppler, support per-resource higher-layer (RRC) configuration to indicate (via 1-bit per resource) whether 1-slot offset relative to the legacy resource-set-level slot offset configuration should be assumed or not  For codebook refinement based on Rel-18 Type-II Doppler, introduce per-resource higher-layer (RRC) configuration to indicate (via 1-bit per resource) whether 1-slot offset relative to the resource group slot offset should be assumed or not | At least one of {59-2-1, 59-2-2, 59-2-3, 59-2-4, 59-2-5} | Yes | n/a | Per CS-RS resource slot offset configuration for Type-I and Type II codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Note: This feature applies to all of the following, FG59-2-1, FG59-2-2, FG59-2-3, FG59-2-4, FG59-2-5 | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-2 | Rel-15 Type-I MP (multi panel) codebook enhancement for up to 128 ports | 1. Support 64 ports 2. Additionally supported number of aggregated ports 3. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously 4. Supported maximum number of panels 5. Max # of CSI-RS resource in a resource set 6. Supported processing capability |  | Yes | n/a | Rel-15 Type-I MP (multi panel) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values bitmap {48 ports, 128 ports}  Component 3 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256}  Component 4 candidate value {2, 4}  Component 5 candidate value {1:8}  Component 6 candidate value {Capability 1, Capability 2}  Note: For component of processing capability  Capability 1:  Reuse legacy Z/Z’ values  OCPU = ceil(P/32)  Capability 2:  Scale the legacy timeline Z/Z’ by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources  OCPU = ceil(P/32) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-3 | Rel-16 eType-II codebook enhancement for up to 128 ports | 1. Support 64 ports 2. Support of parameter combination 1-6 3. Support of rank 1-2 4. Support R=1 5. Additionally supported number of aggregated ports 6. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously with R=1 7. Supported processing capability |  | Yes | n/a | Rel-16 eType-II codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 5 candidate values bitmap {48 ports, 128 ports}  Component 6 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256}  Component 7 candidate value {Capability 1, Capability 2}  Note: For component of processing capability  Capability 1:  Reuse legacy Z/Z’ values  OCPU = ceil(P/32)  Capability 2:  Scale the legacy timeline Z/Z’ by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources  OCPU = ceil(P/32) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-3a | PMI sub-bands with R=2 for Rel-16 eType-II codebook enhancement for up to 128 ports | 1. Support of PMI sub-bands with R=2 for Rel-16 eType-II codebook enhancement for up to 128 ports 2. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously with R=2 | 59-2-3 | Yes | n/a | PMI sub-bands with R=2 for Rel-16 eType-II codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-3b | Parameter combinations 7-8 for Rel-16 eType-II codebook enhancement for up to 128 ports | Support of parameter combinations 7-8 for Rel-16 eType-II codebook enhancement for up to 128 ports | 59-2-3 | Yes | n/a | Parameter combinations 7-8 for Rel-16 eType-II codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-3c | Rank 3,4 for Rel-16 eType-II codebook enhancement for up to 128 ports | Support of Rank 3,4 for Rel-16 eType-II codebook enhancement for up to 128 ports | 59-2-3 | Yes | n/a | Rank 3,4 for Rel-16 eType-II codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-4 | Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports | 1. Support 64 ports 2. Support of parameter combinations with M=1 3. Support of rank 1-2 4. Support R=1 5. Additionally supported number of aggregated ports 6. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously with M=1 and R=1 7. Supported processing capability |  | Yes | n/a | Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 5 candidate values bitmap {48 ports}  Component 6 candidate values  a. {48, 64}  b. {1, …, 64}  c. {64, …, 256}  Component 7 candidate value {Capability 1, Capability 2}  Note: For component of processing capability  Capability 1:  Reuse legacy Z/Z’ values  OCPU = ceil(P/32)  Capability 2:  Scale the legacy timeline Z/Z’ by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources  OCPU = ceil(P/32) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-4a | M=2 and R=1 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports | 1. Support M=2 and R=1 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports 2. Support of parameter combinations with M=2 3. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously with M=2 and R=1 | 59-2-4 | Yes | n/a | M=2 and R=1 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 3 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-4b | R=2 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports | 1. Support R=2 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports 2. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously with M=2 and R=2 | 59-2-4 | Yes | n/a | R=2 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-4c | Rank 3,4 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports | Support rank 3, 4 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports | 59-2-4 | Yes | n/a | Rank 3, 4 for Rel-17 FeType-II PS (port selection) codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5 | Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 1. Support X=1 CQI based on the first/earliest slot of the CSI reporting window and the first/earliest predicted PMI (TDCQI=’1-1’) 2. Support PMI subband R=1 3. Support parameter combinations with L=2,4 4. Support rank = 1,2 5. Support 64 ports 6. Additionally supported number of aggregated ports 7. A list of supported combinations, each combination is { Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously 8. Supported processing capability 9. Value of Y for CPU occupation when P/SP-CSI-RS is configured for CMR 10. Value of Y for CPU occupation when A-CSI-RS is configured for CMR 11. Support for the size of DD-basis, N4=1 12. Scaling factor for active resource counting Kp |  | Yes | n/a | Rel-18 Type-II Doppler  codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 6 candidate values bitmap {48 ports, 128 ports}  Component 7 candidate values  a. {48, 64, 128}  b. {1, …, 64}  c. {64, …, 256}  Component 8 candidate value {Capability 1, Capability 2}  Component 9 candidate values: {1, 2, 3}  Component 10 candidate values: {1, 2, 3}  Component 12 candidate values: {1, 2, 4}  Note: For component of processing capability  Capability 1:  Legacy timeline  OCPU = Y⋅N4⋅ceil(P/32) ), when P/SP-CSI-RS is configured for CMR  OCPU = Y⋅ KDOPP⋅ceil(P/32)), when A-CSI-RS is configured for CMR  Capability 2:  Scale the legacy timeline by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources  OCPU = Y⋅N4⋅, when P/SP-CSI-RS is configured for CMR  OCPU = Y⋅ KDOPP, when A-CSI-RS is configured for CMR  Note: maximum OCPU is 8  Note: KDOPP is the number of CSI-RS resource groups configured for channel measurement, and each CSI-RS resource groups contain K CSI-RS resources for aggregating up to 128 ports  Note: legacy processing timeline is reported in 59-2-5j | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5a | N4>1 for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 1. Support for the size of DD-basis, N4>1 2. A list of supported combinations, each combination is {Max N4, Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously 3. A list of supported combinations, each combination is {Max N4, Max # of Tx ports in one report, Max # of resources and total # of Tx ports} for one CSI report setting 4. Value of d=m for the DD unit size when A-CSI-RS is configured for CMR | 59-2-5 | Yes | n/a | N4>1 for Rel-18 Type-II Doppler  codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values  a. {1,2,4,8}  b. {48, 64,128}  c. {2,3,4 … 64}  d. {64, …, 256}  Component 3 Candidate values  a. {1,2,4,8}  b. {48, 64,128}  c. {4,8,12}  d.{64, …, 256} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5b | DD unit size d=1 when A-CSI-RS is configured for CMR N4>1 | Support value of d=1 for the DD unit size when A-CSI-RS is configured for CMR for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a | Value of d=1 for the DD unit size when A-CSI-RS is configured for CMR N4>1 is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5c | Maximum number of aperiodic CSI-RS resources groups that can be configured in the same CSI report setting for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Supported maximum number of aperiodic CSI-RS resources groups that can be configured in the same CSI report setting for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Candidate values: {4, 8, 12} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5d | PMI subband R=2 for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 1. Support PMI subband R=2 for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports 2. A list of supported combinations, each combination is {Max # of Tx ports in one report, Max # of resources and total # of Tx ports} across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously with R=2 | 59-2-5 | Yes | n/a | PMI subband R=2 for Rel-18 Type-II Doppler  codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values  a. {48, 64,128}  b. {2,3,4 … 64}  c. {64, …, 256} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5e | X=1 based on first and last slot of WCSI for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Support X=1 based on first and last slot of WCSI for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a | X=1 based on first and last slot of WCSI, for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5f | X=2 CQI based on 2 slots for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Support X=2 CQI based on 2 slots for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a | X=2 CQI based on 2 slots for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5g | l = (n – nCSI,ref ) for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Support l = (n – nCSI,ref ) for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a | l = (n – nCSI,ref) for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5h | L=6 for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Support L=6 for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a | L=6 for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5i | Rank 3 and 4 for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Support Rank 3 and 4 for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a | Rank 3 and 4 for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5j | Processing timeline for CSI reference slot for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 1. Aperiodic CSI report timing relaxation, w, Rel-18 Type-II Doppler codebook enhancement for up to 128 ports 2. Aperiodic CSI report timing relaxation Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Component 1 candidate values:  UE reports candidate value, w, independently for each SCS in unit of symbols: {14\*(KP–1)\*d, 14\*KP\*d}  Note: Kp is according to Component 12 of FG59-2-5  Note: d=4 (minimum periodicity of periodic CSI-RS)  Component 2 candidate values: {CAP1, CAP2}  For N4 = 1  1) For AP CSI-RS: (Z,Z’) = (Z2 + 14\*( KDOPP –1)\*m, Z'2)  2) For P/SP CSI-RS: (Z,Z’) = (Z2 + w, Z'2)  For N4 > 1 and CAP1 in component 2  1) For AP CSI-RS: (Z,Z’) = (Z2 + 14\*( KDOPP –1)\*m, Z'2)  2) For P/SP CSI-RS: (Z,Z’) = (Z2 + w, Z'2)  For N4 > 1 and CAP2 in component 2  1) For AP CSI-RS: (Z,Z’) = (Z2 + 14\*( KDOPP –1)\*m + Z'2, 2Z'2)  2) For P/SP CSI-RS: (Z,Z’) = (Z2 + w + Z'2, 2Z'2)  Z2/Z'2 are defined in Table 5.4-2 in TS38.214  KDOPP is the number of CSI-RS resource groups configured for channel measurement, and each CSI-RS resource groups contain K CSI-RS resources for aggregating up to 128 ports  M = {1,2}, is the offset between two adjacent AP CSI-RS resources for the CMR in slots | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-5k | Maximum periodicity of CMR when configured as periodic CSI-Rs for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | Supported maximum periodicity of CMR when configured as periodic CSI-Rs for Rel-18 Type-II Doppler codebook enhancement for up to 128 ports | 59-2-5 | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Candidate values (in slots): {4, 5, 8, 10, 20} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-6 | Rel-15 Type-I SP (single panel) codebook enhancement for CRI-based CSI refinement | 1. Maximum number of Ks configured CSI-RS resources for channel measurement 2. Maximum number of M reported CRI |  | Yes | n/a | Rel-15 Type-I SP (single panel) codebook enhancement for CRI-based CSI refinement is not supported | Per band and Per BC | n/a | n/a | n/a | Component 1 candidate values: {2, 3, 4, 5, 6, 7, 8}  Component 2 candidate values: {1, 2, 3, 4, 5, 6, 7, 8} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-6a | Configuration of MR CSI-RS resource for Rel-15 Type-I SP (single panel) codebook enhancement for CRI-based CSI refinement | 1. Support the NW configuration of MR (<M) of KS CSI-RS resources to be selected as part of reporting the M CRI(s), for A-CSI only, for Rel-15 Type-I SP (single panel) codebook enhancement for CRI-based CSI refinement 2. Maximum number of MR | 59-2-6 | Yes | n/a | NW configuration of MR (<M) of KS CSI-RS resources to be selected as part of reporting the M CRI(s) is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-7 | Rel-16 eType-II codebook enhancement for CRI-based CSI refinement | 1. Maximum number of Ks configured CSI-RS resources for channel measurement 2. Maximum number of M reported CRI |  | Yes | n/a | Rel-16 eType-II codebook enhancement for CRI-based CSI refinement is not supported | Per band and Per BC | n/a | n/a | n/a | Component 1 candidate values: {2, 3, 4}  Component 2 candidate values: {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-7a | Configuration of MR =1 CSI-RS resource for Rel-16 eType-II codebook enhancement for CRI-based CSI refinement | Support the NW configuration of MR =1 of KS CSI-RS resources to be selected as part of reporting the M CRI(s), for A-CSI only, for Rel-16 eType-II codebook enhancement for CRI-based CSI refinement | 59-2-7 | Yes | n/a | NW configuration of MR =1 of KS CSI-RS resources to be selected as part of reporting the M CRI(s) is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-8 | Delay offset report for aperiodic standalone CJT calibration reporting | 1. Support delay offset report for aperiodic standalone CJT calibration reporting 2. Maximum number of configured TRS resource sets for delay offset report 3. Maximum number of configured TRS resource sets for delay offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 4. Maximum number of simultaneously active CSI-RS resources for delay offset report per CC 5. Maximum number of simultaneously active CSI-RS resources for delay offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 6. Value of X for CPU occupation (OCPU=X⋅NTRP) |  | Yes | n/a | Delay offset report for aperiodic standalone CJT calibration reporting is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {2, 4, 6, 8, 10, 12}  Component 3 candidate values: {2, 4, 6, 8, 12, … 64}  Component 4 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32}  Component 5 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32, …, 64}  Component 6 candidate values: {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-8a | Maximum number of TRS resource sets in a report configuration for delay offset report | Maximum number of TRS resource sets in a report configuration for delay offset report | 59-2-8 | Yes | n/a |  | Per FS | n/a | n/a | n/a | Candidate values: {2, 3, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-8b | Maximum number of delay offset report settings per BWP | Maximum number of delay offset report settings (*CSI-ReportConfig)* configured with *resourcesForChannelMeasurement* linked to a same BWP ID | 59-2-8 | Yes | n/a |  | Per FS | n/a | n/a | n/a | Candidate values: {1, 2, 3, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-8c | Quantization for delay offset report | 1. Maximum number of quantization points MD for delay offset report 2. Quantization range AD for delay offset report | 59-2-8 | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Component 1 candidate values: {32, 64, 128, 256}  Component 2 candidate values: bitmap {0.5CP, CP} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-8d | Delay offset compensated Rel-18 eType-II CJT codebook report | 1. Support of RRC configuration a UE to perform PMI calculation for the Rel-18 eType-II CJT CSI report assuming pre-compensation using the UE-reported delay offset 2. Supported mode(s) | 59-2-8 | Yes | n/a | Delay offset compensated Rel-18 eType-II CJT codebook report is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {Joint trigger, separate trigger, both} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-8e | Per CSI trigger state configuration whether delay offset is compensated for Rel-18 eType-II CJT codebook report | Support RRC configuration to indicate whether the UE should perform delay offset compensation based on the latest linked delay offset report when calculating the Rel-18 Type-II CJT CSI. | 59-2-8d | Yes | n/a | Per CSI trigger state configuration whether delay is compensated for Rel-18 eType-II CJT codebook report is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {Joint trigger, separate trigger, both} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-9 | Frequency offset report for aperiodic standalone CJT calibration reporting | 1. Support frequency offset report for aperiodic standalone CJT calibration reporting 2. Maximum number of configured TRS resource sets for frequency offset report 3. Maximum number of configured TRS resource sets for frequency offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 4. Maximum number of simultaneously active CSI-RS resources for frequency offset report per CC 5. Maximum number of simultaneously active CSI-RS resources for frequency offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 6. Value of X for CPU occupation (OCPU=X⋅NTRP) |  | Yes | n/a | Frequency offset report for aperiodic standalone CJT calibration reporting is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {2, 4, 6, 8, 10, 12}  Component 3 candidate values: {2, 4, 6, 8, 12, … 64}  Component 4 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32}  Component 5 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32, …, 64}  Component 6 candidate values: {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-9a | Maximum number of TRS resource sets in a report configuration for frequency offset report | Maximum number of TRS resource sets in a report configuration for frequency offset report | 59-2-9 | Yes | n/a |  | Per FS | n/a | n/a | n/a | Candidate values: {2, 3, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-9b | Maximum number of frequency offset report settings per BWP | Maximum number of frequency offset report settings (*CSI-ReportConfig)* configured with *resourcesForChannelMeasurement* linked to a same BWP ID | 59-2-9 | Yes | n/a |  | Per FS | n/a | n/a | n/a | Candidate values: {1, 2, 3, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-9c | Quantization for frequency offset report | 1. Maximum number of quantization points MFO for frequency offset report 2. Quantization range AFO for frequency offset report | 59-2-9 | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Component 1 candidate values: {16, 32, 256}  Component 2 candidate values: bitmap {0.1ppm, 0.2ppm} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-9d | Joint delay and frequency offset report for aperiodic standalone CJT calibration reporting | 1. Support joint delay and frequency offset report for aperiodic standalone CJT calibration reporting 2. Maximum number of configured TRS resource sets for joint delay and frequency offset report 3. Maximum number of configured TRS resource sets for joint delay and frequency offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 4. Maximum number of simultaneously active CSI-RS resources for joint delay and frequency offset report per CC 5. Maximum number of simultaneously active CSI-RS resources for joint delay and frequency offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 6. Value of X for CPU occupation (OCPU=2X⋅NTRP) |  | Yes | n/a | Joint delay and frequency offset report for aperiodic standalone CJT calibration reporting is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {2, 4, 6, 8, 10, 12}  Component 3 candidate values: {2, 4, 6, 8, 12, … 64}  Component 4 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32}  Component 5 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32, …, 64}  Component 6 candidate values: {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-10 | Phase offset report for aperiodic standalone CJT calibration reporting | 1. Support wideband phase offset report for aperiodic standalone CJT calibration reporting 2. Maximum number of configured CSI-RS resources for phase offset report 3. Maximum number of configured CSI-RS resources for phase offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 4. Maximum number of simultaneously active CSI-RS resources for phase offset report per CC 5. Maximum number of simultaneously active CSI-RS resources for phase offset report across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC 6. Value of X for CPU occupation (OCPU=X⋅NTRP) |  | Yes | n/a | Phase offset report for aperiodic standalone CJT calibration reporting is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {2, 4, 6, 8, 10, 12}  Component 3 candidate values: {2, 4, 6, 8, 12, … 64}  Component 4 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32}  Component 5 candidate values: {2, 4, 6, 8, 12, 16, 20, 24, 28, 32, …, 64}  Component 6 candidate values: {1, 2} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-10a | Maximum number of CSI-RS resources in a report configuration for phase offset report | Maximum number of CSI-RS resources in a report configuration for phase offset report | 59-2-10 | Yes | n/a |  | Per FS | n/a | n/a | n/a | Candidate values: {2, 3, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-10b | Maximum number of phase offset report settings per BWP | Maximum number of phase offset report settings (*CSI-ReportConfig)* configured with *resourcesForChannelMeasurement* linked to a same BWP ID | 59-2-10 | Yes | n/a |  | Per FS | n/a | n/a | n/a | Candidate values: {1, 2, 3, 4} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-10c | Maximum number of quantization points M for phase offset report | Maximum number of quantization points M for phase offset report | 59-2-10 | Yes | n/a |  | Per band and Per BC | n/a | n/a | n/a | Candidate values: {16, 32} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-10d | RRC configuration of 1 SRS port of antenna switching associated with phase offset report | Support of RRC configuration of 1 SRS port of antenna switching associate with phased offset report | 59-2-10 | Yes | n/a | RRC configuration of 1 SRS port of antenna switching associated with phase offset report is not supported | Per band and Per BC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-10e | Subband phase offset report for aperiodic standalone CJT calibration reporting | 1. Support subband phase offset report for aperiodic standalone CJT calibration reporting 2. Maximum number of reported subbands 3. Minimum subband size |  | Yes | n/a | Subband phase offset report for aperiodic standalone CJT calibration reporting is not supported | Per band and Per BC | n/a | n/a | n/a | Component 2 candidate values: {2, 4, 6, 8, 10, 12, 14, 16}  Component 3 candidate values: {1, 2, 4, 8,6} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-11 | xT6R antenna switching SRS port grouping | Support configuration of SRS port groups for xT6R antenna switching |  | Yes | n/a | xT6R antenna switching SRS port grouping is not supported | Per FSPC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-12 | xT8R antenna switching SRS port grouping | Support configuration of SRS port groups for xT8R antenna switching |  | Yes | n/a | xT6R antenna switching SRS port grouping is not supported | Per FSPC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-13 | Association up to 128 CSI-RS ports and SRS for non-codebook-based PUSCH | 1. Support association between {48, 64, 128} CSI-RS ports and SRS resource set for non-codebook-based PUSCH 2. A list of supported combinations, each combination is {Max # of Tx ports, Max # of resources, and total # of Tx ports} simultaneously |  | yes | n/a | Association up to 128 CSI-RS ports and SRS for non-codebook-based PUSCH is not supported | Per FS | n/a | n/a | n/a | Component 2 candidate value: Maximum size of the list is 16.  The candidate values for the max # of Tx port is  {48, 64, 128}  The candidate value set of the max # of resources is:  {2, …, 64}  The candidate value set of total # of ports is:  {48, …, 256} | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-2-14 | QCL assumption for PDSCH with two indicated TCI states | 1. Supported QCL assumption for PDSCH with two indicated TCI states |  | yes | n/a |  | Per band | n/a | n/a | n/a | Candidate values: bitmap {Scheme C, Scheme D, Scheme E}  Scheme C: The PDSCH DMRS port(s) are QCLed with the DL-RS associated with the first TCI state with respect to QCL-TypeA and QCLed with the DL-RS in the second TCI state with respect to QCL-TypeA except for {Doppler shift}  Scheme D: The PDSCH DMRS port(s) are QCLed with the DL-RS associated with the first TCI state with respect to QCL-TypeA and QCLed with the DL-RS in the second TCI state with respect to QCL-TypeA except for {average delay}  Scheme E: The PDSCH DMRS port(s) are QCLed with the DL-RS associated with the first TCI state with respect to QCL-TypeA and QCLed with the DL-RS in the second TCI state with respect to QCL-TypeA except for {Doppler shift, average delay} | Optional with capability signalling | |
