3GPP TSG-RAN WG2 #104 DRAFT R2-1819115

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**Source: NTT DOCOMO, INC.**

**Title: Mapping capability field names on to L1/RF/RRM UE features**

**Document for: Information**

**Agenda Item: 10.4.4.1 TS (UE capabilities)**

## Introduction

This paper provides information on mapping capability field names on to L1/RF/RRM UE features in [1, 2].

## References

[1] R2-1819109, “LS on RAN1 NR UE features,” RAN1.

[2] RP-182900, “RAN4 UE feature list for NR,” NTT DOCOMO, INC.

## L1 UE feature list (RAN1)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | # | Feature group | Components | Field name in TS 38.331 | Parent IE in TS 38.331 | Type (see R2-1712078) | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | RAN WG recommendation | **TSG-RAN decision** |
| 0. Waveform, modulation, subcarrier spacings, and CP | 0-1 | CP-OFDM waveform for DL and UL | 1) CP-OFDM for DL2) CP -OFDM for UL | *N.A* | *N.A* | N.A. | N.A. | N.A. |  | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 0-2 | DFT-S-OFDM waveform for UL | Transform precoding for single-layer PUSCH | *N.A* | *N.A* | N.A. |  N.A. | N.A. |  | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 0-4 | UL modulation scheme | 1) QPSK modulation2) 16QAM modulation | *N.A* | *N.A* | N.A. | N.A. | N.A. |  | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 0-10 | Extended CP | Extended CP | *extendedCP* | *BandNR* | Type 1 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
| 1. Initial access and mobility | 1-1 | Basic initial access channels and procedures | 1) RACH preamble format 2) SS block based RRM measurement [3) RMSI/broadcast OSI reception][4] Paging] | *N.A* | *N.A* | N.A. | No need | No need | RAN2 to check components 3 and 4 for SA and NSA applicability | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 1-1a | [On demand based system information] |  | *N.A* | *N.A* |  |  [Yes] | [No need] | RAN2 to check | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 1-3 | SS block based SINR measurement (SS-SINR) | 1) SS-SINR measurement | *ss-SINR-Meas* | *MeasAndMobParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 1-4 | SS block based RLM | 1) SS block based RLM | *ssb-RLM* | *MeasAndMobParametersCommon* | Type 4 | No need | No need |  |  | Mandatory with capability signaling which shall be set to ‘1’  |
|  | 1-5 | CSI-RS based RRM measurement with associated SS-block | 1) CSI-RSRP measurement2) CSI-RSRQ measurement | *csi-RSRP-AndRSRQ-MeasWithSSB* | *MeasAndMobParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signalingNote: This does not discourage RAN4 to complete their workNote: there is expectation that RAN4 will complete the corresponding RRM measurement  |
|  | 1-5a | CSI-RS based RRM measurement without associated SS-block | 1) CSI-RSRP measurement 2) CSI-RSRQ measurement3) There is SS-block in the target frequency on which the RRM measurement is performed | *csi-RSRP-AndRSRQ-MeasWithoutSSB* | *MeasAndMobParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signalingNote: This does not discourage RAN4 to complete their workNote: there is expectation that RAN4 will complete the corresponding RRM measurement  |
|  | 1-6 | CSI-RS based RS-SINR measurement | 1) CSI-SINR measurement | *csi-SINR-Meas* | *MeasAndMobParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 1-7 | CSI-RS based RLM | 1) CSI-RS based RLM | *csi-RS-RLM* | *MeasAndMobParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Mandatory with capability signaling  |
|  | 1-8 | RLM based on a mix of SS block and CSI-RS signals within active BWP |  | *ssb-AndCSI-RS-RLM* | *MeasAndMobParametersCommon* | Type 4 | No need | No need |  | [Mandatory /optional with capability signaling] |  |
|  | 1-9 | CSI-RS based contention free RA for HO |  | *csi-RS-CFRA-ForHO* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Optional with capability signaling | Optional with capability signaling |
|  | 1-10 | Support of SCell without SS/PBCH block | 1) Support SCell without SS/PBCH block | *scellWithoutSSB* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. | Component 1) Whether or not UE is able to use SS/PBCH block from other Cells for time/frequency synchronization of SCell without SS/PBCH block | Mandatory with capability signaling for intra-band CAThis feature is not supported for inter band CA |  Mandatory with capability signaling for intra-band CAThis feature is not supported for inter band CA |
|  | 1-11 | Support of CSI-RS RRM measurement for SCell without SS/PBCH block |  | *csi-RS-MeasSCellWithoutSSB* | *FeatureSetDownlink* | Type 3 | N. A. | N.A. | RAN4 to check |  | Optional with capability signaling |
|  | 1-12 | E-UTRA RS-SINR measurement |  | *rs-SINR-MeasEUTRA* | *EUTRA-ParametersCommon* | Type 4 | No need | [No need] | RAN2 to decide FR1/FR2 differentiation | Optional with capability signaling | Optional with capability signaling |
|  | 1-13 | Maximal number of CSI-RS resources for RRM and RS-SINR measurement across all measurement frequencies per slot |  | *maxNumberCSI-RS-RRM-RS-SINR* | *MeasAndMobParametersCommon* | Type 4 | No need | No need | Note: If UE supports any of 1-5, 1-5a, and 1-6, UE shall report this capability 1-13 | Candidate value set: {4,8,16,32,64, 96} |  |
|  | 1-14 | Maximal number of CSI-RS resources within a slot per PCell/PScell for CSI-RS based RLM |  | *maxNumberResource-CSI-RS-RLM* | *MeasAndMobParametersFRX-Diff* | Type 4 | No need | Yes | Note: If UE supports any of 1-7 and 1-8, UE shall report this capability 1-14 | Candidate value set: {2,4, 6, 8} |  |
| 2. MIMO | 2 -1 | Basic PDSCH reception | 1. Data RE mapping2. Single layer transmission3. Support one TCI state | *N.A* | *N.A* | N.A. | N.A. | N.A. |  | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 2-2 | PDSCH beam switching | 1. Time duration (definition follows section 5.1.5 in TS 38.214), Xi, to determine and apply spatial QCL information for corresponding PDSCH receptionTime duration is defined counting from end of last symbol of PDCCH to beginning of the first symbol of PDSCHXi is the number of OFDM symbols, i is the index of SCS, l=1,2, corresponding to 60,120 kHz SCS. | *timeDurationForQCL* | *FeatureSetDownlink* | Type-3  | No need | Applicable only for FR2 |  | Mandatory with capability signaling for FR2Candidate value set for X1 is {7, 14, 28}, Candidate value set for X2, {14, 28} |  |
|  | 2-3 | PDSCH MIMO layers | 1. Supported maximal number of MIMO layers | *maxNumberMIMO-LayersPDSCH* | *FeatureSetDownlinkPerCC* | Type 3 | N.A. | N.A. |  | Mandatory with capability signalingCandidate values: {1,2,4,8} |  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. Some relaxations to this requirement may be applicable in the future (including in Rel-15).Mandatory in all cases means mandatory with capability signaling. It is not expected that there is a signaling change (i.e. signaling remains to be defined as {1, 2, 4, 8} in every band and every band combination, including FR1 and FR2 in all cases. |
|  | 2-4 | TCI states for PDSCH | 1. Support number of active TCI states per BWP per CC , including control and data2. maximum number of configured TCI states per CC for PDSCH | *tci-StatePDSCH {**1. maxNumberConfiguredTCIstatesPerCC**2. maxNumberActiveTCI-PerBWP**}* | *MIMO-ParametersPerBand* | Type 1  | N.A.  | N.A. | Note: UE is required to track only the active TCI statesNote: For component 1 of FG2-4, if a UE reports X active TCI state(s), it is not expected that more than X active QCL type D assumption(s) for any PDSCH and any CORESETs for a given BWP of a serving cell become active for the UE. | Mandatory with capability Component-1: Candidate value set: {1, 2, 4, 8 }Component-2: candidate value set: {4, 8, 16, 32, 64, 128}UE is mandated to signal 64 for FR2. For FR1, UE is mandated to report at least the max number of allowed SSB in the band  | Component-1: Candidate value set: {1, 2, 4, 8 }Component-2: candidate value set: {4, 8, 16, 32, 64, 128}UE is mandated to signal [64, 128] for FR2 and FFS the values for FR1 |
|  | 2-4a(new FG) | Additional active TCI state for PDCCH | Support one additional active TCI state for control in addition to the supported number of active TCI states for PDSCH | *additionalActiveTCI-StatePDCCH* | *MIMO-ParametersPerBand* | Type 1  | N.A.  | N.A. | Note: Only applicable if Component-1 of 2-4 is set to 1 | Mandatory with capability signalling  | Mandatory with capability signalling |
|  | 2-5 | Basic downlink DMRSfor scheduling type A  | 1. Support 1 symbol FL DMRS without additional symbol(s) 2. Support 1 symbol FL DMRS and 1 additional DMRS symbol 3. Support 1 symbol FL DMRS and 2 additional DMRS symbols for at least one port.  | *N.A* | *N.A* | N.A. | N.A. | N.A. | conditioned to whether PDSCH scheduling type A is supported | Mandatory without UE capability(condition to scheduling capability) | Mandatory without UE capability(condition to scheduling capability) |
|  | 2-6 | Basic downlink DMRSfor scheduling type B | 1. Support 1 symbol FL DMRS without additional symbol(s)2. Support 1 symbol FL DMRS and 1 additional DMRS symbol  | *N.A* | *N.A* | N.A. | N.A. | N.A. | conditioned to whether PDSCH scheduling type B is supported | Mandatory without UE capability (condition to scheduling capability) | Mandatory without UE capability (condition to scheduling capability) |
|  | 2-6a | Support 1+2 DMRS (downlink) | 1. Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port | *oneFL-DMRS-TwoAdditionalDMRS-DL* | *FeatureSetDownlink* | Type 3Note: per band per band combination | No need | Yes |  | Mandatory with UE capability signaling | Mandatory with capability signaling |
|  | 2-6b | Support alternative additional DMRS location | Support alternative additional DMRS position for co-existence with LTE CRS | *additionalDMRS-DL-Alt* | *FeatureSetDownlink* | Type 3 | No need | N.A. | Note: This FG applies to FR1 only and 15kHz SCS. Note: this applies to one additional DMRS case only  | Optional with UE capability signaling |  |
|  | 2-7 | Supported 2 symbols front-loaded DMRS(downlink) | 1. Support 2 symbols FL-DMRS | *twoFL-DMRS (MSB)* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 2-8 | Supported 2 symbols front-loaded +2 symbols additional DMRS(downlink) | 1. Support 2-symbol FL DMRS + one additional 2-symbols DMRS  | *twoFL-DMRS-TwoAdditionalDMRS-DL* | *FeatureSetDownlink* | Type 3Note: per band per band combination | No need | Yes |  |  | Optional with capability signaling |
|  | 2-9 | Support 1+3 DMRS symbols(downlink) | 1. Support 1 symbol FL DMRS and 3 additional DMRS symbols | *oneFL-DMRS-ThreeAdditionalDMRS-DL* | *FeatureSetDownlink* | Type 3Note: per band per band combination | No need | Yes |  |  | Optional with capability signaling |
|  |  2-10 |  Support DMRS type (downlink) | Support DMRS {type 1, both type 1 and type 2}  | *supportedDMRS-TypeDL* | *Phy-ParametersFRX-Diff* | Type 4  | No need | Yes |  |   | Type 1 is mandatory with capability signaling. Type 2 is optional with capability signaling.  |
|  | 2-11 | Downlink dynamic PRB bundling (downlink) | 1. Support dynamic PRB bundling indication via DCINote: Support of semi-static PRB bundling--mandatory  | *dynamicPRB-BundlingDL* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Optional | Optional with capability signaling |
|  | 2-12 | Basic PUSCH transmission | Data RE mappingSingle layer (single Tx) transmission Single port, single resource SRS transmission (SRS set use is configured as for codebook) | *N.A* | *N.A* | N.A.  | N.A. | N.A. | Note: support of SRS set usage configured as for codebook does not imply UE support of codebook based PUSCH MIMO transmission  | Mandatory without UE capability | Mandatory without UE capability |
|  | 2-13 | PUSCH codebook coherency subset | 1. Supported codebook coherency subset type:  | *pusch-TransCoherence* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Optional with UE capabilityCandidate value set: {non-coherent, partial/non-coherent, full/partial/non-coherent} |  |
|  | 2-14 | Codebook based PUSCH MIMO transmission  | 1. Supported codebook based PUSCH MIMO with maximal number of supported layers2. Supported max number of SRS resource per set (SRS set use is configured as for codebook). | *mimo-CB-PUSCH {**1. maxNumberMIMO-LayersCB-PUSCH**2. maxNumberSRS-ResourcePerSet**}* | *FeatureSetUplinkPerCC* | Type 3 | N.A. | N.A. |  | Optional with UE capabilityComponent-1:Candidate value: {no-codebook based MIMO, 1, 2, 4}Component-2Candidate value: {1, 2}Note: for SUL, uplink MIMO is not supported.  |  |
|  | 2-15 | non-codebook based PUSCH transmission | 1. Maximal number of supported layers (non-codebook transmission scheme)2. Supported max number of SRS resource per set (SRS set use is configured as for non-codebook transmission).3. Maximum number of simultaneous transmitted SRS resources at one symbol  | *maxNumberMIMO-LayersNonCB-PUSCH**mimo-NonCB-PUSCH {**1. maxNumberSRS-ResourcePerSet**2. maxNumberSimultaneousSRS-ResourceTx**}* | *FeatureSetUplinkPerCC* | Type 3 | N.A. | N.A. |  | Optional with UE capabilityComponent-1 candidate values: { 1, 2, 4}Component-2Candidate value: {1,2,3,4}Component-3Candidate value: {1,2,3,4}Note: for SUL, uplink MIMO is not supported |  |
|  | 2-15a | Association between CSI-RS and SRS  | 1. Support association between NZP-CSI-RS and SRS resource set via RRC parameter “SRSresoureset” 2. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously. | *srs-AssocCSI-RS {**1.1. maxNumberTxPortsPerResourcePerBand**1.2. maxNumberResourcesPerBand**1.3. totalNumberTxPortsPerBand**}* | *MIMO-ParametersPerBand*  | Type 3 | N.A. | N.A. |  | OptionalComponent-2: Maximum size of the list is 16. the candidate values for the max # of Tx port in one resource is {2, 4, 8, 12, 16, 24, 32}The candidate value set of the max # of resources is:{from 1 to 64}The candidate value set of total # of ports is:{from 2 to 256} | Optional with capability signaling |
| *1.2. maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC**1.3. totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC* | *CA-ParametersNR* |
|  | 2-15b | CSI-RS processing framework for SRS | 1. Maximum number of periodic SRS resources associated with CSI-RS per BWP2. Maximum number of aperiodic SRS resources associated with CSI-RS per BWP3. Maximum number of semi-persistent SRS resources associated with CSI-RS per BWP4. UE can process Y SRS resources associated with CSI-RS resources simultaneously in a CC. Includes P/SP/A SRS.5. UE can process X SRS resources associated with CSI-RS resources simultaneously across all CCs. Includes P/SP/A SRS. | *csi-RS-ProcFrameworkForSRS {**1. maxNumberPeriodicSRS-AssocCSI-RS-PerBWP**2. maxNumberAperiodicSRS-AssocCSI-RS-PerBWP**3. maxNumberSP-SRS-AssocCSI-RS-PerBWP**4. simultaneousSRS-AssocCSI-RS-PerCC**}* | *MIMO-ParametersPerBand**Phy-ParametersFRX-Diff (for FR1 + FR2 band combination)* | Type 3 | N.A. | N.A. | NOTE: Other MIMO capability other than component 5 may further restrict (reduce) the number of SRS associated with CSI-RS that the UE has to simultaneously derive. | Optional with capability signalingComponent-1 candidate values: {1, 2, 3, 4}Component-2 candidate values {1, 2, 3, 4}Component-3 candidate values: {0, 1, 2, 3, 4}Component-4candidate values: {from 1 to 8}Component-5:candidate values: {from 5 to 32} |  |
| *5. simultaneousSRS-AssocCSI-RS-AllCC* | *CA-ParametersNR* |
|  | 2-16 | Basic uplink DMRS (uplink) for scheduling type A | 1. Support 1 symbol FL DMRS without additional symbol(s)2. Support 1 symbol FL DMRS and 1 additional DMRS symbols 3. Support 1 symbol FL DMRS and 2 additional DMRS symbols  | *N.A* | *N.A* | N.A. | N.A. | N.A. | conditioned to whether PUSCH scheduling type A is supported | Mandatory without UE capability  | Mandatory without capability signaling |
|  | 2-16a | Basic uplink DMRSfor scheduling type B | 1. Support 1 symbol FL DMRS without additional symbol(s)2. Support 1 symbol FL DMRS and 1 additional DMRS symbol  | *N.A* | *N.A* | N.A. | N.A. | N.A. | conditioned to whether PUSCH scheduling type B is supported | Mandatory without UE capability  | Mandatory without capability signaling |
|  | 2-16b | Support 1+2 DMRS (uplink) | 1. Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port | *oneFL-DMRS-TwoAdditionalDMRS-UL* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Mandatory with UE capability signaling | Mandatory with capability signaling |
|  | 2-17 |  Support DMRS type (uplink) | Support DMRS {type 1, both type 1 and type 2 } | *supportedDMRS-TypeUL* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Support both type 1 and type 2 are mandatory with capability signaling  | Support both type 1 and type 2 are mandatory with capability signaling  |
|  | 2-18 | Supported 2 symbols front-loaded DMRS (uplink) | 1. Support 2 symbols FL-DMRS | *twoFL-DMRS (LSB)* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Mandatory with capability signaling |
|  | 2-18a | Supported 2 symbols front-loaded +2 symbols additional DMRS (uplink) | 1. Support 2-symbol FL DMRS + one additional 2-symbols DMRS  | *twoFL-DMRS-TwoAdditionalDMRS-UL* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Mandatory with capability signaling |
|  | 2-19 | Support 1+3 uplink DMRS symbols(uplink) | 1. Support 1 symbol FL DMRS and 3 additional DMRS symbols | *oneFL-DMRS-ThreeAdditionalDMRS-UL* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling  |
|  | 2-20 | Beam correspondence | 1. Support Beam correspondence2. When CA is configured, whether the same beam correspondence relationship for beam management is supported across CCs. Note: RAN4 to check the feasibility for component-2, e.g. intra-band or inter-band | *beamCorrespondence* | *MIMO-ParametersPerBand* | Type 1 | No need | N.A. | Note: Beam correspondence means each Tx port can be beamformed in a desirable direction but does not imply setting phase across ports | [Mandatory/optional] with capability signalingComponent-2, candidate value: {Yes, No} | [Mandatory/optional] with capability signaling |
|  | 2-21 | Periodic beam report | 1. Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot2. Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot | *periodicBeamReport* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Mandatory with UE capability at least for FR2 FFS: for FR1 | Mandatory with UE capability for FR2[Mandatory/optional] with UE capability for FR1 |
|  | 2-22 | Aperiodic beam report | 1. Support report on PUSCH | *aperiodicBeamReport* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Mandatory with UE capability at least for FR2FFS: for FR1 | Mandatory with UE capability for FR2[Mandatory/optional] with UE capability for FR1 |
|  | 2-23 | Semi-persistent beam report on PUCCH | 1. Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot(or piggybacked on a PUSCH)2. Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot(or piggybacked on a PUSCH) | *sp-BeamReportPUCCH* | *MIMO-ParametersPerBand* | Type 1 | N.A. | Yes |  | Optional with capability signaling  | Optional with capability signaling |
|  | 2-23a | Semi-persistent beam report on PUSCH | 1. Support report on PUSCH  | *sp-BeamReportPUSCH* | *MIMO-ParametersPerBand* | Type 1 | N.A. | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 2-24 | SSB/CSI-RS for beam measurement  | 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 shall not exceed MB\_1 1a. The max number of CSI-RS resources (sum of aperiodic/periodic/semi-persistent) across all CCs configured to measure L1-RSRP shall not exceed MC\_1 2. The max number of CSI-RS (2Tx) resources (sum of aperiodic/periodic/semi-persistent) across all CCs to measure L1-RSRP within a slot shall not exceed MB\_2 3. Supported density of CSI-RS 4. The max number of aperiodic CSI-RS resources across all CCs configured to measure L1-RSRP shall not exceed MD\_1 | *BeamManagementSSB-CSI-RS {**1. maxNumberSSB-CSI-RS-ResourceOneTx**2. maxNumberCSI-RS-ResourceOneTx**3. maxNumberCSI-RS-ResourceTwoTx**4. supportedCSI-RS-Density**5. maxNumberAperiodicCSI-RS-Resource**}* | *MIMO-ParametersPerBand* | Type 1 | No need | Yes |  | Mandatory with capability signalingComponent-1, candidate value set for MB\_1 is {0, 8, 16, 32, 64}On FR2, UE is mandated to signal MB\_1 >=8On FR1, MB\_1 >=8 is supported mandatory with capability signaling. Component-1a, candidate value set for MC\_1 is {0, 4, 8, 16, 32, 64}For FR1, UE is mandated to report at least 8. Component-2, candidate value set for MB\_2 is {0, 4, 8, 16, 32, 64}Component-3: candidate value set: {“not supported”, “1 only”, “3 only”, “both 1 and 3”}On FR2, UE is mandated to signal either “3 only” or “both 1 and 3”On FR1, either “3 only” or “both 1 and 3” is mandatory with UE capability signaling.Component-4, candidate value set for MD\_2 is {0, 1, 4, 8, 16, 32, 64}For both FR1 and FR2, UE is mandated to report at least 4 |  |
|  | 2-25 | Beam reporting timing | 1. The number of symbols, Xi, between the last symbol of SSB/CSI-RS and the first symbol of the transmission channel containing beam report is at least RBi, where*i* is the index of SCS, *i*=1,2,3,4 corresponding to 15,30,60,120 kHz SCS. | *beamReportTiming* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Mandatory with capability Candidate value sets: X1 is {2, 4, 8}X2 is {4,8, 14, 28}X3 is { 8,14, 28}X4 is{14,28, 56} | Candidate value sets: []X1 is {2, 4, 8}X2 is {4,8, 14, [28]}X3 is { 8,14, 28}X4 is{14,28, 56} |
|  | 2-26 | Receiving beam selection using CSI-RS resource repetition "ON" | 1. Support Rx beam switching procedure using CSI-RS resource repetition "ON"2. Recommended CSI-RS resource repetition number per resource set,  | *maxNumberRxBeam* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Support Rx beam switching is mandatory for FR2Componet-2: candidate value set {2, 3, 4, 5, 6, 7, 8} | Mandatory with UE capability at least for FR2 |
|  | 2-27 | Beam switching | 1. Maximum number of Tx + Rx beam changes a UE can conduct during a slot across the whole band CC $B\_{B\\_Total,}$. This number is defined as per SCSNote: it is assumed that spec enable the possibility to restrict the same beam across intra-band CCsNote: this FG is not applicable to FR1 | *maxNumberRxTxBeamSwitchDL* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A |  | Optional with capability signaling Candidate value set: {4, 7, 14} |  |
|  | 2-28 | A-CSI-RS beam switching timing | 1. Minimum time between the DCI triggering of AP-CSI-RS and aperiodic CSI-RS transmission shall be at least KBi symbols. (Symbols measured from last symbol containing the indication to first symbol of CSI-RS), where*i* is the index of SCS, l=1,2 corresponding to 60,120 kHz SCS. | *beamSwitchTiming* | *MIMO-ParametersPerBand* | Type1 | N.A. | N.A. | [Note: any value larger than 56 is not supported in RRC configuration now. ] | Optional with capability signalingOnly applicable to FR2Candidate values:{14, 28, 48, 224, 336}  |  |
|  | 2-29 | Non-group based beam reporting | 1. Support of non-group based RSRP reporting with N\_max RSRP values reported  | *maxNumberNonGroupBeamReporting* | *MIMO-ParametersPerBand* | Type1 | N.A | N.A. |  | Mandatory with capability for both FR1 and FR2candidate value set is {1, 2,4} | candidate value set is {1, 2,4} at least for FR2FFS: for FR1 |
|  | 2-29a | Group based beam reporting | 1. Support of beam group RSRP reporting for group of 2 beams  | *groupBeamReporting* | *MIMO-ParametersPerBand* | Type1 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 2-30 | Uplink beam management | 1 Support of SRS based beam management 2. Supported max number of SRS resource per set (SRS set use is configured as for beam management).3. Supported max number of SRS resource sets (SRS set use is configured as for beam management). | *uplinkBeamManagement {**1. maxNumberSRS-ResourcePerSet-BM**2. maxNumberSRS-ResourceSet**}* | *MIMO-ParametersPerBand* | Type1 | N.A. | N.A. | Note: Component-3 also impose additional constraint on the maximum number of SRS resource sets per supported time domain behavior (periodic/semi-persistent/aperiodic) as {1,1,1,2,2,2,4,4} corresponding to reported values {from 1 to 8} | Component-2, candidate value set is {2, 4, 8, 16} Component-3, candidate value set is {from 1 to 8} | [Mandatory/Optional] with capability signaling Component-2, candidate value set is {2, 4, 8, 16} Component-3, candidate value set is {from 1 to 8} |
|  | 2-31 | Beam failure recovery | 1. Maximal number of CSI-RS resources across all CCs for UE to monitor PDCCH quality 2. Maximal number of different SSBs across all CCs for UE to monitor PDCCH quality 3. Maximal number of different CSI-RS and/or SSB resources across all CCs for new beam identifications.  | *1. maxNumberCSI-RS-BFR**2. maxNumberSSB-BFR**3. maxNumberCSI-RS-SSB-BFR* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Component-1 candidate value set: {from 1 to 16} Component-2 candidate: {from 1 to 16} Component-3:Candidate value set is: {from 1 to 128}[UE is mandate to support at least 64.]  |  |