| CATT [9] | **CSI enhancements**  In RAN#102 meeting [1], specifying CSI enhancements for CJT calibration report and up to 128 CSI-RS ports was agreed. In this section, UE features of CSI enhancements are discussed.  It has already been agreed to report Dd/FO/PO among TRPs for time/frequency/reciprocity error calibration, then Dd/FO/PO reporting shall be basic feature(s) of Rel-19 UE. One issue is whether Dd, FO and PO reporting are separate UE features or not. In our opinion, separate UE features shall be introduced, since each reporting focuses on one specific scenario, and can be adopted independently.  **Proposal 2: Support CJTC Dd, FO and PO reporting as three separate basic features for Rel-19 UE.**  For CSI enhancements for up to 128 ports, two schemes (Scheme A and Scheme B) are agreed for Rel-19 Type I SP codebook refinement. Scheme A is a low feedback overhead codebook with lower performance, while Scheme B is a high feedback overhead codebook with better performance. These two schemes are corresponding to different optimization goals, and they will not be used jointly. Therefore, it is preferred that Scheme A and Scheme B are supported as separate UE features.  **Proposal 3: Support Rel-19 Type I SP codebook Scheme A and Scheme B as separate basic UE features for Rel-19 UE.** |
| OPPO [10] | **UE feature for CSI enhancements**  The agreements should be considered in UE feature discussion. Furthermore, some additional UE features are also needed though without explicit agreements:   * For Rel-19 Type I SP CB, similar to other Rel-19 CB refinements, 64 ports can be basic UE capability, with 48/128 ports as additional UE capability. * For Rel-19 Type I SP CB, in previous agreements, Scheme1 and sequent Scheme-A are the baseline schemes, which requires lower overhead and complexity compared to Scheme B. Scheme A should be basic UE feature, and Scheme B can be supported as additional UE feature with higher complexity and overhead. * The extension of Rel-18 SD NES Type-1 CB to up to 128 ports should be separate UE feature, with prerequisite of Rel-18 SD NES Type-1 CB and Rel-19 Type I SP CB. * For mapping from CSI-RS resource index/port index per resource and port index to CSI/PMI calculation, supporting both Method 1 and Method 2 would lead to additional UE complexity, so UE is not mandated to supported both. * Configuring K aggregated resources for SRS resource set with usage of 'nonCodebook' would also introduce additional complexity for precoder calculation, and the benefit is unclear.   ***Proposal 3: The following UE features should be introduced for up to 128 ports codebook enhancement***   * ***Support Rel-19 Type I SP CB for up to 128 ports***   + ***64 ports as basic feature with supported (N1, N2) value from (16,2) and (8,4)***   + ***48 ports as separate UE feature with supported (N1, N2) value from (8,3) and (6,4)***   + ***128 ports as separate UE feature with supported (N1, N2) value from (16,4) and (8,8)***   + ***Scheme A for Rank 1-8 as basic feature***     - ***Scheme B as separate UE feature***   + ***Support 3-bit scaling factor for RI= {1, 2, or both}***   + ***Support Rel-18 SD NES Type-1 CB with extended port subset indication*** * ***Support Rel-19 Type I MP CB for up to 128 ports***   + ***64 ports as basic feature with supported (N1, N2) values from [FFS]***   + ***48 ports as separate UE feature with supported (N1, N2) values from [FFS]***   + ***128 ports as separate UE feature with supported (N1, N2) values from [FFS]*** * ***Support Rel-19 eType II CB for up to 128 ports（based on Rel-16 eType II CB）***   + ***64 ports as basic feature with supported (N1, N2) value from (16,2) and (8,4)***   + ***48 ports as separate UE feature with supported (N1, N2) value from (8,3) and (6,4)***   + ***128 ports as separate UE feature with supported (N1, N2) value from (16,4) and (8,8)*** * ***Support Rel-19 FeType II CB for up to 64 ports（based on Rel-17 FeType II CB）***   + ***64 ports as basic feature***   + ***48 ports as separate UE feature*** * ***Support Rel-19 eType-II Doppler CB for up to 128 ports（based on Rel-18 eType-II Doppler CB）***   + ***64 ports as basic feature with supported (N1, N2) value from (16,2) and (8,4)***   + ***Support 48 ports as separate UE feature with supported (N1, N2) value from (8,3) and (6,4)***   + ***Support 128 ports as separate UE feature with supported (N1, N2) value from (16,4) and (8,8)*** * ***Mapping method from CSI-RS resource index/port index to CSI/PMI calculation for Rel-19 Type I and eType II CB from {Method 1，Method 2 or both}*** * ***Support K aggregated NZP CSI-RS resources for up to 128 ports within one slot as basic feature***   + ***Support K aggregated NZP CSI-RS resources within 2 consecutive slots as separate UE feature*** * ***Support configuring up to 128 ports with K aggregated resources for SRS resource set with usage of 'nonCodebook'*** * ***Timeline for Rel-19 Type I and eType II CB from Capability 1 and Capability 2***   ***Proposal 4: The following UE features should be introduced for Rel-19 CRI-based CSI refinement***   * ***Support Rel-19 CRI-based CSI refinement for Rel-15 Type-I SP codebook as basic feature***   + ***The supported maximum value of M from {1,2,3,4}***   + ***The supported maximum value of Ks from [FFS]*** * ***Support Rel-19 CRI-based CSI refinement for Rel-16 eType-II codebook as separate feature***   + ***The supported maximum value of M from {1,2}***   + ***The supported maximum value of Ks from {1,2,3,4}*** * ***Support configuration of MR always selected resources as separate feature***   The agreements should be considered in UE feature discussion. For linkage between CJTC Delay offset reporting and Rel-18 eType-II CJT CSI, two schemes, joint trigging and separate trigging, were agreed in Rel-19. Between the two schemes, joint triggering can achieve shorter latency with lower signaling overhead, which can be the basic feature for linkage-based reporting. Separate trigging would introduce more issue, and can be considered as additional UE feature.  ***Proposal 5: The following UE features should be introduced for CJT calibration (CJTC) reporting***   * ***Support Delay offset reporting for CJT calibration***   + ***Supported value of X for OCPU*** * ***Linkage of CJTC Delay offset reporting and Rel-18 eType-II CJT CSI as separate UE feature***   + ***Support joint triggering as basic feature***   + ***Support separate triggering as separate UE feature***     - ***Indication of delay offset (DO) compensation on the linked Rel-18 Type-II CJT CSI as additional UE feature*** * ***Support Frequency offset reporting for CJT calibration***   + ***Supported value of X for OCPU*** * ***Support Delay+Frequency offset reporting for CJT calibration***   + ***Supported value of X for OCPU*** * ***Support wideband phase offset report for CJT calibration***   + ***Support subband phase offset report for CJT calibration as separate UE feature***     - ***Supported subband size***     - ***Supported maximal subband number NSB-P***   + ***Supported value of X for OCPU*** * ***Support new QCL assumptions for PDSCH pre-compensation on CJT reporting***    + ***Scheme C, D, E as separate UE features***   Based on the agreement, the following UE feature is needed:  ***Proposal 6: The following UE feature should be introduced for SRS port grouping:***   * ***Support SRS port grouping for {xT8R, xT6R or both}.*** |
| Ericsson [11] | **UE capabilities for Rel-19 Type I and Type II codebook refinements**  In Rel-19, two schemes are supported for Rel-19 Type I SP codebooks: Schemes A and B. Based on evaluations performed during the normative phase, it was observed Scheme B provides better performance compared to Scheme A at the expense of a slight increase in feedback overhead. Hence, it has to be first decided which among the two features shall be basic capabilities or if both can be part of the basic capability. We propose to down-select between the following two alternative approaches for defining the basic UE capabilities for Rel-19 Type I SP Codebook:   1. Downselect one of the following Alternatives as baseline feature for Rel-19 Type I SP Codebook:  * Alt 1: Base feature supports both Rel-19 Type I SP codebook schemes A and B * Alt 2: Support two separate baseline features for Rel-19 Type I SP codebook Scheme A and Scheme B   We next propose the following components to be defined as part of basic UE capabilities for Rel-19 Type I SP codebooks and Rel-19 Type II codebooks:   1. For Rel-19 Type I SP Codebooks and Rel-19 Type II Codebooks, support the following components as part of respective basic UE capabilities:  * Support of P=64 ports * Support of group based hard CBSR * Support of either Capability 1 or Capability 2 with regards to timeline, CPU usage, and active resource counting   The following UE capabilities can be defined as optional capabilities:   1. In Rel-19, support the following as optional UE capabilities for Rel-19 Type I and Type II codebook refinements:  * Support of P=128 ports (for both Rel-19 Type I and Type II codebooks) * Support of P=48 ports (for both Rel-19 Type I and Type II codebooks) * Support for 3-bit scaling factor for rank = 1 (only for Rel-19 Type I SP Codebook) * **Support for 3-bit scaling factor for rank = 2 (only for Rel-19 Type I SP Codebook)** * **Support of port subset indication for Rel-19 Type-I SP Codebook** * Support of Rel-19 Type I Multi-panel codebook   There were two set of capabilities agreed in Rel-19 for Rel-19 Type I SP Codebooks and Rel-19 Type II Codebooks. We propose to defined the following components for each of the two set of capabilities:   1. For Rel-19 Type I Single Panel and Type II codebook refinements for 48, 64 and 128 CSI-RS ports, support the following two capabilities:  * **Capability 1**   + **Reuse legacy Z/Z’ values**   + **OCPU = ceil(P/32)**   + **Active resource counting of 1** * Capability 2   + **Scale the legacy timeline Z/Z’ by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources**   + **OCPU = 1**   + **Active resource counting of 1**   **UE capabilities for hybrid beamforming**  For Rel-19 CSI feedback for hybrid beamforming, we propose the following as the basic UE feature:   1. For Rel-19 CSI-based CSI refinement, support the following as part of basic capability:  * Support for Type I Single Panel codebook * The maximum value of the number of CSIs to feedback, M = {1, …., min(4,Ks)) * The maximum value of the number Ks of NZP CSI-RS resources, Ks = {1, 2, 3, 4}   With regards to UE optional features for Rel-19 CSI feedback for hybrid beamforming, we propose the following:   1. For Rel-19 CSI-based CSI refinement, support the following as part of optional capability:  * Support for Type II codebook   + **The maximum value of the number of CSIs to feedback, M = {1,2)**   + The maximum value of the number Ks of NZP CSI-RS resources, Ks = {1, 2, 3, 4} * Support of MR CSI-RS resources for which UE feeds back CSI without feeding back CRI   **UE capabilities for UE reporting for CJT calibration**  For Rel-19 UE reporting for CJT calibration, we propose the following as separate basic UE features:   1. For Rel-19 UE reporting for CJT calibration, support the following as separate UE basic capabilities:  * Support of wideband phase offset reporting * Support of delay offset reporting * Support of frequency offset reporting * Support of joint delay offset and frequency offset reporting   For Rel-19 UE reporting for CJT calibration, we propose the following as optional UE features:   1. For Rel-19 UE reporting for CJT calibration, support the following as separate UE optional capabilities:  * Support of wideband phase offset reporting * **Support of linking CJTC Dd and Rel-18 eType II CJT CSI reports for UE sided pre-compensation of delay offset** |
| Qualcomm Incorporated [12] | **CSI enhancement**  Overall, there are four topics discussed under “CSI enhancement” of Rel-19 NR MIMO Phase 5.   1. Up-to-128-port Type-I/II CSI; 2. Multi-CRI; 3. SRS port grouping; 4. UE-assisted CJT calibration (CJTC).   In the following proposals, the above four topics will be labeled respectively as **Proposal** “**2-1**” “**2-2**” “**2-3**” “**2-4**”.  Besides, depending on whether there already exists explicit UE-capability-related RAN1 agreement on each FG, the proposals are further labeled as e.g. **Proposal** “**2-1A**” (already with UE-capability-related agreement, although may not necessarily with every detailed component), and **Proposal** “**2-1B**” (no UE-capability-related agreement yet). Up-to-128-port Type-I/II CSI  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-2-1-1 | Up-to-128-port Type-I single-panel codebook | 1. {# of Tx ports in one report, Max # of reports and total # of Tx ports} across all CCs simultaneously  2. Supported Codebook Mode(s) | 2-35 | YES | N/A | Rel-19 Type-I single-panel codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values:  Maximum 16 triplets  - # of Tx ports in one report: {64,48,128} (note: 64 is basic, 48 and 128 are optional)  - Max # reports: {1,2,3,4}  - Max # total ports: {48 to 256}  Component 2 candidate values:  {ModeA, ModeB}  Note: ModeA is basic, ModeB is optional | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-10 | CSI processing timeline for Rel-19 Type-I SP and Type-II codebook | Support from two timeline capabilities, for Rel-19 Type-I single-panel codebook | XX-2-1-1, XX-2-1-2, XX-2-1-3, or, XX-2-1-4 | YES | N/A | BaseStation does not know UE’s CSI processing timeline, and may have to assume a long report latency | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values:  Capability 1: Reuse legacy Z/Z’ values  Capability 2: Scale the legacy timeline Z/Z’ by ceil(P/32) where P is the total number of ports across all the K aggregated CSI-RS resources  Note: A UE that supports FG XX-2-1-1, XX-2-1-2, XX-2-1-3, or, XX-2-1-4 must signal this FG | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-11 | 2 consecutive slots for receiving K = {2,3,4} CSI-RS resources | Support receiving K = {2,3,4} CSI-RS resources in 2 consecutive slots | 2-33 | YES | N/A | UE only support receiving K={2,3,4} CSI-RS resources in a same slot | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-12 | Per-layer scaling factor for rank1 | Support per-layer scaling factor for rank1, for Rel-19 Type-I single-panel codebook | XX-2-1-1 | YES | N/A | UE does not support per-layer scaling factor for rank1 | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-12a | Per-layer scaling factor for rank2 | Support per-layer scaling factor for rank2, for Rel-19 Type-I single-panel codebook | XX-2-1-1 | YES | N/A | UE does not support per-layer scaling factor for rank2 | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-13 | NES SD Type1 timeline for Rel-19 Type-I single-panel codebook | Support NES SD Type1 timeline from two timeline capabilities, for Rel-19 Type-I single-panel codebook | XX-2-1-1 | YES | N/A | BaseStation does not know UE’s CSI processing timeline, and may have to assume a long report latency | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values:  Capability 1: Reuse legacy Z/Z’ values (i.e., Z2 and Z’2)  Capability 2 timeline: Scale the legacy timeline Z/Z’ (i.e., Z2 and Z’2) by where M is the number of sub-configurations that refer to the any of the K aggregated CSI-RS resources | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-2 | Up-to-128-port Type-I mult-panel codebook | 1. {# of Tx ports in one report, Max # of reports and total # of Tx ports} across all CCs simultaneously  2. Supported number of panels, Ng | 2-35 | YES | N/A | Rel-19 Type-I multi-panel codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values:  Maximum 16 triplets  - # of Tx ports in one report: {64,48,128} (note: 64 is basic, 48 and 128 are optional)  - Max # reports: {1,2,3,4}  - Max # total ports: {48 to 256}  Component 2 candidate values:  {2,4} | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-3 | Up-to-128-port eType-II regular codebook | 1. {# of Tx ports in one report, Max # of reports and total # of Tx ports} to support regular eType-II for R=1  2. Support of parameter combinations 1-6  3. Support of rank 1,2 | 2-35 | YES | N/A | Rel-19 eType-II regular codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values:  Maximum 16 triplets  - # of Tx ports in one report: {64,48,128} (note: 64 is basic, 48 and 128 are optional)  - Max # reports: {1,2,3,4}  - Max # total ports: {48 to 256} | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-4 | Up-to-64-port FeType-II port-selection codebook | 1. {# of Tx ports in one report, Max # of reports and total # of Tx ports} to support Port-selection FeType-II with M=1 and R=1  2. Support rank 1,2  3. Support parameter combinations with M=1 | 2-35 | YES | N/A | Rel-19 FeType-II port-selection codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values:  Maximum 16 triplets  - # of Tx ports in one report: {64,48} (note: 64 is basic, 48 is optional)  - Max # reports: {1,2,3,4}  - Max # total ports: {48 to 256} | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1-5 | Up-to-128-port Type-II-Doppler codebook | 1. Support X=1 CQI based on the first/earliest slot of the CSI reporting window and the first/earliest predicted PMI (TDCQI=’1-1’)  2. Support of Rel-16 eType-II regular codebook refinement for predicted PMI with PMI subband R=1  3. Support parameter combinations with L=2,4  4. Support for rank = 1,2  5. A list of supported combinations, each combination is {Max # of Tx ports in one report, Max # of reports and total # of Tx ports} across all CCs simultaneously  7. Value of Y for CPU occupation (OCPU = Y.N4), when P/SP-CSI-RS is configured for CMR  8. Value of Y for CPU occupation (OCPU = Y.K), when A-CSI-RS is configured for CMR  9. Support for the size of DD-basis, N4=1  10. Scaling factor for active resource counting Kp | 2-35 | YES | N/A | Rel-19 Type-II-Doppler codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 5 candidate values  - # of Tx ports in one report: {64,48,128} (note: 64 is basic, 48 and 128 are optional)  - Max # reports: {1,2,3,4}  - Max # total ports: {48, …, 256}  Component 7 candidate values: {1, 2, 3}  Component 8 candidate values: {1, 2, 3}  Component 10 candidate values: {1, 2, 4}  Note: When N4=1, OCPU =4  Note: OCPU ≥ 4 when P/SP-CSI-RS is configured for CMR  Note: when K=12, OCPU =8 | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1- | CSI-RS port mapping method1 for aggregation of K={2,3,4} CSI-RS resources | Support CSI-RS port mapping method1 (N1-dimension aggregation) for Rel-19 Type-I/II codebooks | XX-2-1-1, XX-2-1-3, or, XX-2-1-5 | YES | N/A | For K={2,3,4} CSI-RS resources, UE only supports CSI-RS port mapping method2 (N2-dimension aggregation) | Per-band and per-BC | N/A | N/A | N/A | The support of mapping method2 (N2-dimension aggregation) is required for the prerequisite FGs | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1- | {K=3, Q=16} for P = KQ = 48 CSI-RS ports | Support K=3 CSI-RS resources each with Q=16 ports for Rel-19 Type-I/II codebooks | XX-2-1-1, XX-2-1-3, XX-2-1-4, or, XX-2-1-5 | YES | N/A | {K=3, Q=16} is not supported by UE  Note: P=48 ports can still be supported by {K=2, Q=24} | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-1- | {K=4, Q=16} for P = KQ = 64 CSI-RS ports | Support K=4 CSI-RS resources each with Q=16 ports for Rel-19 Type-I/II codebooks | XX-2-1-1, XX-2-1-3, XX-2-1-4, or, XX-2-1-5 | YES | N/A | {K=4, Q=16} is not supported by UE  Note: P=64 ports can still be supported by {K=2, Q=32} | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling |  Multi-CRI  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-2-2-1 | Multi-CRI report for Rel-15 Type-I single-panel codebook | 1. Supported max # CSI-RS resources in the resource set (max Ks);  2. Supported max # reported CSI-RS resources (max M) out of Ks measured | 2-36 | YES | N/A | Multi-CRI report for Rel-15 Type-I single-panel codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values: {2,3,4,5,6,7,8}  Note: If Ks={2,3,4}, max # ports per resource is 32; If Ks={5,6,7,8}, max # ports per resource is 16  Component 2 candidate values: {1,2,3,4} | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-2-2 | Reserved reported CSI-RS resource(s) for Rel-15 Type-I single-panel codebook | Support MR = {1,2} reserved reported CSI-RS resources out of M reported (MR < M) for aperiodic CSI report | XX-2-1 | YES | N/A | Reserved reported CSI-RS resource(s) for aperiodic report is not supported by UE for FG XX-2-1 | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-2-3 | Multi-CRI report for Rel-16 eType-II regular codebook | 1. Supported max # CSI-RS resources in the resource set (max Ks);  2. Supported max # reported CSI-RS resources (max M) out of Ks measured | 16-3a | YES | N/A | Multi-CRI report for Rel-16 eType-II regular codebook is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | Component 1 candidate values: {2,3,4}  Note: max # ports per resource is 16  Component 2 candidate values: {1,2} | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-2-4 | Reserved reported CSI-RS resource for Rel-16 eType-II regular codebook | Support MR = {1} reserved reported CSI-RS resources out of M reported (MR < M) for aperiodic CSI report | XX-2-3 | YES | N/A | Reserved reported CSI-RS resource(s) for aperiodic report is not supported by UE for FG XX-2-3 | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling |  SRS port grouping  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-2-3-1 | SRS port grouping | Support SRS port grouping |  | YES | N/A | SRS port grouping is not supported | Per-band and per-BC | N/A | N/A | N/A | UE antenna ports are divided as two groups for two-CW reception:  • SRS port group 0, corresponding to CW0, comprises the even y/2 out of y ports; and  • SRS port group 1, corresponding to CW1, comprises the odd y/2 out of y ports  Note: The y SRS ports of one or more sets of SRS resources for antenna switching (xTyR) are indexed in an ascending order according to SRS resource set ID, SRS resource ID within each set, and port number within each SRS resource | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-3-2 | Both groups of SRS ports for single-CW reception | Support UE antenna ports associated with both groups of SRS ports for single-CW reception | XX-2-3-1 | YES | N/A | UE antenna ports associated with only one of the two SRS port groups are used for single-CW reception | Per-band and per-BC | N/A | N/A | N/A | Applicable to reception of PDSCH with single-CW (i.e. <= 4 layers), and non-PMI report hypotheses of rank1-to-4 | Optional with capability signaling |  UE-assisted CJTC  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-2-4-1 | CJTC inter-TRP delay offset (DO) report | Support CJTC DO report | 2-35 | YES | N/A | CJTC DO report is not supported by UE | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-2 | CJTC inter-TRP frequency offset (FO) report | Support CJTC FO report | 2-35 | YES | N/A | CJTC FO report is not supported by UE | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-3 | CJTC inter-TRP phase offset (PO) report | Support CJTC wideband PO report | 2-35 | YES | N/A | CJTC wideband PO report is not supported by UE | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-3a | CJTC inter-TRP subband phase offset (PO) report | Support CJTC subband PO report | XX-2-4-3 | YES | N/A | CJTC subband PO report is not supported by UE | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-4 | Scaling parameter X for CJTC DO CPU | Value of X | XX-2-4-1 | YES | N/A | Network does not know how much CPU UE would take for DO report | Per-band and per-BC | N/A | N/A | N/A | O\_CPU =X \* N\_TRP | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-5 | Scaling parameter X for CJTC FO CPU | Value of X | XX-2-4-2 | YES | N/A | Network does not know how much CPU UE would take for FO report | Per-band and per-BC | N/A | N/A | N/A | O\_CPU =X \* N\_TRP | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-6 | Scaling parameter X for CJTC PO CPU | Value of X | XX-2-4-3 | YES | N/A | Network does not know how much CPU UE would take for PO report | Per-band and per-BC | N/A | N/A | N/A | O\_CPU =X \* N\_TRP | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-4 | Two TCI states for CJT schemeC for PDSCH | Support CJT schemeC for PDSCH with two TCI states | 40-1-4 | YES | N/A | CJT schemeC PDSCH is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint/DL TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift} of the second indicated joint/DL TCI state | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-4-5 | Two TCI states for CJT schemeD for PDSCH | Support CJT schemeD for PDSCH with two TCI states | 40-1-4 | YES | N/A | CJT schemeD PDSCH is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint/DL TCI states with respect to QCL-TypeA except for QCL parameters {average delay} of the second indicated joint/DL TCI state | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-6 | Two TCI states for CJT schemeE for PDSCH | Support CJT schemeE for PDSCH with two TCI states | 40-1-4 | YES | N/A | CJT schemeE PDSCH is not supported by UE | Per-band and per-BC | N/A | N/A | N/A | PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint/DL TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, average delay} of the second indicated joint/DL TCI state | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-2-6 | Linking CJTC DO report to Type-II-CJT CSI report, with two separate triggering | Support Type-II-CJT CSI report being clauclated based on DO-compensation linked to DO report triggered by a different DCI | 40-3-1-1, XX-2-4-1 | YES | N/A |  | Per-band and per-BC | N/A | N/A | N/A |  | Optional with capability signaling | |