|  | 2-32 | Basic CSI feedback | 1. Type I single panel codebook based PMI (further discuss which mode or both to be supported as mandatory) 2. 2Tx codebook for FR1 and FR2 3. 4Tx codebook for FR14. 8Tx codebook for FR1 when configured as wideband CSI report5. p-CSI on PUCCH formats over 1 – 2 OFDM symbols once per slot (or piggybacked on a PUSCH)6. p-CSI report on PUCCH formats over 4 – 14 OFDM symbols once per slot (or piggybacked on a PUSCH)7. a-CSI on PUSCH (at least Z value >= 14 symbols, detail processing time to be discussed separately) further check a-CSI on p-CSI-RS and/or SP-CSI-RS from component-7 | *N.A* | *N.A* | N.A. | N.A. | N.A. |  | Mandatory without UE capability | Mandatory without capability signaling |
|  | 2-32a | Semi-persistent CSI report on PUCCH | 1. Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot(or piggybacked on a PUSCH) s2. Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot (or piggybacked on a PUSCH) | *sp-CSI-ReportPUCCH* | *Phy-ParametersCommon* | Type 4 | No | No |  | Optional | Optional with capability signaling |
|  | 2-32b | Semi-persistent CSI report on PUSCH | 1. Support report on PUSCH  | *sp-CSI-ReportPUSCH* | *Phy-ParametersCommon* | Type 4 | No | No |  | Optional | Optional with capability signaling |
|  | 2-33 | CSI-RS and CSI-IM reception for CSI feedback | 1. Supported max # of configured NZP-CSI-RS resources per CC, 2. Supported max # of ports across all configured NZP-CSI-RS resources per CC3. Supported max # of configured CSI-IM resources per CC4. Supported max # simultaneous NZP-CSI-RS resources in active BWPs across all CCs4a. Supported max # simultaneous NZP-CSI-RS resources per CC5. Supported max total # of CSI-RS ports in simultaneous NZP-CSI-RS resources in active BWPs across all CCs5a. Supported max total # of CSI-RS ports in simultaneous NZP-CSI-RS resources per CC | *csi-RS-IM-ReceptionForFeedback {**1. maxConfigNumberNZP-CSI-RS-PerCC**2. maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC**3. maxConfigNumberCSI-IM-PerCC**4a. maxNumberSimultaneousNZP-CSI-RS-PerCC**5a. totalNumberPortsSimultaneousNZP-CSI-RS-PerCC**}* | *MIMO-ParametersPerBand**Phy-ParametersFRX-Diff (for FR1 + FR2 band combination)* | Type 3 | N.A. | N.A. | Note: all the candidate values are the range of capability signaling which doesn’t determine whether UE is mandatory to support all the signaling values.  | Mandatory with capability signalingComponent-1 candidate values: {from 1 to 32} Component-2 candidate values: {2, 4, 8, 12, 16, 24, 32, 40, 48 … ,256} Component-3: candidate values: {1,2,4,8,16,32}Component-4: candidate values {5, 6, 7, 8, 9, 10, 12, 14, 16, …, 62, 64} (includes all even numbers between 16 and 64)Component-4a: candidate values {1, 2, 3 … 32}Component-5: candidate values {8, 16, 24, …, 248, 256}Component-5a: candidate values {8, 16, 24, … 128 } |  |
| *4. maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC**5. totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC* | *CA-ParametersNR* |
|  | 2-33a | Supported PDSCH RE-mapping patterns | 1. Supported max # of RE mapping patterns, each pattern can be described as a resource (including NZP/ZP CSI-RS and CRS, CORESET and SSB and bitmap configured in 5-26/27)Note: patterns are counted as per symbol per CC 2. Supported max # of RE mapping patterns, each pattern can be described as a resource (including NZP/ZP CSI-RS and CRS, CORESET and SSB and bitmap configured in 5-26/27/27a)Note: patterns are counted as per slot per CC | *1. pdsch-RE-MappingFR1-PerSymbol**2. pdsch-RE-MappingFR2-PerSymbol**3. pdsch-RE-MappingFR1-PerSlot**4. pdsch-RE-MappingFR2-PerSlot* | *Phy-ParametersFR1**Phy-ParametersFR2* | Type 4 | No need | Yes |  | Mandatory with capability signalingcandidate values: {10, 20} for FR1{6, 20} for FR2Compponent-2 candidate values: {from 16: 16: 256 } for FR1{16: 16: 256} for FR2 |  |
|  | 2-33b(New FG) | SP CSI-RS  | 1. Support SP CSI-RS | *sp-CSI-RS* | *Phy-ParametersFRX-Diff* | Type 4 | No | Yes |  |  | Mandatory with capability signaling |
|  | 2-33c(New FG) | SP CSI-IM | 2. Support SP CSI-IM  | *sp-CSI-IM* | *Phy-ParametersFRX-Diff* | Type 4 | No | Yes |  |  | Optional with capability signaling |
|  | 2-34 | NZP-CSI-RS based interference measurement | 1. Support NZP-CSI-RS based interference measurement  | *nzp-CSI-RS-IntefMgmt* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Optional with capability signaling  |  |
|  | 2-35 | CSI report framework  | 1. Maximum number of periodic CSI report setting per BWP for CSI report1a. Maximum number of periodic CSI report setting per BWP for beam report2. Maximum number of aperiodic CSI report setting per BWP for CSI report2a. Maximum number of aperiodic CSI report setting per BWP for beam report2b. Maximum number of configured aperiodic CSI triggering states in CSI-AperiodicTriggerStateList per CC, 3. Maximum number of semi-persistent CSI report setting per BWP for CSI report3a. Maximum number of semi-persistent CSI report setting per BWP for beam report4. UE can process Y CSI report(s) simultaneously in a CC. CSI reports can be P/SP/A CSI and any latency class and codebook type.5. UE can process X CSI report(s) simultaneously across all CCs. CSI reports can be P/SP/A CSI and any latency class and codebook type.  | *csi-ReportFramework {**1. maxNumberPeriodicCSI-PerBWP-ForCSI-Report**1a. maxNumberPeriodicCSI-PerBWP-ForBeamReport**2. maxNumberAperiodicCSI-PerBWP-ForCSI-Report**2a. maxNumberAperiodicCSI-PerBWP-ForBeamReport**2b. maxNumberAperidicCSI-triggeringStatePerCC**3. maxNumberSemiPersistentCSI-PerBWP-ForCSI-Report**3a. maxNumberSemiPersistentCSI-PerBWP-ForBeamReport**4. simultaneousCSI-ReportsPerCC**}* | *MIMO-ParametersPerBand**Phy-ParametersFRX-Diff (for FR1 + FR2 band combination)* | Type 3 | N.A. | N.A. | NOTE: Other MIMO capability other than component 5 may further restrict (reduce) the number of simultaneously CSI report that UE is required to updateNote: The CSI report in component 4 includes the beam report and CSI reportNote: The CSI report in component 5 includes the beam report and CSI report Note: each component is independentNote: CSI report setting are counted in the CC indicated by the parameter carrier in CSI-ResourceConfig. | Mandatory with capabilityComponent-1 candidate values: {1, 2, 3, 4}Component-2 candidate values {1, 2, 3, 4}Component-2b candidate values {3, 7, 15, 31, 63, 128}Component-3 candidate values: {0, 1, 2, 3, 4}~~Component-4: signaling is a bitmap of size 8~~ Component-4candidate values: {from 1 to 8}Component-5:candidate values: {from 5 to 32} | Component-1 candidate values: {1, 2, 3, 4}Component-1a candidate values: {1, 2, 3, 4}Component-2 candidate values {1, 2, 3, 4}Component-2a candidate values {1, 2, 3, 4}Component-3 candidate values: {0, 1, 2, 3, 4}Component-3a candidate values: {0, 1, 2, 3, 4}Component-4candidate values: {from 1 to 8}Component-5:candidate values: {from 5 to 32}FFS: whether some minimum values above can be mandated or not |
| *5. simultaneousCSI-ReportsAllCC*  | *CA-ParametersNR* |
|  | 2-36 | Type I single panel codebook  | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously. Note: the above list doesn’t differentiate the latency class and feedback type.2. Supported Codebook Mode(s)3. Max # of CSI-RS resource in a resource set  | *1. SupportedCSI-RS-Resource {**1.1. maxNumberTxPortsPerResourcePerBand**1.2. maxNumberResourcesPerBand**1.3. totalNumberTxPortsPerBand**}**2. modes**3. maxNumberCSI-RS-PerResourceSet* | *CodebookParameters* | Type 3 | No need |  | Note: simultaneously doesn’t mean in the same slotNote: for the purpose component-1 calculation: CSI-RS resources and CSI-RS ports within one CSI-RS resource are counted N times if the CSI-RS resource is referred by N report settings | Mandatory with capability signaling Component-1: Maximum size of the list is 16. the candidate values for the max # of Tx port in one resource is {2, 4, 8, 12, 16, 24, 32}The candidate value set of the max # of resources is:{from 1 to 64}The candidate value set of total # of ports (including both channel and NZP-CSI-RS based interference measurement) is:{from 2 to 256}Component-2 candidate values: {“Mode-1 only”, “Mode-1 and Mode-2”}. Component-3 Candidate values set: {1:8} |  |
| *1.2. maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC**1.3. totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC* | *CA-ParametersNR* |
|  | 2-37 | Support Semi-open loop CSI | 1. Support Semi-open loop CSI report | *semiOpenLoopCSI* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling  |
|  | 2-38 | CSI report without PMI | Support CSI report without PMI | *csi-ReportWithoutPMI* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | RAN1 to clarify whether it depends on SRS Tx switch |  | [Mandatory/Optional] with capability signaling  |
|  | 2-39a | CSI report without CQI | Support CSI report without CQI | *csi-ReportWithoutCQI* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  |  2-40 | Type I multi-panel codebook | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously. Note: the above list doesn’t differentiate the latency class and feedback type.2. Supported Codebook Mode(s): 3. Supported number of panels, Ng4. Max # of CSI-RS resource in a resource set  | *1. SupportedCSI-RS-Resource {**1.1. maxNumberTxPortsPerResourcePerBand**1.2. maxNumberResourcesPerBand**1.3. totalNumberTxPortsPerBand**}**2. modes**3. nrofPanels**4. maxNumberCSI-RS-PerResourceSet* | *CodebookParameters* | Type 3 | N.A. | N.A. | Note: simultaneously doesn’t mean in the same slotNote: for the purpose component-1 calculation: CSI-RS resources and CSI-RS ports within one CSI-RS resource are counted N times if the CSI-RS resource is referred by N report settings | Optional with capability signaling Component-1: Maximum size of the list is 16. the candidate values for the max # of Tx port in one resource is {8, 16, 32}The candidate value set of the max # of resources is:{from 1 to 64}The candidate value set of total # of ports (including both channel and NZP-CSI-RS based interference measurement) is:{from 2 to 256}Component-2 candidate values: Component-2 candidate values: {Mode-1, Mode-2, both}Component-3:Candidate value: {2,4} Component-4: candidate value set is {1:8} | Optional with capability signaling |
| *1.2. maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC**1.3. totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC* | *CA-ParametersNR* |
|  | 2-41 | Type II codebook  | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously. Note: the above list doesn’t differentiate the latency class and feedback type.2. Parameter “Lx” (number of beams) in codebook generation, where x is index of Tx ports, corresponding to 4,8,12,16,24 and 32 ports. 3. Support amplitude scaling type 4. Support amplitude subset restriction level~~5. Max # of CSI-RS resource in a resource set~~ | *1. SupportedCSI-RS-Resource {**1.1. maxNumberTxPortsPerResourcePerBand**1.2. maxNumberResourcesPerBand**1.3. totalNumberTxPortsPerBand**}**2. parameterLx**3. amplitudeScalingType**4. amplitudeSubsetRestriction*  | *CodebookParameters* | Type 3 | N.A. | N.A. | Note: simultaneously doesn’t mean in the same slotNote: for the purpose component-1 calculation: CSI-RS resources and CSI-RS ports within one CSI-RS resource are counted N times if the CSI-RS resource is referred by N report settings | Optional with capability signaling Component-1: Maximum size of the list is 16. the candidate values for the max # of Tx port in one resource is {4, 8, 12, 16, 24, 32}The candidate value set of the max # of resources is:{from 1 to 64}The candidate value set of total # of ports (including both channel and NZP-CSI-RS based interference measurement) is:{from 2 to 256}Component-2, candidate values {2,3,4}Component-3, candidate values set: {wideband, wideband/subband}Component-4, candidate value set: {“no amplitude subset restriction”, “support amplitude subset restriction”}Component-5: candidate value set is {1:8} |  |
| *1.2. maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC**1.3. totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC* | *CA-ParametersNR* |
|  | 2-42 | Support Type II SP-CSI feedback on long PUCCH | 1.Support type II SP-CSI feedback part-1 on PUCCH formats over 4 – 14 OFDM symbols once per slot | *type2-SP-CSI-Feedback-LongPUCCH* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | [Optional] | Optional with capability signaling |
|  | 2-43 | Type II codebook with port selection | 1. A list of supported combinations, each combination is {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} across all CCs simultaneously. Note: the above list doesn’t differentiate the latency class and feedback type.2. Parameter “Lx” (number of selected ports) in codebook generation, where x is index of Tx ports, corresponding to 4,8,12,16,24 and 32 ports. 3. Support amplitude scaling type ~~4. Max # of CSI-RS resource in a resource set~~ | *1. SupportedCSI-RS-Resource {**1.1. maxNumberTxPortsPerResourcePerBand**1.2. maxNumberResourcesPerBand**1.3. totalNumberTxPortsPerBand**}**2. parameterLx**3. amplitudeScalingType**4. amplitudeSubsetRestriction*  | *CodebookParameters* | Type 3 | N.A. | N.A. | Note: simultaneously doesn’t mean in the same slotNote: for the purpose component-1 calculation: CSI-RS resources and CSI-RS ports within one CSI-RS resource are counted N times if the CSI-RS resource is referred by N report settings | Optional with capability signaling Component-1: Maximum size of the list is 16. the candidate values for the max # of Tx port in one resource is {4, 8, 12, 16, 24, 32}The candidate value set of the max # of resources is:{from 1 to 64}The candidate value set of total # of ports (including both channel and NZP-CSI-RS based interference measurement) is:{from 2 to 256}Component-2, candidate values set for “Lx” is {2,3,4}Component-3, candidate values set: {wideband, wideband/subband}Component-4: candidate value set is {1:8} |  |
| *1.2. maxNumberSimultaneousNZP-CSI-RS-ActBWP-AllCC**1.3. totalNumberPortsSimultaneousNZP-CSI-RS-ActBWP-AllCC* | *CA-ParametersNR* |
|  | 2-44 | Basic DL PTRS | Support 1 port of PTRS | *onePortsPTRS (MSB)* | *Phy-ParametersFRX-Diff* | Type 4 | N.A. | Yes |  | Mandatory with UE capability signaling for FR2Optional for FR1 | Mandatory with UE capability signaling for FR2Optional for FR1 |
|  | 2-46 | Downlink PTRS density recommendation | 1. Preferred threshold sets, TSi for determine PTRS density, candidate value range is the same as that of downlink PTRS RRC configuration. *i* is the index of SCS, *i*=1,2,3,4 corresponding to 15,30,60,120 kHz SCS. | *ptrs-DensityRecommendationSetDL {**1. frequencyDensity1**2. frequencyDensity2**3. timeDensity1**4. timeDensity2**5. timeDensity3**}* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | OptionalFor each TSi, it composes of two values each selected from {1..276} for frequency density, and three values each selected from {0..29} for time density  | Optional with capability signaling  |
|  | 2-47 | Basic UL PTRS | Support 1 port of PTRS  | *onePortsPTRS (LSB)* | *Phy-ParametersFRX-Diff* | Type 4 | N.A. | Yes |  | Mandatory with UE capability signaling for FR2Optional with UE capability signaling for FR1 | Mandatory with UE capability signaling for FR2 |
|  | 2-48 | Uplink PTRS | 1. Supported 2 ports of PTRS | *twoPortsPTRS-UL* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | Optional  | Optional with capability signaling  |
|  | 2-49 | Uplink PTRS density recommendation | 1. Preferred threshold sets, TSi , for determine PTRS density, candidate value range is the same as that of uplink PTRS RRC configuration.*i* is the index of SCS, *i*=1,2,3,4 corresponding to 15,30,60,120 kHz SCS.  | *ptrs-DensityRecommendationSetUL {**1. frequencyDensity1**2. frequencyDensity2**3. timeDensity1**4. timeDensity2**5. timeDensity3**6. sampleDensity1**7. sampleDensity2**8. sampleDensity3**9. sampleDensity4**10. sampleDensity5**}* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | OptionalFor each TSi, it composes of two values each selected from {1..276} for frequency density, and three values each selected from {0..29} for time density, and five values each selected from {1..276} for sample density | Optional with capability signaling  |
|  | 2-50 | Basic TRS | 1. Support of TRS (mandatory)2. All the periodicity are supported.3. Support TRS bandwidth configuration as both “BWP” and “min(52, BWP)” | *N.A* | *N.A* | N.A. | N.A. | N.A. | Note: TRS bandwidth configuration does not imply UE processing bandwidth | Mandatory without UE capability signaling | Mandatory without capability signaling |
|  | 2-51 | TRS***(CSI-RS for tracking)*** | ~~1. Support TRS BW~~2. TRS burst length (X), 3. Max # of TRS resource sets (per CC) UE is able to track simultaneously4. Max # of TRS resource sets configured to UE per CC5. Max # of TRS resource sets configured to UE across CCs | *csi-RS-ForTracking {**1. burstLength**2. maxSimultaneousResourceSetsPerCC**3. maxConfiguredResourceSetsPerCC**4. maxConfiguredResourceSetsAllCC**}* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. |  | ~~Component-1:~~ ~~candidate values set: {BWP, min(52,BWP), both}~~Mandatory with capability signalingComponent-2:candidate values {1 , ”both 1 and 2”}. UE is mandated to report “both 1 and 2”Component-3: Candidate value set: {1 to 8}Component-4: Candidate value set: {1 to 64} UE is mandated to report at least 8 for FR1 and [8 or 16 or 32] for FR2. To be decided in plenary. Component-5: Candidate value set: {1 to 128} to be decided in plenaryUE is mandated to report at least X for FR1 and Y for FR2. X and Y are to be decided in plenary.  |  |
|  | 2-51a(new added FG) | Aperiodic TRS  | DCI triggering Aperiodic TRS associated with periodic TRS | *aperiodicTRS* | *MIMO-ParametersPerBand* | Type 1 | N.A. | Yes |  | Optional with capability signaling  | Optional with capability signaling |
|  | 2-52 | Basic SRS | 1. Support 1 port SRS transmission2. Support periodic/aperiodic SRS transmission3. Support SRS Frequency intra/inter-slot hopping within BWP4. At least one SRS resource per CC for aperiodic and periodic separately | *N.A* | *N.A* |  |  |  |  | Mandatory without UE capability | Mandatory without capability signaling |
|  | 2-53 | 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 slot3. Maximum number of periodic SRS resources (configured to UE) per BWP4. Maximum number of periodic SRS resources (configured to UE) per BWP per slot5. Maximum number of semi-persistent SRS resources (configured to UE) per BWP6. Maximum number of semi-persistent SRS resources (configured to UE) per BWP per slot7. Maximum number of SRS port per resource  | *supportedSRS-Resources {**1. maxNumberAperiodicSRS-PerBWP**2. maxNumberAperiodicSRS-PerBWP-PerSlot**3. maxNumberPeriodicSRS-PerBWP**4. maxNumberPeriodicSRS-PerBWP-PerSlot**5. maxNumberSemiPersitentSRS-PerBWP**6. maxNumberSP-SRS-PerBWP-PerSlot**7. maxNumberSRS-Ports-PerResource**}* | *FeatureSetUplink* | Type 3 | N.A. | N.A. |  | Mandatory with capability signaling 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, 4}Support SP-SRS is mandatory with capability |  |
|  | 2-55 | SRS Tx switch | 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  | *srs-TxSwitch {**1. supportedSRS-TxPortSwitch**2. txSwitchImpactToRx**3. txSwitchWithAnotherBand**}* | *BandParameters* | Type 3 | N.A. | N.A. | Component-2 is agreed with conditioned to RAN4’s decision.—Component-2 is per band pair per band combinationNote that Component-3 is per band pair per band combinationNote that the band pair in Component-2 and Component-3 can be an LTE band and an NR band | Mandatory with capability signalingComponent-1 is a list of TRx pairs, candidates are {“Not supported”, “1T2R”, “1T4R”, “2T4R”, “1T4R/2T4R”, “1T=1R”, “2T=2R”, “4T=4R”}Note: 2T4R is 2 pairs of antennasComponent-2: Candidate value set:, {yes, no},Note: “R” refers to a subset/set of receive antennas for PDSCH; “T” refers to the SRS antennas used for DL CSI acquisitionComponent-3: Candidate value set:, {yes, no}, | [Mandatory/Optional] with capability signalingComponent-1 is a list of TRx pairs, candidates are {“1T2R”, “1T4R”, “2T4R”, “1T4R/2T4R”, “T=R”}Component-2: Candidate value set:, {yes, no}, |
|  | 2-56 | SRS carrier switch | 1. Report inter-cell switching time capability | *srs-SwitchingTimesListNR**srs-SwitchingTimesListEUTRA* | *BandParameters* | Type 1 | No need | N.A.  | RAN4 reply LS, R1-1805817, includes candidate value sets | Optional with capability signaling candidate values set is up to RAN4 |  |
|  | 2-58 | For SRS for CB PUSCH and antenna switching on FR1, zero slot offset for aperiodic SRS transmission | For SRS for CB PUSCH and antenna switching on FR1, support of zero slot offset between aperiodic SRS triggering and transmission | *zeroSlotOffsetAperiodicSRS* | *FeatureSetUplink* | Type 3 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 2-59 | Configured spatial relations | Maximum number of configured spatial relations per CC for PUCCH and SRS | *spatialRelations {**1. maxNumberConfiguredSpatialRelations**2. maxNumberActiveSpatialRelations**3. additionalActiveSpatialRelationPUCCH**4. maxNumberDL-RS-QCL-TypeD**}* | *MIMO-ParametersPerBand* | Type 1 | N.A. | N.A. | Note: Only applicable for FR2 | candidate value set: {4, 8, 16, 32, 64, 96} |  |
|  | 2-60 | Active spatial relations | Maximum total number of {unique DL RS (except for aperiodic NZP CSI-RS) and SRS without spatial relation configured, and, TCI states available for DCI triggering of aperiodic NZP CSI-RS}, for indicating spatial domain transmit filter for PUCCH and SRS for PUSCH, per BWP per CC | Type 1 | N.A. | N.A. | Note: Only applicable for FR2FFS whether DL RS in the active TCI states and the active spatial relation info can be different if 2-60 is set to 1 and if different whether or not new UE behavior is needed | Candidate value set: {1, 2, 4, 8, 14} |  |
|  | 2-61 | Additional active spatial relation for PUCCH | Support one additional active spatial relation for PUCCH | Type 1  | N.A.  | N.A. | Note: Only applicable if 2-20b is set to 1 | Mandatory with capability signaling  | Mandatory with capability signaling  |
|  | 2-62 | Max number of downlink RS resources used for QCL type-D in the active TCI states and active spatial relation info | Max number of downlink RS resources in the active TCI states and active spatial relation info per CCNote: Reference relationship follows 2-4/2-60 | Type 1 | N.A | N.A. |  | Optional with capability signaling Candidate value set: {1,2,4,8, 14} |  |
| 3.DL control channel and procedure | 3-1 | Basic DL control channel | 1) One configured CORESET per BWP per cell in addition to CORESET0- CORESET resource allocation of 6RB bit-map and duration of 1 – 3 OFDM symbols for FR1- For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSSs, CORESET resource allocation of 6RB bit-map and duration 1-3 OFDM symbols for FR2- For type 1 CSS with dedicated RRC configuration and for type 3 CSS, UE specific SS, CORESET resource allocation of 6RB bit-map and duration 1-2 OFDM symbols for FR2- REG-bundle sizes of 2/3 RBs or 6 RBs- Interleaved and non-interleaved CCE-to-REG mapping- Precoder-granularity of REG-bundle size - PDCCH DMRS scrambling determination- TCI state(s) for a CORESET configuration2) CSS and USS configurations for unicast PDCCH transmission per BWP per cell- PDCCH aggregation levels 1, 2, 4, 8, 16- UP to 3 search space sets in a slot for a scheduled SCell per BWPThis search space limit is before applying all dropping rules. - For type 1 with dedicated RRC configuration, type 3, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot- For type 1 PDCCH CSS without dedicated RRC configuration and for type 0, 0A, and 2 PDCCH CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1-PDCCH CSS without dedicated RRC configuration, or Types 0, 0A, or 2 PDCCH-CSS configurations within a single span of three consecutive OFDM symbols within a slot3) Monitoring DCI formats 0\_0, 1\_0, 0\_1, 1\_14) Number of PDCCH blind decodes per slot with a given SCS follows Case 1-1 table5) Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per slot per scheduled CC for FDD6) Processing one unicast DCI scheduling DL and 2 unicast DCI scheduling UL per slot per scheduled CC for TDD | *N.A* | *N.A* | N.A. | N.A. | N.A |  | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 3-1’ | For type 1 CSS with dedicated RRC configuration and for type 3 CSS, UE specific SS, CORESET resource allocation of 6RB bit-map and duration 3 OFDM symbols for FR2 |  | *type1-3-CSS* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 3-2 | PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot | - For a given UE, all search space configurations are within the same span of 3 consecutive OFDM symbols in the slot | *pdcchMonitoringSingleOccasion* | *Phy-ParametersFR1* | Type 4 | No need | Applicable only to FR1 |  | [Optional with capability signaling] | Optional with capability signaling |