## 3-antenna-port codebook-based transmissions

|  |  |
| --- | --- |
| Company | Summary |
| ZTE Corporation/Sanechips [1] | At least the following FGs of 3TX UL transmission should be introduced or extended:   * Codebook-based 3Tx PUSCH transmission`   + Component 1: Maximum number of PUSCH MIMO layers for codebook-based PUSCH     - Candidates: {1, 2, 3}   + Component 2: Maximum number of 4-port SRS resources per SRS resource set with usage set to 'codebook’ for codebook-based 3Tx PUSCH     - Candidates: {1, 2}   + Component 3: Maximum number of 3 unmuted SRS ports per SRS resource set with usage set to 'codebook’ for codebook-based 3Tx PUSCH * Non-codebook-based PUSCH transmission (extension of existing FG)   + Component 1: Maximal number of supported layers     - Candidates: {1, 2, 3 (extension of existing candidates), 4}   + Component 2: Supported max number of SRS resource per set     - Candidates: {1, 2, 3, 4}   + Component 3: Maximum number of simultaneous transmitted SRS resources at one symbol     - Candidates: {1, 2, 3, 4} * 3Tx SRS antenna switching   + Component 1: 3T6R antenna switching   + Component 2: 3T3R antenna switching * Maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching   + Component 1: Support of maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching * Maximum 2 SP and 1 periodic SRS sets for 3T3R antenna switching   + Component 1: Support of maximum 2 SP and 1 periodic SRS sets for 3T3R antenna switching |
| Huawei/HiSilicon [2] | The following UE features are proposed:  ***Proposal 4.9: Introduce the following FGs for 3-antenna-port PUSCH transmission:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | [TBD] | 3-antenna-port codebook-based transmission | 1. Indicates the maximum layers supported for codebook-based PUSCH transmission is 3. |  | Yes | No | 3Tx codebook-based PUSCH transmission is not supported. | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | 3-antenna-port codebook-based transmission | 1. Indicates the maximum supported number of SRS ports is 3. |  | Yes | No | 3Tx codebook-based PUSCH transmission is not supported. | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | 3-antenna-port codebook-based transmission | 1. Indicates the number of supported 4-port SRS resources in a resource set where the last port is muted. |  | Yes | No | Do not support configuration of 2 4-port SRS resources in a resource set where the last port is muted. | TBD | n/a | n/a | n/a | Candidate value {1,2} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | 3-antenna-port codebook-based transmission | 1. Indicates support of full-power Mode 0 for codebook-based 3TX PUSCH transmission. |  | Yes | No | Full-power Mode 0 is not supported for 3Tx codebook-based PUSCH transmission. | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | 3-antenna-port non-codebook-based transmission | 1. Indicates support of non-codebook-based 3TX PUSCH transmission. |  | Yes | No | Non-codebook-based 3TX PUSCH transmission is not supported. | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | 3-antenna-port non-codebook-based transmission | 1. Indicates the maximum layers supported for non-codebook-based 3TX PUSCH transmission. |  | Yes | No | The maximum layer supported for non-codebook-based 3TX PUSCH transmission is 1. | TBD | n/a | n/a | n/a | Candidate value {1,2,3} | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | M-TRP PUSCH repetition of 3-antenna-port PUSCH transmission | 1. Indicates support of M-TRP PUSCH repetition for 3-antenna-port PUSCH transmission. |  | Yes | No | M-TRP PUSCH repetition is not supported for 3TX PUSCH transmission. | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | PTSR of 3-antenna-port PUSCH transmission | 1. Indicates the number of supported PTRS ports for PUSCH transmission. |  | Yes | No | PTRS is not supported for 3TX PUSCH transmission. | TBD | n/a | n/a | n/a | Candidate value {1,2} | Optional with capability signalling | |
| CMCC [3] | Based on the agreements related with UE optional feature and considering in previous meetings, we suggest taking the following UE feature list as a starting point:  ***Proposal 5: Take the following UE feature list as a starting point for the feature of Rel-19 for 3-antenna-port codebook-based transmissions:***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | | 59. NR\_MIMO\_Ph5 | 59-3-1 | Codebook based PUSCH transmission for 3TX | 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 | | 59. NR\_MIMO\_Ph5 | 59-3-1a | UL full power transmission mode of *fullpower* | 1. Supported UL full power transmission mode of *fullpower* | 59-3-1 | | 59. NR\_MIMO\_Ph5 | 59-3-2 | Non-codebook based PUSCH transmission for 3TX | 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 | | 59. NR\_MIMO\_Ph5 | 59-3-3 | Support of 3T6R antenna switching | 1. Support SRS Tx port switch 2. Report whether the uplink TX switching impact to downlink receiving in a band 3. Report whether the UL Tx is switched together with UL Tx in another band | 2-53 | |
| Samsung [4] | **UL 3TX**  Considering above agreements and some basic features which have been agreed in normative phase and/or Rel-19 MIMO work item description without explicit description on UE capability, the following list of UE capabilities can be a starting point of further discussion.   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Prerequisite FGs | Consequence if the feature is not supported by the UE | Type | Need of FR1/FR2 differentiation | Note | Mandatory  /Optional | | X-3-1 | Codebook based 3TX PUSCH transmission | 1. Support non-coherent codebook subset only.  2. Support 4-port SRS resource with muting port 1003  3. Supported codebook based PUSCH MIMO with maximal number of supported layers  4. Supported maximum number of SRS resource per set (SRS set use is configured as for codebook). | 2-14 | Codebook based 3TX PUSCH transmission is not supported | Per FS | N/A | Component 3 candidate value: {no-codebook based MIMO, 1, 2, 3}  Component 4 candidate value: {1, 2} | Optional with capability signalling | | X-3-2 | Non-codebook based 3TX 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 | 2-15 | Non-codebook based 3TX PUSCH transmission is not supported | Per FSPC | N/A | Component 1 candidate value: {1, 2, 3}  Component 2 candidate value: {1, 2, 3, 4}  Component 3 candidate value: {1, 2, 3, 4} | Optional with capability signalling | | X-3-1-1 | Multi-TRP PUSCH repetition type A – codebook based 3TX PUSCH transmission | Support of multi-TRP PUSCH repetition type A for codebook based 3TX PUSCH transmission | X-3-1, 23-3-1 | Multi-TRP PUSCH repetition type A is not supported for codebook based 3TX PUSCH transmission. | Per FS | N/A |  | Optional with capability signalling | | X-3-1-2 | Multi-TRP PUSCH repetition type B – codebook based 3TX PUSCH transmission | Support of multi-TRP PUSCH repetition type B for codebook based 3TX PUSCH transmission | X-3-1, 23-3-1-1 | Multi-TRP PUSCH repetition type B is not supported for codebook based 3TX PUSCH transmission. | Per FSPC | N/A |  | Optional with capability signalling | | X-3-2-1 | Multi-TRP PUSCH repetition type A –  non-codebook based 3TX PUSCH transmission | Support of multi-TRP PUSCH repetition type A for non-codebook based 3TX PUSCH transmission | X-3-2, 23-3-1-2 | Multi-TRP PUSCH repetition type A is not supported for non-codebook based 3TX PUSCH transmission. | Per FS | N/A |  | Optional with capability signalling | | X-3-2-2 | Multi-TRP PUSCH repetition type B –  non-codebook based 3TX PUSCH transmission | Support of multi-TRP PUSCH repetition type B for non-codebook based 3TX PUSCH transmission | X-3-2, 23-3-1-3 | Multi-TRP PUSCH repetition type B is not supported for non-codebook based 3TX PUSCH transmission. | Per FSPC | N/A |  | Optional with capability signalling | | X-3-3 | Two PT-RS ports for 3TX PUSCH | Support two PT-RS ports for 3TX PUSCH | X-3-1 or X-3-2 | Two PT-RS ports for 3TX PUSCH are not supported | Per Band | N/A |  | Optional with capability signalling | | X-3-4 | Full-power mode 0 for codebook based 3TX PUSCH | Support full-power mode 0 for codebook based 3TX PUSCH transmission | X-3-1 | Full-power mode 0 for codebook based 3TX PUSCH transmission is not supported | Per FS | N/A |  | Optional with capability signalling | | X-3-5 | SRS 3T6R antenna switching | 1. Support of 3T6R for antenna switching by using 4-port SRS resource with muting port 1003  2. Downgrade antenna switching configurations  3. Report the entry number of the first-listed band with UL in the band combination that affects this DL  4. Report the entry number of the first-listed band with UL in the band combination that switches together with this UL |  | SRS 3T6R antenna switching is not supported | Per FS | N/A | Component 2 candidate value: combination (including empty) of {1T1R, 1T2R, 1T4R, 2T2R, 2T4R, 2T6R}  Component 3 candidate value: {1,2,…,32}  Component 4 candidate value: {1,2,…,32} | Optional with capability signalling | | X-3-6 | SRS 3T3R antenna switching | Support of SRS 3T3R antenna switching |  | SRS 3T3R antenna switching is not supported | Per FS | N/A |  | Optional with capability signalling | | X-3-7 | Maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching | Support of maximum 2 SP SRS resource sets and maximum 1 periodic SRS resource set for 3T6R antenna switching | X-3-5 | Maximum one SRS resource set for periodic SRS and maximum one SRS resource set for semi-persistent SRS is supported | Per FS | N/A | Note: The two SP-SRS resource sets are not activated at the same time | Optional with capability signalling | |
| Samsung (Moderator) [5] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | 59-3-1 | Non-codebook based PUSCH transmission for 3TX | 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 | yes | n/a | 3TX UE is not properly supported. | Per band | n/a | n/a | n/a | Component-1 candidate values: {1, 2, 3,}  Component-2  Candidate value: {1,2,3}  Component-3  Candidate value: {1,2,3} | Optional with UE capability | | 59. NR\_MIMO\_Ph5 | 59-3-2 | Support of 3T6R antenna switching | 1. Support SRS Tx port switch, 2. Report whether the uplink TX switching impact to downlink receiving in a band,   3) Report whether the UL Tx is switched together with UL Tx in another band | 2-53 | yes | n/a | 3TX 3T6R antenna switching is not supported. | Per band | n/a | n/a | n/a | Component-1 candidates: {"Not supported", "3T6R”} | Optional with UE capability | |
| vivo [6] | **Support for 3-antenna-port codebook-based transmissions**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  | Components | Pre-requisite |  |  |  |  |  |  |  |  |  | | x. NR\_MIMO\_Phase 5 | x-3-1 | Support of number of 4-port SRS resources in a resource set where one the ports is muted |  |  |  |  |  |  |  |  |  |  | Optional  {0,1,2} | | x. NR\_MIMO\_Phase 5 | x-3-2 | Supported number of layers of 3Tx codebook |  | x-3-1 | … | … |  | .. | … | … |  | … | Optional  {1,2,3} | | x. NR\_MIMO\_Phase 5 | x-3-3 | Support of UL full power mode 0 for 3Tx codebook |  | x-3-1 | … | … |  | .. | … | … |  | … | Optional | | x. NR\_MIMO\_Phase 5 | x-3-4 | Supported number of PTRS ports |  | x-3-1 | … | … |  | .. | … | … |  | … | Optional  {0, 1, 2} | | x. NR\_MIMO\_Phase 5 | x-3-5 | Supported number of layers for non-codebook based UL transmission for UEs supporting 3Tx UL |  |  |  |  |  |  |  |  |  |  | Optional  {none, 1, 2, 3} | | x. NR\_MIMO\_Phase 5 | x-3-6 | Supported SRS Tx switch for UEs supporting 3Tx UL |  | x-3-1 |  |  |  |  |  |  |  |  | Optional  {none, 3T3R, 3T6R, 3T3R-3T6R } | |
| Nokia [7] | |  |  |  |  | | --- | --- | --- | --- | | FG | FG name | Components | Note | | MIMO-4-1 | Non-coherent UL codebook to facilitate 3-antenna-port codebook-based transmissions | * Support Full Power Mode 0 * Support up to 2 PTRS ports, PTRS-DMRS association for 1 and/or 2 PTRS ports, PTRS association for CB-based M-TRP PUSCH repetition * Support Rel-17 M-TRP PUSCH repetition (2 SRS resource sets, each with up to 2 of 4-port SRS resources) * 3TX UE may report a max number of layers of up to 3 * 3TX UE may report max number of SRS ports of up to 3 | **(RAN1 #116)**  For codebook-based uplink transmission by a 3TX UE, support full-power Mode 0, subject to UE capability.  **(RAN1 #116bis)**  For a 3TX UE, support Rel-17 M-TRP PUSCH repetition,  **(RAN1 #117)**  For codebook-based UL transmission by a 3TX UE, subject to its capability, | | MIMO-4-2 | 3T6R SRS antenna switching | * Re-use 4T8R principles * a 3TX UE may report a max number of SRS ports of up to 3 | **(RAN1 #118bis)**  To support 3T6R antenna switching for a 3TX UE, | | MIMO-4-3 | UE capability signaling for 3T3R antenna switching | * a 3TX UE may report a max number of SRS ports of up to 3 | **Updated WID (in RP-242394) to support 3T3R**   1. Specify non-coherent UL codebook to facilitate 3-antenna-port codebook-based transmissions, enhancement(s) to enable 3T6R SRS antenna switching, as well as UE capability signaling for 3T3R antenna switching and 3-antenna-port non-codebook-based transmissions, without enhancement on UL full power transmission and without enhancement on SRS resource   Note: UL full power transmission mode 1 and 2 are not supported.  Note: Other than UE capability signaling, no other enhancement is specified for 3T3R SRS antenna switching. | | MIMO-4-4 | UE capability signaling for 3-antenna-port non-codebook-based transmissions | * NCB-based PUSCH: capability of up to max 3 layers * SRI indication: re-use legacy-based solution according to N\_SRS * For S-TRP: one SRS resources set with up to N\_SRS single port SRS resources * For Rel-17 M-TRP PUSCH repetition: two SRS resource sets, each with N\_SRS single-port SRS resources | (RAN1 #118bis)  To support non-codebook-based PUSCH transmission by a 3TX UE, | |