|  | 3-3 | More than one CORESET configurations per BWP in addition to CORESET0 |  | *multipleCORESET* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | Whether/How to differentiate FR1 and FR2 is up to RAN2 | Optional with capability signaling for FR1Mandatory with capability signaling for FR2 | Optional with capability signaling for FR1Mandatory with capability signaling for FR2 |
|  | 3-4 | More than one TCI state configurations per CORESET |  | *multipleTCI* | *BandNR* | Type 1 | N.A. | N.A. | UE is only required to track one active TCI state per CORESETUE is required to support minimum between 64 and number of configured TCI states in 2-4 component 2). | Optional with capability signaling | Mandatory with capability signaling which shall be set to ‘1’ |
|  | 3-5 | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 |  | *pdcch-MonitoringAnyOccasions* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 3-5a | For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS,, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a DCI gap | For type 1 CSS with dedicated RRC configuration, type 3 CSS and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2, with minimum time separation (including the cross-slot boundary case) between two DL unicast DCIs , between two UL unicast DCIs, or between a DL and an UL unicast DCI in different monitoring occasions for a same UE as* 2OFDM symbols for 15kHz
* 4OFDM symbols for 30kHz
* 7OFDM symbols for 60kHz with NCP
* 14OFDM symbols for 120kHz

In addition for TDD the minimum separation between the first two UL unicast DCIs in the first monitoring occasion within the first 3 OFDM symbols of a slot can be zero OFDM symbols. | Type 3 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 3-5b |  All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a span gap | All PDCCH monitoring occasion can be any OFDM symbol(s) of a slot for Case 2, and for any two PDCCH monitoring occasions in same or different search spaces, there is a minimum time separation of X OFDM symbols (including the cross-slot boundary case) between the start of two spans, where each span is of length up to Y consecutive OFDM symbols in which PDCCH is configured to be monitored.For the set of monitoring occasions which are within the same span:* Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD
* Processing one unicast DCI scheduling DL and two unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD
* Processing two unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD
 | Type 3 | N.A.  | N.A. | This capability is necessary for each SCS. | Optional with capability signalingCandidate value set for (X, Y):{[(7, 3)], [(4, 3) and (7, 3)], [(2, 2) and (4, 3) and (7, 3)]} | Optional with capability signaling |
|  | 3-6 | Dynamic SFI monitoring  | 1) Adjust periodic and semi-persistent signal reception and transmission in response to detected dynamic UL/DL configuration | *dynamicSFI* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes | Yes |  | [Optional with capability signaling] | Optional with capability signaling |
|  | 3-7 | Precoder-granularity of CORESET size |  | *precoderGranularityCORESET* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Optional with capability signaling | Optional with capability signaling |
|  | 3-8 | Up to 10 search spaces in a Scell | Up to 10 search spaces in a slot in a SCell per BWP.  | *maxNumberSearchSpaces* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Optional with capability signaling |  |
| 4.UL control channel and procedure | 4-1 | Basic UL control channel | 1) PUCCH format 0 over 1 OFDM symbols once per slot 2) PUCCH format 0 over 2 OFDM symbols once per slot with frequency hopping as “enabled”3) PUCCH format 1 over 4 – 14 OFDM symbols once per slot with intra-slot frequency hopping as “enabled”5) One SR configuration per PUCCH group6) HARQ-ACK transmission once per slot with its resource/timing determined by using the DCI7)SR/HARQ multiplexing once per slot using a PUCCH (or piggybacked on a PUSCH) when SR/HARQ-ACK are supposed to be sent by overlapping PUCCH resources with the same starting symbols in a slot8) HARQ-ACK piggyback on PUSCH9) Semi-static beta-offset configuration for HARQ-ACK10) Single group of overlapping PUCCH/PUCCH and overlapping PUCCH/PUSCH s per slot per PUCCH cell group for control multiplexing | *N.A* | *N.A* | N.A. | N.A. | N.A. | RAN4 to check feasibility of frequency hopping for PUCCH formats for FR2 | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 4-2 | 2 PUCCH of format 0 or 2 in consecutive symbols | 1) 2 PUCCH format 0/2 in different symbols and once per slot for HARQ-ACK, 2) 2 PUCCH format 0 in different symbols and once per slot for SR 3) 2 PUCCH format 2 in different symbols and once per slot for CSI over two consecutive OFDM symbols | *twoPUCCH-F0-2-ConsecSymbols* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes | Yes |  |  | Optional with capability signaling |
|  | 4-3 | PUCCH format 2 over 1 – 2 OFDM symbols once per slot with frequency hopping as “enabled” |  | *pucch-F2-WithFH* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | Note: RAN1 to check consistency with 2-32 | Mandatory with capability signaling which shall be set to ‘1’ | Mandatory with capability signaling which shall be set to ‘1’ |
|  | 4-4 | PUCCH format 3 over 4 – 14 OFDM symbols once per slot with frequency hopping as “enabled” |  | *pucch-F3-WithFH* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | Note: RAN1 to check consistency with 2-32 | Mandatory with capability signaling which shall be set to ‘1’ | Mandatory with capability signaling which shall be set to ‘1’ |
|  | 4-5 | PUCCH format 4 over 4 – 14 OFDM symbols once per slot with frequency hopping as “enabled”  |  | *pucch-F4-WithFH* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | Note: RAN1 to check consistency with 2-32 | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 4-6 | Non-frequency hopping for PUCCH formats 0 and 2 with frequency hopping as “disabled” |  | *freqHoppingPUCCH-F0-2* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | [Optional with capability signaling] | Mandatory with capability signaling |
|  | 4-7 | Non-frequency hopping for PUCCH format 1, 3, and 4 with frequency hopping as “disabled” |  | *freqHoppingPUCCH-F1-3-4* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | [Optional with capability signaling] | Mandatory with capability signaling |
|  | 4-10 | Dynamic HARQ-ACK codebook |  | *dynamicHARQ-ACK-Codebook* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Mandatory with capability signaling  | Mandatory with capability signaling which shall be set to ‘1’ |
|  | 4-11 | Semi-static HARQ-ACK codebook |  | *semiStaticHARQ-ACK-Codebook* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 4-12 | HARQ-ACK spatial bundling for PUCCH or PUSCH per PUCCH group |  | *spatialBundlingHARQ-ACK* | *Phy-ParametersCommon* | Type 4 | No need | No need | Applicable to UE supporting more than 4 layers | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 4-13 | More than one SR configurations per PUCCH group |  | *multipleSR-Configurations* | *MAC-ParametersXDD-Diff* | Type 4 | No need | Yes | RAN2 to check | Optional with capability signaling | Optional with capability signaling |
|  | 4-19 | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same starting symbol in a slot | Overlapping PUCCH resources have the same starting symbols in a slot while precluding the case of SR/HARQ-ACK by overlapping PUCCH resources with the same starting symbols in a slot | *sameSymbol in mux-SR-HARQ-ACK-CSI-PUCCH-OncePerSlot* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 4-19a | SR/HARQ-ACK multiplexing once per slot using a PUCCH (or piggybacked on a PUSCH) when SR/HARQ-ACK are supposed to be sent with different starting symbols in a slot | Overlapping PUCCH resources have different starting symbols in a slot | *mux-SR-HARQ-ACK-PUCCH* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 4-19b | SR/HARQ-ACK/CSI multiplexing more than once per slot using a PUCCH (or piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with the same or different starting symbol in a slot | Overlapping PUCCH resources have same or different starting symbols in a slot | *mux-SR-HARQ-ACK-CSI-PUCCH-MultiPerSlot* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 4-19c | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or piggybacked on a PUSCH) when SR/HARQ-ACK/CSI are supposed to be sent with different starting symbols in a slot | Overlapping PUCCH resources have different starting symbols in a slot | *diffSymbol in mux-SR-HARQ-ACK-CSI-PUCCH-OncePerSlot* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 4-20 | UCI code-block segmentation  |  | *uci-CodeBlockSegmentation* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 4-21 | Dynamic beta-offset configuration and indication for HARQ-ACK and/or CSI |  | *dynamicBetaOffsetInd-HARQ-ACK-CSI* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 4-22 | 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3, or 4 in the same slot | 1) 1 PUCCH format 0 or 2and 1 PUCCH format 1, 3, and 4 in the same slot | *onePUCCH-LongAndShortFormat* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 4-22a | 2 PUCCH transmissions in the same slot which are not covered by 4-22 and 4-2 |  | *twoPUCCH-AnyOthersInSlot* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 4-23 | Repetitions for PUCCH format 1, 3,and 4 over multiple slots with K = 2, 4, 8 |  | *pucch-Repetition-F1-3-4* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | [Mandatory with capability signaling] | Mandatory with capability signaling |
|  | 4-24 | PUCCH-spatialrelationinfo indication by a MAC CE per PUCCH resource |  | *pucch-SpatialRelInfoMAC-CE* | *BandNR* | Type 1 | N.A. | N.A. |  | Mandatory with capability signaling for FR2Optional with capability signaling for FR1 | Mandatory with capability signaling for FR2Optional with capability signaling for FR1 |
|  | 4-25 | Parallel SRS and PUCCH/PUSCH transmission across CCs in inter-band CA | 1) Parallel SRS and PUCCH/PUSCH transmission across CCs in inter-band CA | *parallelTxSRS-PUCCH-PUSCH* | *CA-ParametersNR* | Type 3 | N.A. | N.A. | This feature is supported only in inter-band CA |  | Optional with capability signaling |
|  | 4-26 | Parallel PRACH and SRS/PUCCH/PUSCH transmissions across CCs in inter-band CA | Parallel PRACH and SRS/PUCCH/PUSCH transmissions across CCs in inter-band CA | *parallelTxPRACH-SRS-PUCCH-PUSCH* | *CA-ParametersNR* | Type 3 | N.A. | N.A. | This feature is supported only in inter-band CA |  | Optional with capability signaling |
|  | 4-27 | More than one group of overlapping channels for control multiplexing | More than one group of overlapping PUCCHs and PUSCHs per slot per PUCCH cell group for control multiplexing | *mux-MultipleGroupCtrlCH-Overlap* | *Phy-ParametersFRX-Diff* | Type 4 | No | Yes |  | Optional with capability signaling |  |
| 5. Scheduling/HARQ operation | 5-1 | Basic scheduling/HARQ operation | 1) Frequency-domain resource allocation- RA Type 0 only and Type 1 only for PDSCH without interleaving- RA Type 1 for PUSCH without interleaving2) Time-domain resource allocation- 1-14 OFDM symbols for PUSCH once per slot- One unicast PDSCH per slot - Starting symbol, and duration are determined by using the DCI- PDSCH mapping type A with 7-14 OFDM symbols- PUSCH mapping type A and type B- For type 1 without dedicated RRC configuration and for type 0, 0A, and 2, PDSCH mapping type A with {4-14} OFDM symbols and type B with {2, 4, 7} OFDM symbols3) TBS determination4) Nominal UE processing time for N1 and N2 (Capability #1)5) HARQ process operation with configurable number of DL HARQ processes of up to 166) Cell specific RRC configured UL/DL assignment for TDD7) Dynamic UL/DL determination based on L1 scheduling DCI with/without cell specific RRC configured UL/DL assignment8) Intra-slot frequency-hopping for PUSCH scheduled by Type 1 before RRC connection 9) In TDD support at most one switch point per slot for actual DL/UL transmission(s)10) DL scheduling slot offset K0=011) DL scheduling slot offset K0=1 for type 1 without dedicated RRC configuration and for type 0, 0A, and 212) UL scheduling slot offset K2<=12For type 1 without dedicated RRC configuration and for type 0, 0A, and 2, interleaving for VRB-to-PRB mapping for PDSCH | *N.A* | *N.A* | N.A. |  |  |  | Mandatory without capability signaling | Mandatory without capability signaling |