| Apple [8] | **3Tx UL operation**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | 59-3-1 | Support of codebook-based non-coherent 3Tx PUSCH | 1. Support of maximum number of 3 PUSCH MIMO layers for codebook-based non-coherent PUSCH 2. Support of 3 port SRS resource 3. Maximum number of 3 port SRS resources per SRS resource set with usage set to 'codebook’ for codebook-based 3Tx PUSCH |  | Yes | n/a | Codebook-based non-coherent 3Tx PUSCH is not supported | Per FSPC | n/a | n/a | n/a | Component 3 candidate values {1, 2}  Note: 3 port SRS resource is supported by 4 port SRS resource with SRS port 1004 muted. | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-1a | UL PTRS for codebook-based non-coherent 3Tx PUSCH | Maximum number of UL PTRS ports for codebook-based non-coherent 3Tx PUSCH | 59-3-1 | yes | n/a | UL PTRS is not supported for codebook-based non-coherent 3Tx PUSCH | Per FSPC | n/a | n/a | n/a | Component candidate values {1, 2}  Note: Applicability of this feature to PUSCH TDM repetition. | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-1b | UL full power transmission mode 0 | Support of UL full power transmission mode of fullpower when UE is capable of 3Tx codebook-based non-coherent PUSCH operation | 59-3-1 | yes | n/a | UL full power transmission mode 0 is not supported | Per FSPC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-1c | Rel-17 Multi-TRP PUSCH repetition (type A) with codebook-based non-coherent 3Tx PUSCH | Support of Rel-17 Multi-TRP PUSCH repetition (type A) with codebook-based non-coherent 3Tx PUSCH | 59-3-1 | yes | n/a | Rel-17 Multi-TRP PUSCH repetition (type A) is not supported with codebook-based non-coherent 3Tx PUSCH | Per FSPC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-1d | Rel-17 Multi-TRP PUSCH repetition (type B) with codebook-based non-coherent 3Tx PUSCH | Support of Rel-17 Multi-TRP PUSCH repetition (type B) with codebook-based non-coherent 3Tx PUSCH | 59-3-1 | yes | n/a | Rel-17 Multi-TRP PUSCH repetition (type B) is not supported with codebook-based non-coherent 3Tx PUSCH | Per FSPC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-2 | Support of non-codebook-based 3Tx PUSCH | Support of maximum number of 3 PUSCH MIMO layers for non-codebook-based PUSCH |  | Yes | n/a | Non-codebook-based 3Tx PUSCH is not supported | Per FSPC | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-2a | Association between CSI-RS and SRS for non-codebook-based 3Tx PUSCH | 1. Support association between NZP-CSI-RS and SRS resource set for non-codebook-based 3Tx PUSCH 2. A list of supported combinations, each combination is {Max # of Tx ports, Max # of resources, and total # of Tx ports} simultaneously | 59-3-2 | yes | n/a | Association between CSI-RS and SRS for non-codebook-based PUSCH is not supported | Per band | n/a | n/a | n/a | Component 2 candidate value: Maximum size of the list is 16.  The candidate values for the max # of Tx port is  {2, 4, 8, 12, 16, 24, 32, 48, 64, 128}  The candidate value set of the max # of resources is:  {1 to 64}  The candidate value set of total # of ports is:  {2 to 256}  Note: For max # of Tx ports, 1 CSI-RS resource is used for <= 32 ports, and more than 1, up to 4 CSI-RS resources, are used for >32 ports | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-3-3 | 3 port SRS antenna switching | 1. Support of 3 port SRS resource 2. Support of 3 port SRS antenna switching 3. Report the entry number of the first-listed band with UL in the band combination that affects this DL 4. Report the entry number of the first-listed band with UL in the band combination that switches together with this UL |  | Yes | n/a | 3 port SRS antenna switching is not supported | Per FS | n/a | n/a | n/a | Component 2 candidate value: {3T3R, 3T6R, 3T3R and 3T6R}  Component 3 candidate value: {1,2,…,32}  Component 4 candidate value: {1,2,…,32}  Note: 3 port SRS resource is supported by 4 port SRS resource with SRS port 1004 muted. | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-3-3a | Maximum 2 semi-persistent and 1 periodic SRS sets for 3 port SRS antenna switching | Support of maximum 2 semi-persistent SRS resource sets and maximum 1 periodic SRS resource set for 3 port SRS antenna switching | 59-3-3 | Yes | n/a | Maximum one SRS resource set for periodic SRS and maximum one SRS resource set for semi-persistent SRS is supported | Per FS | n/a | n/a | n/a | Note: The two semi-persistent SRS resource sets are not activated at the same time | Optional with capability signalling | |
| CATT [9] | **UL 3TX**  In RAN#102 meeting [1], specifying enhancement for 3-antenna-port codebook-based transmissions was agreed. In this section, UE features of 3Tx are discussed.  In RAN1#118bis meeting [2], on supporting non-codebook-based PUSCH for Rel-19 3Tx UE, it was agreed that UE can report a capability of up to a maximum of 3 layers. Similar to the non-coherent codebook based 3Tx, maximum number of layers for a UE cannot be 3 in the previous releases. This should be the basic capability for non-codebook based 3Tx while the number of {3} should be a component.  **Proposal 4: Support to report a maximum of 3 layers as a component for non-codebook-based PUSCH for Rel-19 3Tx UE.** |
| OPPO [10] | **UE feature for 3-antenna-port codebook-based transmissions**  According to the agreements, for codebook-based uplink transmission, following aspects should be considered in UE feature discussion:   * Maximum number of transmission layers is 3. A new UE feature can be added in the UE feature list, and can be updated based on FG 2-14. The candidate value for supported maximum number of layers is {1, 2, 3}. The new FG and FG 2-14 would not be reported simultaneously. * The maximum number of SRS ports is 3. A new UE feature can be added in the UE feature list, and can be updated based on FG 2-53. The candidate value for supported maximum number of ports is {1, 2, 3}. The new FG and FG 2-53 would not be reported simultaneously.   For non-codebook-based transmission, following aspects should be considered in UE feature discussion:   * Maximum number of transmission layers is 3. A new UE feature can be added in the UE feature list, and can be updated based on FG 2-15. The candidate value for supported maximum number of layers is {1, 2, 3}. The new FG and FG 2-14 would not be reported simultaneously.   For antenna switching, UE feature for 3T6R and 3T3R should be discussion:   * In option one, the UE can report supported combinations such as {t1r1, t1r2, t2r2, t2r4, t2r6, t3r6} in a new feature for 3Tx. In option two, the UE can report 3T6R antenna switching in the existing srs-AntennaSwitchingBeyond4RX-r17 feature, which is used for antenna switching with more than 4Rx. * Introduce UE capability for 3T3R. Alongside introducing UE capability for 3T3R SRS antenna switching, support for downgrading 3T3R also needs to be facilitated.   ***Proposal 2: The following UE features should be introduced for 3Tx uplink transmission:***   * ***Support up to 3 layers for codebook and non-codebook-based transmission.*** * ***Support up to 3 SRS ports for codebook-based transmission.*** * ***Introduce UE capability for 3T6R and 3T3R SRS antenna switching, and the downgrading combinations.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 59. NR\_MIMO\_Ph5 | 59-x1 | 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 | yes | n/a | 3TX UE is not properly supported. | 1. FeatureSetUplinkPerCC  2, 3. FeatureSetUplinkPerCC-v1540 | n/a | | n/a | n/a | Note:  UE is not expected to report this FG and FG2-14 simultaneously. | Optional with UE capability  Component-1:  Candidate value: {codebook based MIMO, 1, 2, 3}  Component-2  Candidate value: {1, 2} | | 59. NR\_MIMO\_Ph5 | 59-x2 | SRS resources | 1) Maximum number of aperiodic SRS resources (configured to UE) per BWP  2) Maximum number of aperiodic SRS resources (configured to UE) per BWP per slot  3) Maximum number of periodic SRS resources (configured to UE) per BWP  4) Maximum number of periodic SRS resources (configured to UE) per BWP per slot  5) Maximum number of semi-persistent SRS resources (configured to UE) per BWP  6) Maximum number of semi-persistent SRS resources (configured to UE) per BWP per slot  7) Maximum number of SRS port per resource | 2-52; 59-x1 | yes | n/a | 3TX UE is not properly supported. | 1. FeatureSetUplink | n/a | n/a | | n/a |  | Optional with UE capability  Mandatory with capability signalling  Component-1: candidate value: {from 1, 2, 4, 8, 16}  Component-2 candidate value: {1,2,3,4,5,6}  Component-3: candidate value: {from 1, 2, 4, 8, 16}  Component-4 candidate value: {1,2,3,4,5, 6}  Component-5: candidate value: {from 1, 2, 4, 8, 16} }  Component-6 candidate value: {1, 2,3,4,5, 6}  Component-7 candidate values: {1, 2, 3} |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 59. NR\_MIMO\_Ph5 | 59-3 | (Update of the existing FG 2-15 for 3TX UL)  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 | yes | n/a | 3TX UE is not properly supported. | 1. FeatureSetUplinkPerCC  2, 3. FeatureSetUplinkPerCC-v1540 | n/a | n/a | n/a | Note:  UE is not expected to report this FG and FG2-15 simultaneously. | Optional with UE capability  Component-1 candidate values: {1, 2, **3**}  Component-2  Candidate value: {1,2,3,4}  Component-3  Candidate value: {1,2,3,4} | |
| Ericsson [11] | **UE features for 3 Tx**  We provide some initial views, considering the basic 3 Tx operation, 3T6R/3T3R SRS antenna switching, and non-codebook based operation. We only address the higher level capabilities in order to focus on the basic structure of the capabilities; a number of additional feature groups will likely be needed, and we expect these will be addressed as the discussions progress.  **Basic 3 Tx UE capability and M-TRP PUSCH repetition**  In order to support 3 Tx, the UE must not transmit PUSCH on port 1003, and so this is a basic requirement for the feature. Note that supporting SRS disabled on port 1003 is not the same thing, since both PUSCH and SRS are mapped to port 1003.  We think the Rel-18 approach to basic capability for 8 Tx in feature group 40-7-1 can be used for 3 Tx, where there are no prerequisites defined. The 3 Tx codebook does not have codebook subsets, since only non-coherent codebooks are defined, so inheriting basic codebook based PUSCH feature group 2-14 does not make sense.  For Rel-17 multi-TRP PUSCH repetition Type A with codebook based transmission, since uplink full power modes are not supported, there only 1 or 2 SRS resources need to be supported per set. The capability can otherwise be reused from Rel-17 feature group 23-3-1.  Our proposals for codebook based capability are then:  **Table 1: High Level Capabilities for Codebook Based 3 Tx, including M-TRP PUSCH Repetition**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Note** | | 3Tx-1 | Basic features for Codebook-based 3Tx PUSCH | 1. Codebook based PUSCH transmission with port 1003 disabled when 4 port SRS resources with port 1003 disabled are configured to the UE.  2. Maximum number of PUSCH MIMO layers for codebook based PUSCH  3. Maximum number of 4 port SRS resources with port 1003 disabled per SRS resource set with usage set to 'codebook’ for codebook-based 3Tx PUSCH | None | Component 2 candidate values: {1, 2, 3}  Component 3 candidate values: {1,2} | | 3Tx-1a | Multi-TRP PUSCH repetition (type A) -codebook based for 3 Tx | 1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions  2. Support of two SRS resource sets with usage set to 'codebook'  3. Supported number of SRS resources in one SRS resource set | 3Tx-1 | Note: Two linked PDCCH candidates are not expected to be associated with different CORESETPoolIndex values  Component 3 candidate values: {1,2} |   **Non-codebook based 3 Tx UE basic capability and M-TRP PUSCH repetition**  The Rel-15 UE capability for the maximum number of SRS resources in non-codebook based operation, *maxNumberSRS-ResourcePerSet*, takes the values 1-4, while the maximum number of layers is 1, 2, or 4. In this case, the maximum number of SRS resources and layers is the same. For 3 Tx operation, the maximum number of layers is 3, so one possibility would be to limit a 3 Tx non-codebook capability to at most 3 SRS resources. One motivation to do so could be to ensure that UEs that have 3 Tx chains and do not virtualize their antennas can simply turn their Tx chains on or off without having to switch among antennas or to add virtualization. However, such UEs could simply support at most 3 SRS resources. On the other hand, there is a potential diversity benefit to maximizing the number of SRS resources, especially if they support a low maximum number of layers.   1. There does not seem to be a strong rationale to reduce the maximum number of SRS resources for non-codebook based operation below the 4 supported in Rel-15. 2. Support *maxNumberSRS-ResourcePerSet*=4 for Rel-19 3 Tx non-codebook based operation   Since the maximum number of layers is 3, the maximum number of simultaneously transmitted SRS resources can be no more than 3.  Given its close similarity to Rel-15 non-codebook based operation, the same prerequisite (basic PUSCH 2-12) seems appropriate.  Copying non-codebook based multi-TRP PUSCH repetition Type A capability 23-3-1-2 from Rel-17 seems to work, except that it targets 3 Tx operation and should depend on the basic non-codebook feature for 3 Tx.  Our proposals for non-codebook based capability are then:  **Table 2: High Level Capabilities for Non-Codebook Based 3 Tx, including M-TRP PUSCH Repetition**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Note** | | 3Tx-2 | 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 | Optional with UE capability  Component-1 candidate values: {1, 2, 3}  Component-2 candidate value: {1,2,3,4}  Component-3 candidate value: {1,2,3} | | 3Tx-2a | Multi-TRP PUSCH repetition (type A) - non-codebook based for 3 Tx | 1. Support of multi-TRP PUSCH repetition for non-codebook based PUSCH (based on PUSCH repetition type A)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions  2. Support of two SRS resource sets with usage set to 'nonCodebook'  3. Supported number of SRS resources in one SRS resource set | 3Tx-2 | Component 3: {1,2,3,4} |   **3T6R/3T3R SRS antenna switching capability**  The 3 Tx SRS antenna switching capability seems straightforward to extend from the 8 Tx capability 40-5-4. Since 3T3R and 3T6R both use 4 port SRS resources with port 1003 disabled, support for the port disabling is a prerequisite and captured in component 1. The other main changes seem to be to remove the 4TnR configurations and to add the 3T3R and 3T6R configurations to component 2.  Our proposal for the SRS antenna switching capability is then:  **Table 3: High Level Capabilities for 3 Tx SRS Antenna Switching**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Note** | | 3Tx-3 | SRS 3 Tx ports—antenna switching | 1. SRS antenna switching transmission with port 1003 disabled when 4 port SRS resources with port 1003 disabled are configured to the UE.  2. Downgrade antenna switching configurations  3. Report the entry number of the first-listed band with UL in the band combination that affects this DL  4. Report the entry number of the first-listed band with UL in the band combination that switches together with this UL | 2-53 | Component 2 candidate value: combination (including empty) of {1T1R, 1T2R, 1T4R, 1T6R, 1T8R, 2T2R, 2T4R, 2T6R, 2T8R, 3T3R, 3T6R}  Component 3 candidate value: {1,2,…,32}  Component 4 candidate value: {1,2,…,32} | |
| Qualcomm Incorporated [12] | **Support for 3-antenna-port codebook-based transmissions**  The UE capabilities for 3Tx are relatively simple comparing to other Rel-19 MIMO features. Maybe the main discussion point is the granularity of the capabilities for 3Tx. From implementation point of view, it is likely UE will not equip all CCs in a band of a band combination with 3 Tx. It is recommended to set the granularity of 3 Tx related capabilities to per SFPC. One can also notice that the Rel-15 legacy UE capability 2-14 (codebook based PUSCH) and 2-15 (noncodebook based PUSCH) are defined as per FeatureSetUplinkPerCC.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-3-1 | 3Tx noncoherent codebook based PUSCH with S-TRP | Component 1: 3Tx noncoherent codebook based PUSCH with S-TRP  Component 2: Number of SRS resources in a resource set for noncoherent codebook based PUSCH with S-TRP |  | YES | N/A | 3Tx noncoherent codebook based PUSCH with S-TRP is not supported | Per FSPC | NO | NO | NO | Component 2 candidate values: {1,2} | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-3-2 | full power mode 0 for 3Tx PUSCH | Support full power mode 0 for 3Tx noncoherent codebook based PUSCH |  | YES | N/A | Full power mode 0 for 3Tx PUSCH is not supported | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-3-3 | 3T6R antenna switching | Support 3T6R antenna switching |  | YES | N/A | 3T6R antenna switching is not supported | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-3-4 | 3T3R antenna switching | Support 3T3R antenna switching |  | YES | N/A | 3T3R antenna switching is not supported | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-3-5 | 3TX noncodebook based PUSCH with S-TRP | Support 3TX noncodebook based PUSCH with S-TRP |  |  |  | 3TX noncodebook based PUSCH with S-TRP is not supported | Per FSPC | NO | NO | NO |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-3-6 | 3Tx noncoherent codebook based PUSCH with M-TRP | Component 1: 3Tx noncoherent codebook based M-TRP PUSCH repetition  Component 2: Number of SRS resources in a resource set for noncoherent codebook based PUSCH with M-TRP |  | YES | N/A | 3Tx noncoherent codebook based M-TRP PUSCH repetition  is not supported | Per FSPC | NO | NO | NO | Component 2 candidate values: {1,2} | Optional with capability signaling | |