|  | 5-1a | UE specific RRC configure UL/DL assignment | Dynamic UL/DL determination based on L1 scheduling DCI with cell-specific and UE specific RRC configured UL/DL assignment | *ue-SpecificUL-DL-Assignment* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. | RAN1 needs to check component |  | Optional with capability signaling |
|  | 5-1b | More than one DL/UL switch point in a slot | In TDD support more than one switch points in a slot for actual DL/UL transmission(s) | *tdd-MultiDL-UL-SwitchPerSlot* | *Phy-ParametersFRX-Diff* | Type 4 | N.A.TDD only | Yes |  |  | Optional with capability signaling |
|  | 5-2 | RA Type 0 for PUSCH |  | *ra-Type0-PUSCH* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-3 | Dynamic switching between RA Type 0 and RA Type 1 for PDSCH |  | *dynamicSwitchRA-Type0-1-PDSCH* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-4 | Dynamic switching between RA Type 0 and RA Type 1 for PUSCH |  | *dynamicSwitchRA-Type0-1-PUSCH* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Optional with capability signaling | Optional with capability signaling |
|  | 5-6 | PDSCH mapping type A with less than 7 OFDM symbols  | For type 1 CSS with dedicated RRC configuration and USS, PDSCH mapping type A with less than 7 OFDM symbols | *pdsch-MappingTypeA* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Mandatory with capability signaling [which shall be set to “1”] | Mandatory with capability signaling which shall be set to “1” |
|  | 5-6a | PDSCH mapping type B |  | *pdsch-MappingTypeB* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 5-7 | Interleaving for VRB-to-PRB mapping for PDSCH |  | *interleavingVRB-ToPRB-PDSCH* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | Mandatory with capability signaling |  |
|  | 5-9 | Intra-slot frequency-hopping for PUSCH except for PUSCH scheduled by Type 1 before RRC connection |  | *intraSlotFreqHopping-PUSCH* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 5-10 | Inter-slot frequency hopping for PUSCH |  | *interSlotFreqHopping-PUSCH* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-11 | Up to 2 unicast PDSCHs per slot for different TBs for UE processing time Capability 1 | Up to 2 unicast PDSCHs per slot only in TDM is supported for Capability 11. PDSCH(s) for Msg. 4 is included
 | *pdsch-ProcessingType1-DifferentTB-PerSlot* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCS |  | Optional with capability signaling |
|  | 5-11a | Up to 7 unicast PDSCHs per slot for different TBs for UE processing time Capability 1 | Up to 7 unicast PDSCHs per slot only in TDM is supported for Capability 11. PDSCH(s) for Msg. 4 is included
 | Type 3 | N.A. | N.A. | This capability is necessary for each SCS |  | Optional with capability signaling |
|  | 5-11b | Up to 4 unicast PDSCHs per slot for different TBs for UE processing time Capability 1 | Up to 4 unicast PDSCHs per slot only in TDM is supported for Capability 11. PDSCH(s) for Msg. 4 is included
 | Type 3 | N.A. | N.A. | This capability is necessary for each SCS |  | Optional with capability signaling |
|  | 5-12 | Up to 2 PUSCHs per slot for different TBs for UE processing time Capability 1 | Up to 2 unicast PUSCHs per slot only in TDM is supported for Capability 1 | *pusch-ProcessingType1-DifferentTB-PerSlot* | *FeatureSetUplink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCS |  | Optional with capability signaling |
|  | 5-12a | Up to 7 PUSCHs per slot for different TBs for UE processing time Capability 1 | Up to 7 unicast PUSCHs per slot only in TDM is supported for Capability 1 | Type 3 | N.A. | N.A. | This capability is necessary for each SCS |  | Optional with capability signaling |
|  | 5-12b | Up to 4 PUSCHs per slot for different TBs for UE processing time Capability 1 | Up to 4 unicast PUSCHs per slot only in TDM is supported for Capability 1 | Type 3 | N.A. | N.A. | This capability is necessary for each SCS |  | Optional with capability signaling |
|  | 5-14 | Type 1 configured PUSCH repetitions over multiple slots | 1) K = 2, 4, 8 times repetitions with RV sequences | *type1-PUSCH-RepetitionMultiSlots* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-16 | Type 2 configured PUSCH repetitions over multiple slots | 1) K = 2, 4, 8 times repetitions with RV sequences | *type2-PUSCH-RepetitionMultiSlots* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-17 | PUSCH repetitions over multiple slots  | 1) K = 2, 4, 8 times repetitions | *pusch-RepetitionMultiSlots* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Mandatory with capability signaling |
|  | 5-17a | PDSCH repetitions over multiple slots  | 1) K = 2, 4, 8 times repetitions | *pdsch-RepetitionMultiSlots* | *Phy-ParametersCommon* | Type 4 | No need |  |  |  | Optional with capability signaling |
|  | 5-18 | DL SPS |  | *downlinkSPS* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-19 | Type 1 Configured UL grant | 1) K = 1 | *configuredUL-GrantType1* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-20 | Type 2 Configured UL grant  | 1) K = 1 | *configuredUL-GrantType2* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-21 | Pre-emption indication for DL |  | *pre-EmptIndication-DL* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-22 | CBG-based re-transmission for DL using CBGTI |  | *cbg-TransIndication-DL* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-23 | CBGFI for CBG-based re-transmission for DL |  | *cbg-FlushIndication-DL* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-24 | Dynamic HARQ-ACK codebook using sub-codebooks for CBG-based re-transmission for DL |  | *dynamicHARQ-ACK-CodeB-CBG-Retx-DL* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-25 | CBG-based re-transmission for UL using CBGTI |  | *cbg-TransIndication-UL* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-26 | Semi-static rate-matching resource set configuration for DL | 1. Bitmap 1/2/3
2. controlResourceSet
 | *rateMatchingResrcSetSemi-Static* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Mandatory with capability signaling |
|  | 5-27 | Dynamic rate-matching resource set configuration for DL | 1. Bitmap 1/2/3
 | *rateMatchingResrcSetDynamic* | *Phy-ParametersCommon* | Type 4 | No need | No need |  |  | Optional with capability signaling |
|  | 5-27a | Dynamic rate-matching control resource set for DL |  | *rateMatchingCtrlResrsSetDynamic* | *Phy-ParametersCommon* | Type 4 | No need | No need |  | [Mandatory with capability signaling] |  |
|  | 5-28 | Rate-matching around LTE CRS |  | *rateMatchingLTE-CRS* | *BandNR* | Type 1 | N.A. | N.A. |  |  | Mandatory with capability signaling |
|  | 5-29 | LBRM for PUSCH | Limited buffer rate matching in UL | *pusch-LBRM* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 5-30 | DL scheduling slot offset greater than zero for PDSCH mapping type A | Support of DL scheduling slot offset (K0) greater than zero for PDSCH mapping type A | *dl-SchedulingOffset-PDSCH-TypeA* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 5-30a | DL scheduling slot offset greater than zero for PDSCH mapping type B | Support of DL scheduling slot offset (K0) greater than zero for PDSCH mapping type B | *dl-SchedulingOffset-PDSCH-TypeB* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes | Yes |  |  | Mandatory with capability signaling |
|  | 5-31 | UL scheduling slot offset greater than 12 | Support of UL scheduling slot offset (K2) greater than 12 | *ul-SchedulingOffset* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 5-32 | Separation of two unicast PDSCHs with a gap | For any two consecutive slots n and n+1, if there are more than 1 unicast PDSCH in either slot, the minimum time separation between starting time of any two unicast PDSCHs within the duration of these slots is 4 OFDM symbol for 30kHz and 7 OFDM symbol for 60kHz  | *pdsch-SeparationWithGap* | *FeatureSetDownlink* | Type 3 | No need | No need | Note: this feature only applies to SCS 30kHz and 60kHz | Optional with capability signaling |  |
|  | 5-33 | Separation of two unicast PUSCHs with a gap | For any two consecutive slots n and n+1, if there are more than 1 unicast PUSCH in either slot, the minimum time separation between starting time of any two unicast PUSCHs within the duration of these slots is 2OFDM symbols for 15kHz, 4 OFDM symbols for 30kHz and 7 OFDM symbols for 60kHz | *pusch-SeparationWithGap* | *FeatureSetUplink* | Type 3 | No need | No need | Note: this feature only applies to SCS 15kHz, 30kHz and 60kHz | Optional with capability signaling |  |
| 6. CA/DC, BWP, SUL | 6-1 | Basic BWP operation with restriction | 1) 1 UE-specific RRC configured DL BWP per carrier2) 1 UE-specific RRC configured UL BWP per carrier3) RRC reconfiguration of any parameters related to BWP4) BW of a UE-specific RRC configured BWP includes BW of CORESET#0 (if CORESET#0 is present) and SSB for Pcell/PScell (if configured) and BW of the UE-specific RRC configured BWP includes SSB for Scell if there is SSB on Scell | *N.A* | *N.A* | N.A. | N.A. | N.A. | This feature should be mandatory without capability signaling for at least BWPs which is the same as the set of specified channel BWRAN4 may discuss other BW requirements.UE-specific RRC configured DL/UL BWP can have the same or different numerology from the initial active DL/UL BWP | Mandatory without capability signaling |  |
|  | 6-1a | BWP operation without restriction on BW of BWP(s) | BW of UE-specific RRC configured BWP may not include BW of the initial DL BWP and SSB for PCell/PScell and BW of BWP may not include SSB for Scell1) BW of UE-specific RRC configured BWP may not include BW of the ~~initial DL BWP~~ CORESET#0 (if CORESET#0 is present) and SSB for PCell/PScell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell | *bwp-WithoutRestriction* | *BandNR* | N.A. | N.A. | N.A. | 6-1a is applicable to 6-1, 6-2, 6-3, or 6-4.It is up to RAN2 how to create signaling for 6-1a associated with 6-1, 6-2, 6-3, and 6-4 |  | Optional with capability signaling |
|  | 6-2 | Type A BWP adaptation with same numerology  | 1) Up to 2 UE-specific RRC configured DL BWPs per carrier2) Up to 2 UE-specific RRC configured UL BWPs per carrier3) Active BWP switching by DCI and timer4) Same numerology for all the UE-specific RRC configured BWPs per carrier5) BW of a UE-specific RRC configured BWP includes BW of the ~~initial DL BWP~~ CORESET#0 (if CORESET#0 is present) and SSB for PCell/PScell (if configured) and BW of the UE-specific RRC configured BWP includes SSB for Scell if there is SSB on Scell | *bwp-SameNumerology* | *BandNR* | Type 1 | N.A | N.A. |  |  | Optional with capability signaling |
|  | 6-3 | Type B BWP adaptation with same numerology | 1) Up to 4 UE-specific RRC configured DL BWPs per carrier2) Up to 4 UE-specific RRC configured UL BWPs per carrier 3) Active BWP switching by DCI and timer4) Same numerology for all the UE-specific RRC configured BWPs per carrier5) BW of a UE-specific RRC configured BWP includes BW of the ~~initial DL BWP~~ CORESET#0 (if CORESET#0 is present) and SSB for PCell/PScell (if configured) and BW of the UE-specific RRC configured BWP includes SSB for Scell if there is SSB on Scell | Type 1 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 6-4 | BWP adaptation with different numerologies | 1) Up to 4 UE-specific RRC configured DL BWPs per carrier2) Up to 4 UE-specific RRC configured UL BWPs per carrier3) Active BWP switching by DCI and timer4) More than one numerologies for the UE-specific RRC configured BWPs per carrier5) Same numerology between DL and UL per cell except for SUL at a given time6) BW of a UE-specific RRC configured BWP includes BW of the ~~initial DL BWP~~ CORESET#0 (if CORESET#0 is present) and SSB for PCell/PScell (if configured) and BW of the UE-specific RRC configured BWP includes SSB for Scell if there is SSB on Scell | *bwp-DiffNumerology* | *BandNR* | Type 1 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 6-5 | Basic DL NR-NR CA operation | 1) Up to16 DL carriers 2) Same numerology across carrier for data/control channel at a given time | *supportedBandCombinationList* | *RF-Parameters* | N.A. | N. A. | N.A. | This is conditioned on the support of DL CA band combination(s). The band combination definition is up to RAN4. |  | Optional with capability signaling |
|  | 6-5a | PDCCH blind detection capability for CA | 1. More than 4 DL CCs
2. Reporting value is one of integer from 4 to 16
 | *pdcch-BlindDetectionCA* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | {4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16} |