## Asymmetric DL sTRP/UL mTRP scenarios

|  |  |
| --- | --- |
| Company | Summary |
| ZTE Corporation/Sanechips [1] | We have the following initial thoughts on UE features for asymmetric DL sTRP/UL mTRP scenarios:   * For the support of asymmetric DL sTRP/UL mTRP scenarios, at least taking the follows into account of the basic UE features, respectively:   + PL offset for PUSCH/PUCCH/SRS   + Two separate CLPC adjustment states for SRS   + Two TAs for PUSCH/PUCCH/SRS * Consequently, the support of the follows can be taken as separate UE features:   + PL offset for PDCCH-order based PRACH   + Extended value range of starting bit of block(s) in DCI format 2\_3   + DCI format 1\_1 to indicate TPC command for SRS CLPC adjustment state(s) separate from PUSCH   + Reduction of overlapping in time domain caused by two UL transmissions associated with two TAGs * Besides, the support of separate DL/UL TCI state mode in FR1/FR2 and joint TCI state mode in FR1 for Rel-17/18 unified TCI framework can be taken as the basic component for the basic UE features of asymmetric DL sTRP/UL mTRP scenarios. |
| Huawei/HiSilicon [2] | A UE capability should be defined to support applying a PL offset configured in joint DL/UL TCI for the PUSCH/PUCCH/SRS transmission in FR1 only. The UE that supports this feature should support unified TCI with a joint TCI update for sDCI-based mTRP  ***Proposal 5.1: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability to support applying a PL offset configured in joint DL/UL TCI for the PUSCH/PUCCH/SRS transmission in FR1 only.***   * ***Note: The UE that supports this feature should support unified TCI with joint DL/UL TCI update for sDCI-based mTRP***   Similarly, a UE capability should be defined to support applying a PL offset configured in UL TCI for the PUSCH/PUCCH/SRS transmission in both FR1 and FR2. The UE that supports this feature should support unified TCI with separate DL/UL TCI update for sDCI-based mTRP  ***Proposal 5.2: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability to support applying PL offset configured in UL TCI for the PUSCH/PUCCH/SRS transmission in both FR1 and FR2.***   * ***Note: The UE that supports this feature should support unified TCI with separate DL/UL TCI update for sDCI-based mTRP***   A MAC CE can update the PL offset value(s) in joint or UL TCI state(s). We believe that a UE capability should be introduced for such an update.  ***Proposal 5.3: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability to support MAC-CE update of the configured PL offset value(s)***  We also propose the following:  ***Proposal 5.4: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability to support two SRS CLPC adjustment states separate from PUSCH***  For asymmetric DL sTRP/UL mTRP deployment scenarios in FR1, a new 1-bit DCI field in DCI format 1\_0 can be included to indicate the PL offset for PRACH transmission. We think a UE capability should be introduced for supporting the 1-bit DCI field.  ***Proposal 5.5: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability to support 1-bit DCI field in DCI format 1\_0 to indicate the PL offset for PDCCH-order PRACH transmission in FR1.***  In RAN1 118-bis, it was agreed to support 2TA for the asymmetric DL sTRP/UL mTRP deployment scenarios. It was also agreed to define a UE capability of “Overlapping UL transmission reduction”. Based on this, we think two UE capabilities should be defined:  ***Proposal 5.6: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability to support 2TA enhancement***  ***Proposal 5.7: For asymmetric DL sTRP/UL mTRP deployment scenario, define a UE capability of “Overlapping UL transmission reduction”.***   * ***Note: A UE that supports this feature, also supports 2TA enhancement.***   It was agreed to extend the value range 1~X of starting bit of blocks in DCI format 2\_3. This feature is independent from the asymmetric DL sTRP/UL mTRP deployment scenarios. Hence, we have the following proposal:  ***Proposal 5.8: Define a UE capability of to extend the value range 1~X of starting bit of blocks in DCI format 2\_3 to X=45 for operations in FR1 in shared spectrum or FR2-2 and X = 43 otherwise.***  ***Note: This feature is also available in scenarios in addition to asymmetric DL sTRP/UL mTRP deployment.***  Based on the above discussion, the following UE features are proposed:  ***Proposal 5.9****:* ***Introduce the following FGs for asymmetric DL sTRP/UL mTRP deployment:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | NR MIMO Phase 5 | [TBD] | pathloss offset in joint DL/UL TCI for asymmetric DL sTRP/UL mTRP deployment scenario | 1. support applying a PL offset configured in joint DL/UL TCI for the PUSCH/PUCCH/SRS transmission in FR1 |  | Yes | No | The use of pathloss offset in joint DL/UL TCI for asymmetric DL sTRP/UL mTRP deployment scenario in FR1 is not supported | TBD | n/a | FR1 only | n/a | Note: UE that supports this feature should also support unified TCI with joint DL/UL TCI update for sDCI-based mTRP | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | pathloss offset in UL TCI for asymmetric DL sTRP/UL mTRP deployment scenario | 1. support applying a PL offset configured in UL TCI for the PUSCH/PUCCH/SRS transmission in FR1 and FR2 |  | Yes | No | The use of pathloss offset in UL TCI for asymmetric DL sTRP/UL mTRP deployment scenario in FR1 or FR2 is not supported | TBD | n/a | n/a | n/a | Note: UE that supports this feature should also support unified TCI with separate DL/UL TCI update for sDCI-based mTRP | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | MAC-CE update of PL offset value(s) for asymmetric DL sTRP/UL mTRP deployment scenario | 1. Support of MAC-CE update of the configured PL offset value(s) |  | Yes | No | MAC-CE update of the configured PL offset value(s) is not supported | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | two SRS CLPC adjustment states separate from PUSCH for asymmetric DL sTRP/UL mTRP deployment scenario | 1. Support of two SRS CLPC adjustment states separate from PUSCH |  | Yes | No | two SRS CLPC adjustment states separate from PUSCH is not supported | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Indicate pathloss offset in DCI format 1\_0 for PDCCH-order PRACH transmission for asymmetric DL sTRP/UL mTRP deployment scenario | 1. Support of 1-bit DCI field in DCI format 1\_0 to indicate pathloss offset for PDCCH-order PRACH transmission |  | Yes | No | Applying pathloss offset for PDCCH-order PRACH transmission is not supported | TBD | n/a | FR1 only | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | 2TA enhancement for asymmetric DL sTRP/UL mTRP deployment scenario | 1. Support of 2TA enhancement |  | Yes | No | 2TA enhancement is not supported | TBD | n/a | n/a | n/a |  | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Overlapping UL transmission reduction for asymmetric DL sTRP/UL mTRP deployment scenario | 1. Support of two overlapping UL transmissions associated with different TAGs |  | Yes | No | two overlapping UL transmissions associated with different TAGs | TBD | n/a | n/a | n/a | Note: UE that supports this feature should also support 2TA enhancement for asymmetric DL sTRP/UL mTRP deployment scenario | Optional with capability signalling | | NR MIMO Phase 5 | [TBD] | Extended starting bit of Format 2-3 | 1. Support extended value range of starting bit configuration in DCI format 2\_3 to X=45 for operations in FR1 in shared spectrum or FR2-2 and X = 43 otherwise | TBD | Yes | N/A | UE does not expect to be configured with DCI 2\_3 starting bit above 32. | TBD | N/A | N/A | N/A | Note: This feature is also available in scenarios in addition to asymmetric DL sTRP/UL mTRP deployment | Optional with capability signalling | |
| CMCC [3] | Firstly, applying PL offset on PDCCH-order PRACH is a separate UE capability under the Path loss offset feature group. Secondly, overlapping UL transmission reduction is a separate UE capability under two TAs feature group. Thirdly, extended value range 1~45 of starting bit of blocks in DCI format 2\_3 is a separate UE capability and is appliable to any Rel-19 UE who supports this UE capability, regardless this UE supports two separate SRS CLPC adjustment states or not.  Based on the above analyses, we suggest taking the following UE feature list as a starting point:  ***Proposal 6: Take the following UE feature list as a starting point for the feature of Rel-19 asymmetric DL sTRP/UL mTRP scenarios:***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | | 59. NR\_MIMO\_Ph5 | 59-4-1 | Path loss offset | 1. PL offset in UL TCI state  2. PL offset in joint TCI state | 8-2, 23-1-1 | | 59. NR\_MIMO\_Ph5 | 59-4-1a | Path loss offset on PDCCH-order PRACH | 1.Support applying PL offset on PDCCH-order PRACH | 59-4-1 | | 59. NR\_MIMO\_Ph5 | 59-4-2 | Two separate SRS CLPC adjustment states | 1. Support two separate SRS CLPC adjustment states | 8-2, 23-1-1 | | 59. NR\_MIMO\_Ph5 | 59-4-3 | Extended value range of starting bit of DCI format 2\_3 | 1. Support the extended value range of starting bit of DCI format 2\_3 | 8-5 | | 59. NR\_MIMO\_Ph5 | 59-4-4 | Two TAs | 1. Support two TAs | 23-1-1 | | 59. NR\_MIMO\_Ph5 | 59-4-4a | Overlapping UL transmission reduction | 1. Support of reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions | 59-4-4 | |
| Samsung [4] | **Asymmetric MTRP**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Index | Feature group | Components | Prerequisite FGs | Consequence if the feature is not supported by the UE | Type | Need of FR1/FR2 differentiation | Note | Mandatory  /Optional | | X-4-1 | Pathloss offset with joint DL/UL TCI(s) | Support Pathloss offset for joint DL/UL TCI(s) | 23-1-1 and/or 40-1-1 | Pathloss offset for joint DL/UL TCI(s) is not supported | Per band | FR1 only |  | Optional with capability signalling | | X-4-2 | Pathloss offset for separate UL TCI(s) | Support Pathloss offset for separate UL TCI(s) | 23-10-1 and/or 40-1-2 | Pathloss offset for separate UL TCI(s) is not supported | Per band | N/A |  | Optional with capability signalling | | X-4-3 | Two SRS CLPC adjustment states separate from PUSCH | Support up to two SRS CLPC adjustment states separate from PUSCH |  | Two SRS CLPC adjustment states separate from PUSCH is not supported | Per band | N/A |  | Optional with capability signalling | | X-4-4 | Two TA enhancements for asymmetric MTRP | Support two TA without restriction of multi-DCI based multi-TRP operation in asymmetric MTRP |  | Two TA enhancements for asymmetric MTRP is not supported | Per band | N/A |  | Optional with capability signalling | | X-4-5 | Applying PL offset on PDCCH-order triggered PRACH towards a UL TRP | Support applying PL offset on PDCCH-order triggered PRACH towards a UL TRP | X-4-1 and/or X-4-2 | Applying PL offset on PDCCH-order triggered PRACH towards a UL TRP is not supported | Per band | FR1 only |  | Optional with capability signalling | | X-4-6 | Extended value range of starting bit of blocks in DCI format 2\_3 | Support of extended value range of starting bit of blocks in DCI format 2\_3 from 1~31 to 1~45 |  | Extended value range of starting bit of blocks in DCI format 2\_3 is not supported | Per band | N/A | Note: Extended value range of 1~45 can be used for operations in FR1 in shared spectrum or FR2-2 and 1~43 otherwise | Optional with capability signalling | | X-4-7 | SRS TPC command field for SRS CLPC adjustment state(s) separate from PUSCH in DCI format 1\_1 | Support SRS TPC command field for SRS CLPC adjustment state(s) separate from PUSCH in DCI format 1\_1 |  | SRS TPC command field for SRS CLPC adjustment state separate from PUSCH in DCI format 1\_1 is not supported | Per band | N/A |  | Optional with capability signalling | | X-4-8 | SRS closed-loop indicator field for one of two separate SRS CLPC adjustment states in DCI format 1\_1 | Support SRS closed-loop indicator field for one of two separate SRS CLPC adjustment states in DCI format 1\_1 | X-4-3 | SRS closed-loop indicator field for one of two separate SRS CLPC adjustment states in DCI format 1\_1 is not supported | Per band | N/A |  | Optional with capability signalling | | X-4-9 | Overlapping UL transmission reduction for asymmetric MTRP | Support of reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions when the UE is not configured with UL STx2P for asymmetric MTRP operation with two TA enhancement. | X-4-4 | Reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions is not supported. | Per band | N/A | Note: If UE does not support this feature, UE does not expect the two UL transmissions associated with different TAGs to overlap (i.e., scheduling restriction is applied to avoid overlap between the two UL transmissions) | Optional with capability signalling | |
| Samsung (Moderator) [5] | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | 59-4-1 | Path Loss offset | 1. PL in UL TCI state  2. PL in joint TCI state | 8-2, 23-1-1 | yes | n/a | The function of PL offset is not supported. | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-1a | Path Loss offset on PDCCH-order PRACH | 1.Support Applying PL on PDCCH-order PRACH | 59-4-1 | yes | n/a | Applying PL offset on PDCCH-order PRACH is not supported. | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-2 | Two sepatate SRS closed loop indices | 1. PL in UL TCI state  2. PL in joint TCI state  3. Separate triggering w/ DOC indication | 8-2, 23-1-1 | yes | n/a | The function of two separate SRS closed loop indexes is not supported | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-3 | Extended value range of starting bit of DCI format 2\_3 | 1. Support the extended value range of starting bit of DCI format 2\_3 | 8-5 | yes | n/a | The extended value range of starting bit of DCI format 2\_3 is not supported. | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-4 | DCI format 1\_1 to indicate TPC for separate SRS closed loop index(es) | 1. Support DCI format 1\_1 to indicate TPC for separate SRS closed loop index.  2.Support DCI format 1\_1 to indicate TPC for two separate SRS closed loop indexes. | 8-2 | yes | n/a | The function of DCI 1\_1 indicating TPC command for separate SRS closed loop index(es) is not supported. | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-5 | Support two TAs enhancement | 1.Support two TAs without the restriction of multi-DCI based multi-TRP operation. | 23-1-1 | yes | n/a | The function of 2 TAs for asymmetric DL sTRP/UL mTRP is not supported. | Per band | n/a | n/a | n/a | Further partitioning of this FG may be needed based on existing and future agreements | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-5a | 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 | 59-4-5 | yes | n/a | Reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions is not supported | Per band | n/a | n/a | n/a | 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) | Optional with capability signalling | |
| vivo [6] | **Enhancement for asymmetric DL sTRP/UL mTRP scenarios**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  | Components | Pre-requisite |  |  |  |  |  |  |  |  |  | | x. NR\_MIMO\_Phase 5 | x-4-1 | Support of Asymmetric DL/UL TRP (ADU) |  |  |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-4-2 | Support of PL offset on PDCCH-ordered PRACH towards a TRP without DL transmission |  | x-4-1 |  |  |  |  |  |  |  |  | Optional | | x. NR\_MIMO\_Phase 5 | x-4-3 | Support of 2TA |  | x-4-1 |  |  |  |  |  |  |  |  |  | | x. NR\_MIMO\_Phase 5 | x-4-4 | Support of overlapping UL transmission reduction other than intra-slot TDM PUSCH type-B repetition transmission case |  | x-4-3 |  |  |  |  |  |  |  | The UE does not expect two consecutive UL transmission associated with different TAGs are overlapped if the UE does not support this feature | Optional | | x. NR\_MIMO\_Phase 5 | x-4-5 | Extended value range 1~45 of starting bit of blocks in DCI format 2\_3 |  |  |  |  |  |  |  |  |  | Note: X=45 can be used for operations in FR1 in shared spectrum or FR2-2 and X = 43 otherwise | Optional | |
| Nokia [7] | |  |  |  |  | | --- | --- | --- | --- | | FG | FG name | Components | Note | | MIMO-5-1 | Basic feature for asymmetric DL sTRP/UL mTRP deployment scenarios | * Applying PL Offset to calculate the Tx power of the PUSCH/PUCCH/SRS * Applying PL offset in the calculation of Type 1 PHR * Applying PL offset in the calculation of Type 3 PHR * Applying PL offset to UL TX power calculation * Two SRS CL power control adjustment states [i0, i1] * DCI 2\_3 for indicating the TPC commands [Type A, Type B] | **(RAN1 #116 Athens)**  For the asymmetric DL sTRP/UL mTRP deployment scenarios, support to associate a UL TCI state with a PL offset:  **(RAN1 #118 Maastricht)**  For the asymmetric DL sTRP/UL mTRP scenarios, support to include PL offset in the calculation of Type 1 PHR based on actual PUSCH transmission and Type 1 PHR based on reference PUSCH  **(RAN1 #118 Maastricht)**  Study whether to support Type 3 PHR reporting in a serving cell/BWP where the UE is configured with two separate SRS CLPC adjustment states.  Continue to study whether to support including PL offset in the calculation of Type 3 PHR.  **(RAN1 #116bis Changsha)**  For a UE configured with two SRS CLPC adjustment states, support **Alt2** for indicating one of the SRS CLPC adjustment states to SRS:  **(RAN1 #116bis Changsha)**  For indicating TPC command for those two SRS CLPC adjustment states through DCI when the UE is configured with two SRS CLPC adjustment states, support **Option3**: | | MIMO 5-2 | Starting bit of DCI 2\_3 for asymmetric DL sTRP/UL mTRP deployment scenarios | * For FR1 or shared spectrum X=45 * Otherwise X=43 | **(RAN1 #118bis Hefei)**  About the extended value range 1~X of starting bit of blocks in DCI format 2\_3 in Rel-19, **support Alt1**: | | MIMO-5-3 | Support DCI format 1\_1 to indicate TPC command for SRS CLPC adjustment state(s) |  | **(RAN1 #118bis Hefei)**  Support DCI format 1\_1 to indicate TPC command for SRS CLPC adjustment state(s) separate from PUSCH:   * (**Working Assumption**) Introduce a 2-bit TPC command field to indicate TPC command for SRS associated with separate SRS CLPC adjustment state where:   + The 2-bit TPC command field is present if UE reports supporting a dedicated UE capability, and a corresponding RRC parameter is configured (which is a new RRC to enable this). * (**Working Assumption**) Introduce a 1-bit SRS close-loop indicator to indicate one of the two separate SRS CLPC adjustment states for the TPC command   + The 1-bit SRS close-loop indicator is present if UE reports supporting another dedicated UE capability and a corresponding RRC parameter is configured (which is a new RRC to enable this) and two separate SRS CLPC adjustment states are configured. | | MIMO-5-4 | Support PDCCH-order PRACH towards a UL TRP |  | **(RAN1 #116bis Changsha)**  Support applying PL offset on PDCCH-order PRACH towards a UL TRP in FR1. | | MIMO-5-5 | Overlapping UL transmission reduction |  | **(RAN1 #118bis Hefei)**  Support 2TA for the asymmetric DL sTRP/UL mTRP deployment scenarios: | |
| Apple [8] | **Enhancement for asymmetric DL sTRP/UL mTRP scenarios**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | 59-4-1 | Support of association of a UL TCI state with a PL offset | Support association of a UL TCI state with a PL offset |  | Yes | n/a | Association of a UL TCI state with a PL offset is not supported | Per FS | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-1a | Support of association of a joint TCI state with a PL offset | Support association of a joint TCI state with a PL offset |  | Yes | n/a | Association of a UL TCI state with a PL offset is not supported | Per FS | n/a | FR1 only | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-1b | Support of applying PL offset on PDCCH-order PRACH towards a UL TRP in FR1 | Support applying PL offset on PDCCH-order PRACH towards a UL TRP in FR1 | 59-4-1 or 59-4-1a | Yes | n/a | Applying PL offset on PDCCH-order PRACH towards a UL TRP is not supported | Per FS | n/a | FR1 only | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-1c | Support of MAC-CE to update the PL offset associated with UL and/ or joint TCI state | Support MAC-CE to update the PL offset associated with UL and/ or joint TCI state | 59-4-1 or 59-4-1a | Yes | n/a | MAC-CE is no supported to update the PL offset associated with UL and/ or joint | Per FS | n/a |  | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-1d | Support of including PL offset in the calculation of Type 1 PHR based on actual PUSCH transmission and Type 1 PHR based on reference PUSCH | Support including PL offset in the calculation of Type 1 PHR based on actual PUSCH transmission and Type 1 PHR based on reference PUSCH | 59-4-1 or 59-4-1a | Yes | n/a | PL offset in the calculation of Type 1 PHR is not supported | Per FS | n/a |  | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-2 | Support of two closed-loop power control adjustment states for SRS, both of which are separate from that of the PUSCH | Support two closed-loop power control adjustment states for SRS, both of which are separate from that of the PUSCH |  | Yes | n/a | Only one closed-loop power control adjustment state is supported for SRS when it is separate from that of the PUSCH | Per FS | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-2a | Support of one 1-bit closed-loop-indicator field for each TPC command in DCI format 2\_3 when two closed-loop power control adjustment states are configured for SRS separate from PUSCH | Support one 1-bit closed-loop-indicator field for each TPC command in DCI format 2\_3 when two closed-loop power control adjustment states are configured for SRS separate from PUSCH | 59-4-2 | Yes | n/a | One 1-bit closed-loop-indicator field for each TPC command in DCI format 2\_3 when two closed-loop power control adjustment states are configured for SRS separate from PUSCH is not supported | Per FS | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-3 | Support of Single-DCI based intra-cell Multi-TRP operation with two TA | Support single-DCI based inter-cell Multi-TRP operation with two TA |  | Yes | n/a | Single-DCI based inter-cell Multi-TRP operation with two TA is not supported | Per FS | n/a | n/a | n/a | Candidate value: bitmap {PUSCH TDM repetition Type A, PUSCH TDM repetition Type B, PUCCH TDM repetition, PUSCH SDM, PUSCH SFN, PUCCH SFN}  Note: Single-DCI based Multi-TRP is the operation without the restriction of “the UE is provided two coresetPoolIndex values 0 and 1 for first and second CORESETs, or is not provided coresetPoolIndex value for first CORESETs and is provided coresetPoolIndex value of 1 for second CORESETs”  Note: FG40-2-8, if reported, or supportedNumberTAG” in 38.306 is applied for the maximum number of TAGs | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-4 | Support of Single-DCI based inter-cell Multi-TRP operation with two TA | Support single-DCI based inter-cell Multi-TRP operation with two TA |  | Yes | n/a | Single-DCI based inter-cell Multi-TRP operation with two TA is not supported | Per FS | n/a | n/a | n/a | Candidate value: bitmap {PUSCH TDM repetition Type A, PUSCH TDM repetition Type B, PUCCH TDM repetition, PUSCH SDM, PUSCH SFN, PUCCH SFN}  Note: Single-DCI based Multi-TRP is the operation without the restriction of “the UE is provided two coresetPoolIndex values 0 and 1 for first and second CORESETs, or is not provided coresetPoolIndex value for first CORESETs and is provided coresetPoolIndex value of 1 for second CORESETs”  Note: FG40-2-8, if reported, or supportedNumberTAG” in 38.306 is applied or the maximum number of TAGs | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-5 | Overlapping UL transmission reduction for Single-DCI Multi-TRP operation | Support of overlapping UL transmission reduction for Single-DCI Multi-TRP operation | 59-4-3 or 59-4-4 | Yes | n/a | Overlapping UL transmission reduction for Single-DCI Multi-TRP operation is not supported | Per band | n/a | n/a | n/a | 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) | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-6 | Support of extension of value range of starting bit of block in DCI format 2-3 | Support extension of value range of starting bit of block in DCI format 2-3 |  | Yes | n/a | Extension of value range of starting bit of block in DCI format 2-3 is not supported | Per FS | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-7 | Support of DCI format 1\_1 to indicate 2-bit TPC command for SRS CLPC | Support DCI format 1\_1 to indicate 2-bit TPC command for SRS CLPC |  | Yes | n/a | DCI format 1\_1 to indicate 2-bit TPC command for SRS CLPC is not supported | Per FS | n/a | n/a | n/a |  | Optional with capability signalling | | 59. NR\_MIMO\_Ph5 | 59-4-7a | Support of DCI format 1\_1 to indicate 1-bit SRS close-loop indicator for two SRS CLPC adjustment states separate from PUSCH | Support DCI format 1\_1 to indicate 1-bit SRS close-loop indicator for two SRS CLPC adjustment states separate from PUSCH | 59-4-7 and 59-4-2 | Yes | n/a | DCI format 1\_1 to indicate 1-bit SRS close-loop indicator for two SRS CLPC adjustment states separate from PUSCH is not supported | Per FS | n/a | n/a | n/a |  | Optional with capability signalling | |
| CATT [9] | **Enhancement for asymmetric DL sTRP/UL mTRP scenarios**  In RAN#102 meeting [1], specifying enhancement for asymmetric DL sTRP/UL mTRP scenarios was agreed. In this section, UE features of for asymmetric DL sTRP/UL mTRP scenarios are discussed.  In RAN1#118bis meeting [2], the following agreement was achieved on the extended value range 1~X of starting bit of blocks in DCI format 2\_3 for the asymmetric DL sTRP/UL mTRP deployment scenarios.   |  | | --- | | **Agreement**  About the extended value range 1~X of starting bit of blocks in DCI format 2\_3 in Rel-19, **support Alt1**:   * Alt1: X = 45 (to be captured in RAN2 spec)   + This feature is a separate UE capability and is applicable to any Rel-19 UE who supports this UE capability, regardless this UE supports two separate SRS CLPC adjustment states or not.   + Note: X=45 can be used for operations in FR1 in shared spectrum or FR2-2 and X = 43 otherwise |   To support extending value range 1~X of starting bit of blocks in DCI format 2\_3 for the asymmetric DL sTRP/UL mTRP deployment scenarios, the separate UE capability which is applicable to any Rel-19 UE should be supported, regardless this UE supports two separate SRS CLPC adjustment states or not.  **Proposal 5: Introduce a new UE feature on supporting extend the value range of starting bit of blocks in DCI format 2\_3 to X = 45 in FR1 in shared spectrum or FR2-2 and X = 43 otherwise. Whether the UE supports two separate SRS CLPC adjustment states is not the prerequisite for this UE feature.** |
| OPPO [10] | **UE feature for asymmetric DL sTRP/UL mTRP scenarios**  In addition, for those not clearly stated in previous agreements, we list below per each sub-agenda for consideration and capture each one in the table below for discussion and decision as UE capabilities.  **a) PL offset**  Whether UE supports the PL offset configured in or associated with UL or Joint TCI state should be UE capability.  **b) two CLPC adjustments states for SRS (separated from PUSCH)**  Whether UE supports two CLPC adjustments states for SRS (separated from PUSCH) should be a very basic UE capability.  In addition, whether UE supports DCI format 2\_3 for indicating TPC command and/or closed-loop index (CLI) also should be a UE capability.  ***Proposal 7: The UE capabilities in the following table should be introduced for asymmetric multi-TRP scenario, it includes***   * ***The UE capabilities clearly listed in previous agreements and*** * ***The UE capabilities not clearly listed in previous agreements but to be discussed in Rel-19 MIMO UE features discussion***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | Features | Index | Feature group | Components |  | | 59. NR\_MIMO\_Ph5 | 59-4-1 | Path Loss offset | 1. PL offset in UL TCI state  2. PL offset in joint TCI state | 8-2, 23-1-1 | yes | n/a | The function of PL offset is not supported. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-1a | Path Loss offset on PDCCH-order PRACH at FR1 | 1.Support applying PL offset for PDCCH order PRACH at FR1 | 59-4-1 | yes | n/a | Applying PL offset for PDCCH order PRACH at FR1 is not supported. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-2 | Two separate SRS closed loop indices | 1. Support two separate CLPC adjustment states | 8-2, 23-1-1 | yes | n/a | The function of two separate SRS closed loop indexes is not supported | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-2a | Extended value range of starting bit of DCI format 2\_3 | 1. Support the extended value range of starting bit of DCI format 2\_3 | 8-5 | yes | n/a | The extended value range of starting bit of DCI format 2\_3 is not supported. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-2b | DCI format 2\_3 to indicate TPC for separate SRS closed loop index(es) | 1. Support DCI format 2\_3 to indicate TPC for separate SRS closed loop index.  2.Support DCI format 2\_3 to indicate TPC for two separate SRS closed loop indexes. | 8-2 | yes | n/a | The function of DCI 2\_3 indicating TPC command for separate SRS closed loop index(es) is not supported. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-2c | DCI format 1\_1 to indicate TPC for separate SRS closed loop index(es) | 1. Support DCI format 1\_1 to indicate TPC for separate SRS closed loop index.  2.Support DCI format 1\_1 to indicate TPC for two separate SRS closed loop indexes. | 8-2 | yes | n/a | The function of DCI 1\_1 indicating TPC command for separate SRS closed loop index(es) is not supported. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-3 | Support two TAs enhancement | 1.Support two TAs without the restriction of multi-DCI based multi-TRP operation. | 23-1-1 | yes | n/a | The function of 2 TAs for asymmetric DL sTRP/UL mTRP is not supported. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | | 59. NR\_MIMO\_Ph5 | 59-4-3a | Overlapping UL transmission | 1.Support the overlapping of UL transmission for two TAGs. | 23-1-1 | yes | n/a | UE does not expect two UL transmissions associated with different TAGs are overlapped. | Per band | n/a | n/a | n/a |  | Optional with capability signaling | |
| Ericsson [11] |  |
| Qualcomm Incorporated [12] | **Enhancement for asymmetric DL sTRP/UL mTRP scenarios**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 | | XX. NR MIMO phase 5 | XX-4-1 | Support of applying PL offset for PUCCH/PUSCH/SRS power control | Support applying PL offset for PUCCH/PUSCH/SRS power control | 23-1-1,23-10-1 | YES |  | Applying PL for PUCCH/PUSCH/SRS power control offset is not supported | Per FSPC | NO | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-2 | Support of applying PL offset for PDCCH-order PRACH | Support applying PL offset for PDCCH-order PRACH | 23-1-1,23-10-1 | YES |  | Applying PL offset for PDCCH-order PRACH is not supported | Per FSPC | NO | FFS | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-3 | Two separate SRS CLPC adjustment states | Support two separate SRS CLPC adjustment states | 23-1-1,23-10-1 | YES |  | Two separate SRS CLCP adjustment states are not supported. | Per FSPC | TDD only | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-4 | Extended value range 1 ~ X of starting bit of blocks in DCI format 2\_3 | Support extended value range of 1~X of starting bit of blocks in DCI format 2\_3 |  | YES |  | Extended value range 1 ~ X of starting bit of blocks in DCI format 2\_3 is not supported | Per band | NO | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-5 | DCI format 1\_1 for TPC command indication for separate SRS CLPC adjustment state | Support DCI format 1\_1 for TPC command indication for separate SRS CLPC adjustment state |  | YES |  | DCI format 1\_1 for TPC command indication for separate SRS CLPC adjustment state is not supported | Per FSPC | NO | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-6 | DCI format 1\_1 for TPC command indication for two separate SRS CLPC adjustment states | Support DCI format 1\_1 for TPC command indication for two separate SRS CLPC adjustment states | XX-4-3 | YES |  | DCI format 1\_1 for TPC command indication for two separate SRS CLPC adjustment states is not supported | Per FSPC | NO | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-7 | Asymmetric DL sTRP and UL sTRP with two TA enhancement | Support of two TAGs in a same CC for asymmetric DL sTRP and UL sTRP | 23-1-1,23-10-1 | YES |  | Two TAGs are not supported in a same CC for asymmetric DL sTRP and UL sTRP | Per FSPC | NO | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-8 | Asymmetric DL sTRP and UL mTRP with two TA enhancement | Support of two TAGs in a same CC for asymmetric DL sTRP and UL sTRP | 23-1-1,23-10-1, 40-1-1, 40-1-2 | YES |  | Two TAGs are not supported in a same CC for asymmetric DL sTRP and UL mTRP | Per FSPC | NO | NO | N/A |  | Optional with capability signaling | | XX. NR MIMO phase 5 | XX-4-9 | 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 not configured with UL STx2P for sDCI based multi-TRP operation with two TA enhancement | XX-4-8 | YES |  | Reducing the overlapping duration of the later of the two time-domain overlapping UL transmissions is not supported | Per band | NO | NO | If UE does not report this UE capability, UE does not expect two UL transmissions associated with different TAGs are overlapped |  | Optional with capability signaling | |