|  | 6-6 | Basic UL NR-NR CA operation | 1) Up to16 UL carriers 2) Same numerology across carrier for data/control channel at a given time3) One PUCCH group4) Single TAG | *supportedBandCombinationList* | *RF-Parameters* | N.A. | N.A. | N.A. | This is conditioned on the support of UL CA band combination(s). The band combination definition is up to RAN4. |  | Optional with capability signaling |
|  | 6-7 | Two NR PUCCH group with same numerology | 1) For NR CA UE, same numerology across NR carriers for data/control channel at a given time2) For EN-DC UE, same numerology across NR carriers for data/control channel at a given time, wherein an NR PUCCH group is configured in FR1 and another NR PUCCH group is configured in FR2 | *twoPUCCH-Group* | *FeatureSetUplink* | Type 3 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 6-8 | Different numerology across NR PUCCH groups | 1) For both NR CA UE and EN-DC UE, different numerology between two NR PUCCH groups for data/control channel at a given time | *diffNumerologyAcrossPUCCH-Group* | *CA-ParametersNR* | Type 3 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 6-9 | Different numerologies across NR carriers within the same NR PUCCH group | 1) For both NR CA UE and EN-DC UE, same numerology between DL and UL per carrier for data/control channel at a given time2) For both NR CA UE and EN-DC UE with one NR PUCCH group, different numerologies across NR carriers within the same NR PUCCH groups up to two different numerologies within the same NR PUCCH group for data/control channel at a given time3-1) For NR CA UE with two NR PUCCH groups, different numerologies across NR carriers up to two different numerologies within the same NR PUCCH group wherein NR PUCCH is sent on the carrier with smaller SCS for data/control channel at a given time3-2) For EN-DC UE with two NR PUCCH groups, different numerologies across NR carriers up to two different numerologies within an NR PUCCH group in FR1 wherein NR PUCCH is sent on the carrier with smaller SCS, and same numerology across NR carriers within another NR PUCCH group in FR2 for data/control channel at a given time | *diffNumerologyWithinPUCCH-Group* | *CA-ParametersNR* | Type 3 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 6-10 | Cross carrier scheduling for the same numerology | 1) Cross carrier scheduling for the same numerology with CIF where numerologies for scheduling cell and scheduled cell are same | *crossCarrierScheduling-SameSCS* | *BandNR* | Type 3 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 6-10a | Cross carrier scheduling for different numerologies | 1) Cross carrier scheduling for the different numerologies with CIF where numerologies for scheduling cell and scheduled cell are different | *crossCarrierScheduling-OtherSCS* | *FeatureSetDownlink**FeatureSetUplink* | Type 3,or SCS combination dependent | N.A. | N.A. | This is not supported in Rel-15 |  | Optional with capability signaling |
|  | 6-11 | Number of supported TAGs | Need of multiple capability question about the resolution here | *supportedNumberTAG* | *CA-ParametersNR* | Type 3 | N.A. | N.A. | This feature group is applied to NR-NR CA and EN-DC. For EN-DC, the feature group indicates number of TAGs only for NR CG.* Note: The number of TAGs for the LTE MCG is signalled by existing LTE TAG capability signalling
 |  | {1, 2, 3, 4} |
|  | 6-12 | Support 2 simultaneous UL transmissions for problematic cases |  | *singleUL-Transmission* | *MRDC-Parameters* | Type 3 | N.A. | N.A. | RAN2/4 to decideThis is a UE feature for LTE for a LTE/NR dual connectivity UE |  | Optional with capability signaling |
|  | 6-13 | Case 1 Single Tx UL LTE-NR DC | 1) Case 1: DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-Pcell2) HARQ subframe offset | *tdm-Pattern* | *MRDC-Parameters* | Type 2 | Yes | Yes | This is a UE feature for LTE for a LTE/NR dual connectivity UE |  | Mandatory with capability signaling |
|  | 6-16 | Supplemental uplink | 1) RACH, PUSCH, PUCCH, SRS operations in a band combination including SUL2) Supplemental uplink with same numerology between SUL and non SUL carriers  | *supportedBandCombinationList* | *RF-Parameters* | N.A. | N.A. | N.A. | This is conditioned on the support of SUL band combination(s). The band combination definition is up to RAN4. | Optional with capability signaling |  |
|  | 6-17 | Supplemental uplink with different numerologies between SUL and non SUL carriers | Different numerologies between SUL and non SUL | *supportedBandCombinationList* | *RF-Parameters* | Type 3  | N.A. | N.A. | This is conditioned on the support of SUL band combination(s). The band combination definition is up to RAN4. |  | Mandatory with capability signaling |
|  | 6-18 | Supplemental uplink with dynamic switch | DCI based selection of PUSCH carrier | *dynamicSwitchSUL* | *FeatureSetUplink* | Type 3 | N.A. | N.A. | This is conditioned on the support of SUL band combination(s). The band combination definition is up to RAN4. |  |  |
|  | 6-19 | Simultaneous transmission of SRS on an SUL/non-SUL carrier and PUSCH/PUCCH/SRS/PRACH on the other UL carrier in the same cell |  | *simultaneousTxSUL-NonSUL* | *FeatureSetUplink* | Type 3 | N.A. | N.A. |  |  | Optional with capability signaling |
|  | 6-21 | DL search space sharing for CA |  | *searchSpaceSharingCA-DL* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 6-22 | UL search space sharing for CA |  | *searchSpaceSharingCA-UL* | *FeatureSetUplink* | Type 3 | N.A. | N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 6-23 | Incapability motivated by impacts of PA phase discontinuity with overlapping transmissions with non-aligned starting or ending times or hop boundaries across carriers for intra-band EN-DC, intra-band CA, and FDM based ULSUP | Incapability motivated by impacts of PA phase discontinuity with overlapping transmissions with non-aligned starting or ending times or hop boundaries across carriers for intra-band EN-DC, intra-band CA, and FDM based ULSUP | *pa-PhaseDiscontinuityImpacts* | *FeatureSetUplink* | Type 3 (per band per band combination) | N.A. | N.A. | See LS (R1-1809992) | Optional with capability signaling | Optional with capability signaling |
|  | 6-24 | Applying the same UL timing between NR and LTE | Applying the same UL timing between NR and LTE for dynamic power sharing capable UE operating in intra-band contiguous synchronous EN-DC | *ul-TimingAlignmentEUTRA-NR* | *MRDC-Parameters* | Type 3 | N.A. | N.A. | Note: UEs that set this bit to 0 should be able to operate with a timing difference up to applicable MTTD requirements when operating in a synchronous intra-band contiguous EN-DC network. | Optional with capability signaling |  |
| 7. Channel coding | 7-1 | Channel coding | 1) LDPC encoding and associated functions for data on DL and UL2) Polar encoding and associated functions for PBCH, DCI, and UCI3) Coding for very small blocks | *N.A* | *N.A* | N.A. | No need |  |  | Mandatory without capability signaling | Mandatory without capability signaling |
| 8. UL TPC | 8-1 | Dynamic power sharing for LTE-NR DC | When total transmission power exceeds Pcmax, UE scales NR transmission power. | *dynamicPowerSharing* | *MRDC-Parameters* | Type 3 | N.A. | N.A. | RP-172833 |  | Mandatory with capability signaling |
|  | 8-1a | Operation A with single UL Tx case 1  |  | *tdm-Pattern* | *MRDC-Parameters* | Type 2 | Yes | Yes | RP-172833 | Mandatory with capability signaling conditioned that UE does not support dynamic power sharing, optional for UEs supporting dynamic power sharing | Mandatory with capability signaling conditioned that UE does not support dynamic power sharing, i.e., UE indicate “0” as non-support for 8-1, optional for UEs supporting dynamic power sharing |
|  | 8-2 | Basic power control operation | 1) Accumulated power control mode for closed loop2) 1 TPC command loop for PUSCH, PUCCH respectively3) One or multiple DL RS configured for pathloss estimation4) One or multiple p0-alpha values configured for open loop PC5) PUSCH power control 6) PUCCH power control 7) PRACH power control8) SRS power control 10) PHR | *N.A* | *N.A* | Type 4 | No need | No need |  |  | Mandatory without capability signaling |
|  | 8-3 | TPC-PUSCH-RNTI | Specific group DCI message for TPC commands for PUSCH | *tpc-PUSCH-RNTI* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 8-4 | TPC-PUCCH-RNTI | Specific group DCI message for TPC commands for PUCCH | *tpc-PUCCH-RNTI* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 8-5 | TPC-SRS-RNTI | Specific group DCI message for TPC commands for SRS | *tpc-SRS-RNTI* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 8-6 | Absolute TPC command mode | Absolute TPC command mode | *absoluteTPC-Command* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  |  | Optional with capability signaling |
|  | 8-7 | UL power control with 2 PUSCH closed loops | Two different TPC loops  | *twoDifferentTPC-Loop-PUSCH* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes  | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 8-8 | UL power control with 2 PUCCH closed loops | Two different TPC loops | *twoDifferentTPC-Loop-PUCCH* | *Phy-ParametersXDD-Diff**Phy-ParametersFRX-Diff* | Type 4 | Yes | Yes |  | Mandatory with capability signaling | Mandatory with capability signaling |
|  | 1 [5-5a]? | UE PDSCH processing capability #2  | UE can report values ‘X’ and ‘Fallback’, and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) No scheduling limitation3) N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz  | *pdsch-ProcessingType2* | *FeatureSetDownlink* | Type 3 |  | Applicable to FR1 only | This capability is necessary for each SCS (15kHz, 30kHz, 60kHz) More than one set of per SCS per band reports can be signaled for a given band combination | Optional with capability signalingCandidate values for Component 1:X in {1,..,16}, Fallback {‘SC’,’Cap1-only’} | Optional with capability signalingCandidate values for Component 1:X in {1,..,16}, Fallback {‘SC’,’Cap1-only’} |
|  | 2 [5-5b]? | UE PDSCH processing capability #2 with scheduling limitation for 30kHz-SCS  | Capability #2 supported only if 1 carrier configured in the band (independent of #carriers configured in other bands)2) Max PDSCH BW of 136 PRBs 3) N1 based on Table 5.3-2 of TS 38.214 for 30 kHz SCS4) UE reports the number of unicast PDSCH per slot for different TBs  | *pdsch-ProcessingType2-Limited* | *FeatureSetDownlink* | Type 3 |  | Applicable to FR1 only | This capability is applicable to 30kHz-SCS only | Optional with capability signaling | Optional with capability signalingComponent 4) the value ranges {1, 2, 4, 7} |
|  | 3 [5-5c]? | UE PUSCH processing capability #2 | UE can report values ‘X’ and ‘Fallback’, and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pusch-ProcessingType2* | *FeatureSetUplink* | Type 3 |  | Applicable to FR1 only | This capability is necessary for each SCS (15kHz, 30kHz, 60kHz)More than one set of per SCS per band reports can be signaled for a given band combination | Optional with capability signalingCandidate values for Component 1:X in {1,..,16}, Fallback {‘SC’,’Cap1-only’} | Optional with capability signalingCandidate values for Component 1:X in {1,..,16}, Fallback {‘SC’,’Cap1-only’} |
|  | 4 [5-30a]? | New 64QAM MCS table for PDSCH | New 64QAM MCS table for PDSCH | *dl-64QAM-MCS-TableAlt* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 5 [5-30b]? | New 64QAM MCS table for PUSCH | New 64QAM MCS tables for PUSCH with and without transform precoding respectively  | *ul-64QAM-MCS-TableAlt* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 6 [2-32c]? | New CQI table | CQI table with target BLER of 10^-5 | *cqi-TableAlt* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional with capability signaling | Optional with capability signaling |
|  | 7 [5-30c]? | Dynamic indication of MCS table with new RNTI for PDSCH | 1) Dynamic indication of MCS table using new RNTI for PDSCH | *dl-MCS-TableAlt-DynamicIndication* | *FeatureSetDownlink* | Type 3 | N.A. |  N.A. |  | Optional with capability signaling | Optional with capability signaling |
|  | 8[5-30c] | Dynamic indication of MCS tables with new RNTI for PUSCH | 1) Dynamic indication of MCS tables using new RNTI for PUSCH | *ul-MCS-TableAlt-DynamicIndication* | *FeatureSetUplink* | Type 3 | N.A. | N.A. |  |  |  |
|  | 9 [5-13] | Up to 2 unicast PDSCHs per slot for different TBs for UE processing time Capability 2 |  Up to 2 unicast PDSCHs per slot only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) No scheduling limitation3) N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pdsch-ProcessingType2* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signaled for a given band combination“Fallback” is the same as FG1 [5-5a] | Optional with capability signaling | Optional with capability signalingCandidate values for Component 1:X in {1,..,16},  |