# Discussion Items during RAN1 #119

After review of contributions submitted to RAN1 #119 in this agenda item, the following topics were identified by the moderator for discussion during RAN1 #119.

**General comments**

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

## UE-initiated/event-driven beam management

After review of contributions submitted to RAN1 #119 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 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 A UE-initiated/event-driven beam report  [4. Maximum number of the configured RS(s) for new beam in the RS resource set] | FFS | yes | n/a | UEI/ED beam report is not supported | FFS | FFS | FFS | FFS | [Component 4 candidate values: {1, 2, … , 64}]  FFS: Further partitioning of this FG based on 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 Mode B for UE-initiated/event-driven beam reporting  [2. Supported values of X] | FFS | yes | n/a | UEI/ED beam report Mode-B is not supported | FFS | FFS | FFS | FFS | [Component 2 candidate values: {0,1,…,[N]}]  FFS: 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. | FFS | yes | n/a | Triggering event determination via detecting ≥ M event instances within a time window 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 | 59-1-4 | Event-1 based measurement and report for UE-initiated/event-driven beam management | Support of event-1 based measurement and report. | FFS | yes | n/a | Event-1 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 | 59-1-5 | Event-7 based measurement and report for UE-initiated/event-driven beam management | 1. Support of event-7 based measurement and report.  2. Supported values of Q | FFS | yes | n/a | Event-7 is not supported | FFS | FFS | FFS | FFS | [Component 2 candidate values: {1,2,…,8}]  FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| 59. NR\_MIMO\_Ph5 | 59-1-6 | Cross-CC beam measurement/report | Support of cross-CC beam measurement/report | FFS | yes | n/a | Cross-CC beam measurement/report 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 | 59-1-7 | Counter and timer based reporting | Support event instance(s) counting per new beam within a time window for event determination | FFS | yes | n/a | Counter and timer based reporting 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 | 59-1-8 | Determination of event-2 based on more than one event-2 instances | 1. Support of determining event-2 based on determination of M1 event-2 instances within a time window  2. Support of per candidate beam event instance(s) counting | FFS | yes | n/a | Determination of event-2 based on more than one event-2 instances is not supported | FFS | FFS | FFS | FFS | [Component 1 candidate values for M: {2, 3, …}]  FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-1-9 | Implicit selection of the serving beam RS Scheme-1 | Support QCL RS in the indicated TCI state as the serving beam RS | FFS | yes | n/a | CSI-RS as the serving beam RS for UE\_initiated/event-driven beam reporting 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 | 59-1-10 | Implicit selection of the serving beam RS Scheme-2 | Support SSB which is QCLed with the QCL RS in the indicated TCI state as the serving beam RS | FFS | yes | n/a | SSB as the serving beam RS for UE\_initiated/event-driven beam reporting 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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| --- | --- |
| Company | Comments/Questions/Suggestions |
| Apple | For FG59-1-1  The yellow highlighted part needs to be a separate UE feature to cover both the memory and computation complexity related UE features  For FG59-1-2  Needs to clarify that this is for event-2  The yellow highlighted part (maximum value of X) should be a separate UE features since it is also needed for Mode A  For FG59-1-4  We need to separate Mode-A and Mode-B  For FG59-1-5  We need to separate Mode-A and Mode-B  For the component 2, it can include {best, worst, both}  FG59-1-6  Need clarification about the cross-CC definition, so it is the case when the new/current beam is in a CC different from what?  FG59-1-7, FG59-1-8  It seems to the same or smiliar as FG59-1-3  FG59-1-9/10  It needs further discussion. It should be current beam, not serving beam. At least, this two FGs should be combined |
| Qualcomm | * 59-1-1 and 59-1-3: It is questionable whether these two features should be separated. Since the event evaluation based on “one event instance” (baseline feature) corresponds to M=1, we could merge 59-1-3 into 59-1-1 and set M=1 as the mandatory reported value. * 59-1-3, 59-1-7, and 59-1-8: These three features seem to be duplicated. They could be combined. Alternatively, as mentioned in the first bullet, they could be merged into 59-1-1 (for Event-2), 59-1-4 (Event-1), and 59-1-5 (Event-7). * 59-1-6: Cross-CC measurement and reporting is supported in the legacy CSI framework. We don’t see a strong reason to define a duplicated UE capability for UEI-BR. We could just refer to the legacy UE capability (2-24) as a prerequisite. |
| Ericsson | Like Apple, we propose to separate this into modeA and modeB support. The remaninig capabilities are captured as components to these two large FGs. For example,  59-1-1:  1. Support of mode A beam reporting  2. Support of event 2  3. Supported values of M  4. Maximum number of the configured RS(s) for new beam in the RS resource set  5. Support of event-1: yes/no  6. Support of event-7: Q  And then a similar capability for mode B:  59-1-2:  1. Support of mode B beam reporting: X  2. Support of event 2  3. Supported values of M  4. Maximum number of the configured RS(s) for new beam in the RS resource set  5. Support of event-1: yes/no  6. Support of event-7: Q  For both 59-1-1 and 59-1-2, we should probably add N, the max number of beams to include in the report.  Since the capabilities 59-1-9 and 59-1-10 are related, they should be combined into one capability, with one component that describes what the UE supports.  We agree with Qualcomm that cross-CC reporting should always be supported. |
| Huawei, HiSilicon | FG59-1-1: Support  FG59-1-2: Support  FG59-1-3: Support  FG59-1-4: Support  FG59-1-5: Support  FG59-1-6: Agree with QC and Ericsson that there is no need to define a new capability for cross-CC beam reporting in this AI. Cross-CC beam reporting is a mandatory feature from Rel-15 according to 2-24. Suggest to remove this FG or add it as a component of FG59-1-1.  FG59-1-7: It is not required as it is the same as FG59-1-3  FG59-1-8: It is not required as it is the same as FG59-1-3  FG59-1-9: It is not required. A UE that supports 59-1-1 has no choice but supporting at least one of Scheme-1 or Scheme-2. We think any UE that supports 59-1-1 should support both Scheme-1 and Scheme-2. The RAN1 agreement does not mention that supporting one of Scheme-1 or Scheme-2 is optional. Further, we don’t have “serving beam RS” in RAN1 agreements. We assume it is meant to be “current beam RS”. |
| NTT DOCOMO | For FG59-1-1/59-1-2  We are fine with Ericsson’s suggestion.  For FG59-1-6  We agree with Qualcomm.  For FG59-1-9/59-1-10  We prefer to combine into FG59-1-1/FG59-1-2. |
| ZTE | For FG59-1-1/59-1-2  We support the FL’s suggestion and have concerns on the Ericsson/NTT DOCOMO’s separate solution, which may split this feature significantly.  FG 59-1-2, the highlighted component of ‘supported value of X’ may be discussed in the 9.2.1 firstly, and currently, whether it is subjective to UE capability is pending.  FG 59-1-7 has been covered by FG 59-1-3; FG 59-1-8 has been covered by 59-1-3. Then, we do not identify the new UE FGs of 59-1-9/10 are critical. |
| Xiaomi | We are fine to separate mode A and mode B.  FG 59-1-4: new component with current beam RS determination can be added further.  FG 59-1-8: it can be common for Event 2 and Event 1/7  FG 59-1-9/10: it is not sure for Event 1. |

## CSI enhancements for up to 128 ports

After review of contributions submitted to RAN1 #119 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 Type-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 | 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 | 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 | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Apple | FG59-2-1-1/2/3/4/5  We can agree on these 5 categories of UE features to cover the support of 48/64/128 ports with digital precoding. But we need to put the compoments in yellow  FG59-2-1-6  We prefer to clarify this feature as  Per CS-RS resource slot offset configuration for Type-I and Type II codebook enhancement for up to 128 ports  Except for codebook refinement based on Rel-18 Type-II Doppler, support per-resource higher-layer (RRC) configuration to indicate (via 1-bit per resource) whether 1-slot offset relative to the legacy resource-set-level slot offset configuration should be assumed or not  For codebook refinement based on Rel-18 Type-II Doppler, introduce per-resource higher-layer (RRC) configuration to indicate (via 1-bit per resource) whether 1-slot offset relative to the resource group slot offset should be assumed or not  FG59-2-1-7  Rank related component is needed to seprate RI=1 and RI=2, this is based on the agreement  FG59-2-1-8  We prefer to separate SRS port group for xT6R and xT8R related SRS antenna switching |
| Ericsson | FG59-2-1-1/2/3/4/5 and 8: Fine with using these as starting points for UE feature discussion.  FG59-2-1-6: Agree with comment from Apple.  FG59-2-1-7: The feature should be split into separate features one for rank 1 and another for rank 2. |
| NTT DOCOMO | FG59-2-1-5  The list seems generally good already; while we wonder if the following should be clarified as ” Rel-18 eType-II Doppler codebook”, instead of “Rel-18 Type-II Doppler codebook” for clarity.  Since Doppler codebook is based on Rel-16 eType-II regular codebook only.  G59-2-1-7  We see separate agreements with UE features for rank=1 and rank=2. But it is a strange case if UE reports the support for RI=2 but not for RI=1. Thus, current version is fine to us. |
| Nokia | FG 59-2-1-7 According to a conclusion from RAN1#117, the 3-bit scaling applies only to the Type-I SP codebook. It should be included in the note.  **Conclusion (RAN1#117)**  For the Rel-19 Type-I codebook refinement for 48, 64, and 128 CSI-RS ports, on the agreed 3-bit group-based scaling factor for RI=v=1, there is no consensus on supporting this feature for codebooks other than for Rel-19 Type-I SP codebook refinement. |
| Samsung [CSI FL] | Re FG 59-2-1-1, after further discussion with other companies, we can compromise to introduce two *separate* basic feature groups, one basic FG for Scheme-B, and another basic FG for Scheme-A.  For each of the basic FGs, the following components are needed to add:  1) A list of supported combinations, up to 16, across all CCs in a band when reported per band, and across all CCs in a band combination when reported per BC simultaneously, where each combination is   1. Maximum number of Tx ports in one NZP CSI-RS resource   {16,32}   1. Maximum total number of NZP CSI-RS resources aggregated   {2,4}   1. Maximum total number of Tx ports of aggregated NZP CSI-RS resources   {64}  2) Support of rank 1,2,3,4 |
| Xiaomi | FG59-2-1-1/2/3/4/5 and 8:  We are fine with these as a starting point to discuss UE feature.  FG59-2-1-6/7  We share same view with Apple. |
| Qualcomm | Re FG 59-2-1-1, although we prefer Schee-A as basic feature, we are also OK to compromise to two *separate* FGs.  In addition, we are fine with either one of the following two possible manners:   * Manner1: Both under the umbrella of FG 59-2-1-1, and with a component like “Supported Codebook Mode(s)”, with candidate value {Scheme-A, Scheme-B} – which means no one is more basic over the other. * Or, Manner2: Have two FG numbers 59-2-1-1a and 59-2-1-1b for Scheme-A and Scheme-B respectively.   As for the component “rank” as proposed by Samsung/FL, we’d like to ask: Whether this purpose can be achieved by the following existing FG 2-3 since Rel-15?  It is noted that FG 2-3 is FSPC.   | **Definitions for parameters** | **Per** | **M** | **FDD-TDD**  **DIFF** | **FR1-FR2**  **DIFF** | | --- | --- | --- | --- | --- | | ***maxNumberMIMO-LayersPDSCH***  Defines the maximum number of spatial multiplexing layer(s) supported by the UE for DL reception. For single CC standalone NR, it is mandatory with capability signaling to support at least 4 MIMO layers in the bands where 4Rx is specified as mandatory for the given UE and at least 2 MIMO layers in FR2. If absent, the UE does not support MIMO on this carrier. | FSPC | CY | N/A | N/A | |

**Proposal: 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 | 59-2-2-1 | 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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| Company | Comments/Questions/Suggestions |
| Apple | FG59-2-2-1/2/3  We can have these three FGs in principle, but need to discuss the details about the components |
| Ericsson | FG59-2-2-1/2/3: Fine with using these as starting points for UE feature discussion. |
| Xiaomi | FG59-2-2-1/2/3  We are fine with these as a starting point to discuss UE feature. Regarding the second componets of 59-2-2-1/2, the value of Ks could only be set as 2, 3 or 4 according to previous agreements. |

**Proposal: 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 | 59-2-3-1 | 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 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 | 59-2-3-5 | CJTC subband 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 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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| Company | Comments/Questions/Suggestions |
| Apple | FG2-3/1/2/3/4/5/6  We can agree the above 6 FGs in principle, but detailed discussion is needed for the components and other related FGs, etc.  FG59-2-3-7  We need to discuss how to handle joint and separate triggering, whether we need basisc feature. |
| Ericsson | FG59-2-3-1/2/3/4 and 6/7/8: Fine with using these as starting points for UE feature discussion.  FG59-2-3-5: It should be wideband Dd+FO report. Suggest the following change:  CJTC ~~subband~~ wideband Dd+FO report |
| Xiaomi | FG59-2-3-4: ‘Consequence if the feature is not supported by the UE’ should be ‘CJTC PO report is not supported’  FG59-2-3-5: remove ‘subband’. And the ‘Consequence if the feature is not supported by the UE’ should be ‘CJTC PO report is not supported’ should be ‘CJTC Dd+FO report is not supported’ |

## 3-antenna-port codebook-based transmissions

After review of contributions submitted to RAN1 #119 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 | 59-3-1 | Non-codebook based PUSCH transmission for 3TX | 1. Maximal number of supported 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 | 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,}]  [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 | 1. Maximum number of PUSCH MIMO layers for codebook-based PUSCH  2. 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, 3,}]  [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 | 59-3-3 | 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] | 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 | Support of M-TRP PUSCH repetition for 3-antenna-port PUSCH transmission with type A for codebook based | 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 | FFS: 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 | 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 | 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 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 | 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 | FFS: 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 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 | 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 | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |
| NR MIMO Phase 5 | 59-3-6 | PTSR 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 | 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 | FFS | FFS | FFS | FFS | FFS: Further partitioning of this FG based on existing and future agreements | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| QC | Thanks for FL put together a good set of FGs. We are in general fine with the above proposal, with a few minor comments.  Comment 1: It is better to clearly state that 59-3-1 and 59-3-2 are for single TRP.  Comment 2: For 59-3-2 which is codebook based PUSCH, do we need component 3. If I recall correctly, only one SRS resource for codebook based PUSCH can be transmitted per OFDM symbol, where the single resource can be with multiple SRS ports such as 2, 3, 4, or 8. Component 3 is only needed for SRS for noncodebook based PUSCH.  Comment 3: for 59-3-3, we need two more components are needed: “4. Maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching”, “5. Downgrade antenna switching configurations for 3T6R”  Comment 4: for 59-3-4, Similar as the above, we need two more components are needed: “4. Maximum 2 SP and 1 periodic SRS sets for 3T6R antenna switching”, “5. Downgrade antenna switching configurations for 3T3R”  Comment 5: We need a new FG “Association between CSI-RS and SRS for non-codebook-based 3Tx PUSCH” is needed, which is a legacy FG for noncodebook based PUSCH back in Rel-15. We can also add it as a component under 59-3-1. |
| Apple | For FG59-3-1  Component 1: only 3 layers is needed, others are covered by the legacy feature  Component 2/3 are not needed, covered by the legacy feature  For FG59-3-2  Component 1: only 3 layers is needed, others are covered by the legacy feature  Component 3: not needed, no simultaneous transmission for codebook based SRS  For FG59-3-3  Component 2 and 3 are needed  For FG59-3-3a  Component 2 and 3 are needed |
| Ericsson | **FG 59-3-1:**  Component 2: should be {1,2,3,4}: There should be no problem with more SRS resources than max number of layers; this is already possible in Rel-15 e.g. where UE reports max 1 layer and 4 resources. One we could be to structure the capability as Apple suggests. We are open to that approach, but this seems to be a dependency issue which could be further discussed.  **FG 59-3-2:**  Component 2: should be {1,2}, since UL full power modes are not defined for 3 Tx.  Component 3: Not needed; similar comment as QC/Apple. Copy-paste error from non-codebook?  Either need a new component or note to reflect that 3 Tx is actually used, e.g. “Codebook based PUSCH transmission with port 1003 disabled when 4 port SRS resources with port 1003 disabled are configured to the UE.”  **FG 59-3-3/3a:**  Intention seems to be to add 3T3R/3T6R based on some prior switching capability. It seems better to define the downgrade capabilities directly as QC comments.  Components 2 & 3 are needed.  **FG 59-3-4/4a/5/5a:**  There are two typos: 59-3-4/4a for Type B repetition should be 59-3-5/5a  Missing some descriptive text for the main component, that we have e.g. for FG 23-3-1  1. Support of multi-TRP PUSCH repetition (based on PUSCH repetition type A)  - sequential mapping for repetitions larger than 2  - cyclic mapping for 2 repetitions  The Rel-17 note is also missing  “Note: Two linked PDCCH candidates are not expected to be associated with different CORESETPoolIndex values”  Also missing Rel-17 components. Component 2 is required in Rel-17.  2. 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)  **FG 59-6:**  Typo: ‘PTSR’ should be ‘PTRS’  **FG 59-7:**  Component name and feature group name should be swapped. Mode 0 is not an IE or defined in specs; UE uses Mode 0 when configured with *fullpower*. Suggest:  FG name: “Support of full-power Mode 0 for codebook-based”  Component: “UL full power transmission mode of *fullpower*”  Should clarify that “consequence if the feature is not supported by the UE” is for 3 Tx: “UL full power transmission mode of fullpower is not supported for 3 Tx operation” |
| NTT DOCOMO | FG59-3-1: component 3 is not needed. |
| OPPO | FG59-3-1: Only the first component is needed. The remaining can follow legacy since the candidate values are the same.  FG59-3-2: Component 2 candidates should be {1,2} and component 3 is not needed.  FG59-3-3: Components 2 and 3 are needed.  FG59-7: This FG seems not needed. We can just follow legacy FG 16-5a. It would be strange that UE supports FPM0 only for 3Tx or only not for 3Tx.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 16-5a | UL full power transmission mode of *fullpower* | 1. Supported UL full power transmission mode of *fullpower* | 2-13, 2-14 | Yes | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signaling | |
| Xiaomi | FG 59-3-2:  Component 2: the values can be of {1,2};  FG 59-3-3a: same view as QC that two components needed.  Component 2 and 3 are needed |

## Asymmetric DL sTRP/UL mTRP scenarios

After review of contributions submitted to RAN1 #119 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 | 59-4-1 | 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 | FFS | 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 sepatate SRS closed loop indices | Support of two sepatate SRS closed loop indices | 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 | 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 | FFS: 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) | 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 | 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 |

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| Company | Comments/Questions/Suggestions |
| QC | Thanks for FL put together a good set of FGs. We are in general fine with the above proposal, with a few minor comments below.   * For FG 59-4-5, two FGs are needed. One FG is “DCI format 1\_1 for TPC command indicatinon for a separate SRS CLPC adjustment state” which is used for single separate SRS CLPC adjustment state. The other FG is “DCI format 1\_1 for TPC command indication for two separate SRS CLPC adjustment states” which is used for two separate SRS CLPC adjustment states. FG 59-4-3 “Two sepatate SRS closed loop indices” is the pre-requisite FG of the latter FG. * For FG 59-4-7, the note “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)”, we suggest to remove the sentence in the bracket “(i.e., scheduling restriction is applied to avoid overlap between the two UL transmissions)”. This is because for intra-slot PUCCH/PUSCH repetition, the PUCCH or PUSCH are transmitted back-to-back, and scheduling restriction cannot be applied. In this case, the UE should treat two overlapping UL across different TAGs as error case. In additional, note that in the previous agreement, the sentence in the bracket is not included as shown below.   **Agreement**  Support 2TA for the asymmetric DL sTRP/UL mTRP deployment scenarios:   * Introduce the optional UE capability of “Overlapping UL transmission reduction” for Rel-19 2TA   + If UE does not report this UE capability, UE does not expect two UL transmissions associated with different TAGs are overlapped. |
| Apple | For FG59-4-1  We prefer to separate the feature to associate PL offset with joint/DL TCI state, and UL TCI state  For FG59-4-3  We need to clarify, two separate SRS close loop indices, separate from PUSCH |
| Ericsson | Agree with QC’s comment on FG 59-4-5 that we need two FGs for DCI format 1\_1 for TPC command indication for separate SRS CLPC adjustment states. It is emphasized in the following agreement that we two dedicated UE capabilities, one for indicating support of **one** separate SRS CLPC adjustment state with DCI 1\_1, another one for indicationg support of **two** separate SRS CLPC adjustment states with DCI 1\_1.  Support DCI format 1\_1 to indicate TPC command for SRS CLPC adjustment state(s) separate from PUSCH:   * (**Working Assumption**) Introduce a 2-bit TPC command field to indicate TPC command for SRS associated with separate SRS CLPC adjustment state where:   + The 2-bit TPC command field is present if UE reports supporting a dedicated UE capability, and a corresponding RRC parameter is configured (which is a new RRC to enable this). * (**Working Assumption**) Introduce a 1-bit SRS close-loop indicator to indicate one of the two separate SRS CLPC adjustment states for the TPC command   + The 1-bit SRS close-loop indicator is present if UE reports supporting another dedicated UE capability and a corresponding RRC parameter is configured (which is a new RRC to enable this) and two separate SRS CLPC adjustment states are configured. |
| Huawei, HiSilicon | Except 59-4-4 and 59-4-5, all FGs are only applicable to “asymmetric DL sTRP/UL mTRP scenarios”. We suggest to add “for asymmetric DL sTRP/UL mTRP scenarios” at the end of all these FGs. Otherwise, it will be confusing which ones are only applicable to Asymmetric DL/UL scanrios and which ones are for more general case when these FGs are captured in 38.822 and 38.306.  FG 59-4-1: We think this FG should be split to two different FGs for UL TCI and joint DL/UL TCI. According to RAN1 Agreement, PL offset in joint DL/UL TCI is only applicable in FR1 while PL offset in UL TCI is applicable to both FR1 and FR2.  FG 59-4-2: This feature is only agreed for FR1.  FG 59-4-3: OK in principle but we prefer more accurate naming: “two SRS CLPC adjustment states separate from PUSCH”  FG 59-4-4: Based on RAN1 agreement, the starting bit of value range extends to X=45 for operations in FR1 in shared spectrum or FR2-2 and X = 43 otherwise.  FG 59-4-6: We don’t need to mention “without the restriction of multi-DCI based multi-TRP operation”. Asymmetric DL/UL is only a sDCI-based scheme. The current language implies that Asymmetric DL/UL could be sDCI based scheme or mDCI based scheme which is incorrect. Instead, as mentioned above, we suggest to add “for asymmetric DL sTRP/UL mTRP scenarios” at the end of FG name.  FG 59-4-7: OK  FG 59-4-8: OK |
| NTT DOCOMO | We are fine with FL proposals. We are also fine with Qualcomm/Apple’s suggestions. |
| Nokia | In general good set of FGs.  59-4-5 we also think it may need two FGs as QC and Ericsson discussed  59-4-6 the text may be updated as HW suggested. |
| Xiaomi | Agree with QC’s comment on FG 59-4-5 that we need two FGs for DCI format 1\_1. |
| ZTE | For 59-4-3, it should be accurately named as “Two SRS CLPC adjustment states separate from PUSCH” as commented by HW.  For 59-4-4, it should be accurately named as “Extended value range of starting bit of block in DCI format 2\_3”.  For 59-4-5, two FGs are needed as commented by companies.  For 59-4-6, we also think “without the restriction of multi-DCI based multi-TRP operation” is not needed in the column of description.  For 59-4-7, we do NOT agree with QC’comment that “*This is because for intra-slot PUCCH/PUSCH repetition, the PUCCH or PUSCH are transmitted back-to-back, and scheduling restriction cannot be applied. In this case, the UE should treat two overlapping UL across different TAGs as error case*”. Instead, intra-slot PUSCH/PUCCH repetition can still be scheduled if UE does not support this UE capability, e.g., based on the proper RRC configuration of invalid symbol pattern in this case. |

# Conclusion

Agreements reached during RAN1 #119 as part of this agenda item are summarized in [ ].

# References

1. R1-2409382, Discussion on UE features for NR MIMO Phase 5, ZTE Corporation/Sanechips
2. R1-2409431, UE features for NR MIMO Phase 5, Huawei/HiSilicon
3. R1-2409533, Discussion on UE features for NR MIMO Phase 5, CMCC
4. R1-2409620, UE features for NR MIMO Phase 5, Samsung
5. R1-2409621, Initial list of UE features for Rel-19 MIMO Ph5, Samsung (Moderator)
6. R1-2409704, Discussion on Rel-19 MIMO UE features, vivo
7. R1-2409768, Initial views on UE features NR MIMO Phase 5 WI, Nokia
8. R1-2409829, Views on UE features for NR MIMO Phase 5, Apple
9. R1-2409932, On UE features for NR MIMO Phase 5, CATT
10. R1-2410112, UE features for NR MIMO Phase 5, OPPO
11. R1-2410342, UE features for NR MIMO Phase 5, Ericsson
12. R1-2410501, UE features for NR MIMO phase 5, Qualcomm Incorporated