|  | 10 [5-13a] | Up to 7 unicast PDSCHs per slot for different TBs for UE processing time Capability 2 | Up to 7 unicast PDSCHs per slot only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) No scheduling limitation3) N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pdsch-ProcessingType2* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signaled for a given band combination“Fallback” is the same as FG1 [5-5a] | Optional with capability signaling | Optional with capability signalingCandidate values for Component 1:X in {1,..,16},  |
|  | 11 [5-13c] | Up to 4 unicast PDSCHs per slot for different TBs for UE processing time Capability 2 | Up to 4 unicast PDSCHs per slot only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) No scheduling limitation3) N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pdsch-ProcessingType2* | *FeatureSetDownlink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signaled for a given band combination“Fallback” is the same as FG1 [5-5a] | Optional with capability signaling | Optional with capability signalingCandidate values for Component 1:X in {1,..,16},  |
|  | 12 [5-13d] | Up to 2 PUSCHs per slot for different TBs for UE processing time Capability 2 | Up to 2 unicast PUSCHs per slot only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pusch-ProcessingType2* | *FeatureSetUplink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signaled for a given band combination“Fallback” is the same as FG3 [5-5c] | Optional with capability signaling | Optional with capability signalingCandidate values for Component 1:X in {1,..,16},  |
|  | 13 [5-13e] | Up to 7 PUSCHs per slot for different TBs for UE processing time Capability 2 | Up to 7 unicast PUSCHs per slot only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pusch-ProcessingType2* | *FeatureSetUplink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signaled for a given band combination“Fallback” is the same as FG3 [5-5c] | Optional with capability signaling | Optional with capability signalingCandidate values for Component 1:X in {1,..,16},  |
|  | 14 [5-13f] | Up to 4 PUSCHs per slot for different TBs for UE processing time Capability 2 | Up to 4 unicast PUSCHs per slot only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* UE supports Capability #2 processing time on all configured carriers if # configured carriers in a band <= X, otherwise
	+ If Fallback = ‘SC’, UE supports Capability #2 processing time on lowest cell index among the configured carriers in the band where the value is reported
	+ If Fallback = ‘Cap1-only’, UE supports only Capability #1, in the band where the value is reported

2) N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | *pusch-ProcessingType2* | *FeatureSetUplink* | Type 3 | N.A. | N.A. | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signaled for a given band combination“Fallback” is the same as FG3 [5-5c] | Optional with capability signaling | Optional with capability signalingCandidate values for Component 1:X in {1,..,16},  |

## RF/RRM feature list (RAN4)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| WI | # | Feature group | Components | Field name in TS 38.331 | Parent IE in TS 38.331 | Type (See R4-17121 19) | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Remarks | Recommendation for TSG-RAN | TSG-RAN decision |
| System parameter | 1-1 | 60kHz of subcarrier spacing for FR1 | 1) 60kHz subcarrier spacing for data channel in FR1 | *scs-60kHz* | *Phy-ParametersFR1* | Type 4 | No Need | Applicable only to FR1 |  |  | Optional |
| 1-2 | 64QAM modulation for FR2 PDSCH | 1) 64QAM modulation for FR2 PDSCH | *N.A* | *N.A* |  | No need | Applicable only to FR2 | Capability can be discussed in future, e.g. when low cost device (e.g. IoT) and/or higher frequency band in FR2 are introduced | Mandatory without capability  | Mandatory without capability  |
| 1-3 | 64QAM for PUSCH | 1) 64QAM for PUSCH | *N.A* | *N.A* |  | No need | No need | Capability can be discussed in future, e.g. when low cost device (e.g. IoT) and/or higher frequency band in FR2 are introduced | Mandatory without capability | Mandatory without capability |
| 1-4 | 256QAM for PDSCH | 1) 256QAM for PDSCH | *pdsch-256QAM-FR1* | *Phy-ParametersFR1* | Type 4 for FR1Type 1 for FR2 | No need | Yes | For FR1, it can be revisited in the future whether the 256QAM is mandated in all UE types or categoriesFor FR2, RAN4 agreed that no BS and UE requirements will be introduced in Rel.15.  | Mandatory with capability for FR1Optional for FR2 | Mandatory with capability for FR1Optional for FR2 |
| *pdsch-256QAM-FR2* | *BandNR* |
| 1-5 | 256QAM for PUSCH | 1) 256QAM for PUSCH | *pusch-256QAM* | *BandNR* | Type1 for FR1Type 1 for FR2 | No need | Yes | For FR1, RAN4 can further discuss to mandate 256QAM for PUSCH for FR1 in future release.For FR2, RAN4 agreed that no BS and UE requirements will be introduced in Rel.15. | Optional for FR1Optional for FR2 | Optional for FR1Optional for FR2 |
| 1-6 | pi/2-BPSK for PUSCH | 1) pi/2-BPSK for PUSCH | *pusch-HalfPi-BPSK* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | RAN4 will define the same minimum requirements for pulse-shaped pi/2 BPSK and non pulse-shaped pi/2 BPSK for FR2. | Optional for FR1 | Optional for FR1For FR2, mandatory with capability  |
| 1-7 | pi/2-BPSK for PUCCH format 3/4 | 1) pi/2-BPSK for PUCCH format ¾ | *pucch-F3-4-HalfPi-BPSK* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes |  | Optional for FR1 | Optional for FR1For FR2, mandatory with capability |
| 1-8 | BWP switching delay | 1) Support BWP switching delay specified in TS38.xxx, candidate values set: {type1, type2} | *bwp-SwitchingDelay* | *Phy-ParametersCommon* | Type 4 | No need | No need | For this feature, RAN4 also sent another LS (R4-1803283)Network cannot configure the shorter delay for certain UE type  | Mandatory to report type 1 or type 2 | Mandatory to report type 1 or type 2 |
| 1-10 | Support of EN-DC with LTE-NR coexistence in UL sharing from UE perspective | 1) LTE and NR UL Transmission in the shared carrier via TDM only2) LTE and NR UL Transmission in the shared carrier via FDM only3) LTE and NR UL transmission in the shared carrier via FDM or TDM | *ul-SharingEUTRA-NR* | *MRDC-Parameters* | Type 3 (per band combination) | No Need | Applicable only to FR1 |  | Optional | Optional |
| 1-11 | Switching time between LTE UL and NR UL for EN-DC with LTE-NR coexistence in UL sharing from UE perspective | Support of switching type between LTE UL and NR UL for EN-DC with LTE-NR coexistence in UL sharing from UE perspective. Type 1: ~0usType 2: <20us | *ul-SwitchingTimeEUTRA-NR* | *MRDC-Parameters* | Type 3 (per band combination) | No Need | Applicable only to FR1 | This feature is the switching time between LTE UL and NR UL in the same carrierPer band combination signalling (Type 3)UE Capability signalling elements. 1: ~0us switching type.2: <20us switching type.  |  | Mandatory to report switching time type 1 or type 2 if UE reports its capability in 1-10 as 1) LTE and NR UL Transmission in the shared carrier via TDM only, or 3) LTE and NR UL transmission in the shared carrier via FDM or TDM |
| 1-12 | 7.5kHz UL raster shift | 1) 7.5kHz UL raster shift | *N.A* | *N.A* | N/A | N/A | No need |  | Mandatory in the SUL bands with uplink sharing either from UE perspective or from network perspective7.5KHz raster shift as mandatory without capability signalling. 7.5kHz UL raster shift is mandatory in Bands n1, n2, n3, n5, n7, n8, n20, n28, n66. RAN4 can revisit the above bands in the future release. 7.5KHz raster shift is not mandatory for other LTE refarming band except the bands which were agreed to support 7.5kHz UL raster shift as mandatory | Mandatory in the SUL bands with uplink sharing either from UE perspective or from network perspective7.5KHz raster shift as mandatory without capability signalling. 7.5kHz UL raster shift is mandatory in the uplink of all FDD bands defined in Table 5.2-1 of TS38.101-1. RAN4 can revisit the above bands in the future release. 7.5KHz raster shift is not mandatory for other LTE refarming band except the bands which were agreed to support 7.5kHz UL raster shift as mandatory |
| UE RF | 2-1 | Maximum channel bandwidth supported in each band for DL and UL separately and for each SCS that UE supports within a single CC | 1) FR1 channel bandwidths in TS38.101-1 Table 5.3.5-12) FR2 channel bandwidths in TS38.101-2 Table 5.3.5-1 | *channelBWs-DL**channelBWs-UL* | *BandNR* | Type 1 | No Need | No Need | UE capability signalling shall follow RP-172832 (Per-band capability signalling, separately for DL and UL and for each SCS)Whether a bandwidth newly introduced in future is mandatory for UE shall be discussed case by case. | For FR1, all the bandwidths listed in TS38.101-1 v15.0.0 Table 5.3.5-1 for each band shall be mandatory with a single CC. The bandwidths listed in the slide #3 of R4-1805985 are mandatory with a single CC. 90MHz is optional for n41, n77, n78.For FR2, the set of mandatory CBW is 50, 100, 200 MHz. | For FR1, all the bandwidths listed in TS38.101-1 v15.0.0 Table 5.3.5-1 for each band shall be mandatory with a single CC. The bandwidths listed in the slide #3 of R4-1805985 are mandatory with a single CC. 90MHz is optional for n41, n77, n78.For FR2, the set of mandatory CBW is 50, 100, 200 MHz. |
| 2-2 | Simultaneous reception or transmission with same or different numerologies in CA | 1) Support of simultaneous reception or transmission with same or different numerologies in CA  | *supportedSubcarrierSpacingDL* | *FeatureSetDownlinkPerCC* | Type 3 | No need | No need | From RAN4 perspective UE shall be able to signal the supported SCS per CC for each band combinationSame numerology for intra-band NR CA including both continuous and non-continuous is mandatory support for Rel15The capability of supporting SCS within the single carrier in the CA configuration will be signalled separately, i.e., there is no need to mandatory UE to support mixed numerologies in CA caseIf a UE supports inter-band NR CA including both FR1 band(s) and FR2 band(s), the UE shall support two mixed numerologies between FR1 band(s) and FR2 band(s) in DL and UL with capability signaling |  | Same numerology for intra-band NR CA including both continuous and non-continuous is mandatory with capability in both FR1 and FR2. Two mixed numerologies between FR1 band(s) and FR2 band(s) in DL and UL are mandatory with capability if UE supports inter-band NR CA including both FR1 band(s) and FR2 band(s). Optional for other cases. |
| *supportedSubcarrierSpacingUL* | *FeatureSetUplinkPerCC* |
| 2-3 | Non-contiguous intra-band CA frequency separation class for FR2 | 1) Support of frequency separation classes to handle the total frequency span for DL for intra-band non-contiguous CA2) Support of frequency separation classes to handle the total frequency span for UL for intra-band non-contiguous CA | *intraBandFreqSeparationDL* | *FeatureSetDownlink* | Type 1 | No need | Applicable only to FR2 | UE signals the supported Frequency separation classes with per band granularity (Type 1) based on R4-1803363Separate Frequency separation classes can be signalled for DL and UL | Mandatory to report for UE to support non-continuous CA in FR2 | Mandatory to report for UE to support non-continuous CA in FR2 |
| *intraBandFreqSeparationUL* | *FeatureSetUplink* |
| 2-4 | Simultaneous reception and transmission for inter-band EN-DC (TDD-TDD or TDD-FDD) | 1) Simultaneous reception and transmission for inter-band EN-DC (TDD-TDD or TDD-FDD) | *simultaneousRxTxInterBandENDC* | *MRDC-Parameters* | Type 3 (Per band combination) | No Need | No Need | For TDD-FDD and TDD-TDD band combinations for which simultaneous RxTx capability is agreed to be supported, corresponding capability indication must be set to “supported”.Band combinations for which simultaneous RxTx capability is mandatory EN-DC combinations (Both FR1 LTE – FR1 NR and FR1 LTE- FR2 NR) are captured in TS 38.101-3 | Mandatory/Optional support depends on band combination and captured in TS 38.101-3 | Mandatory/Optional support depends on band combination and captured in TS 38.101-3 |
| 2-5 | Simultaneous reception and transmission for inter band CA (TDD-TDD or TDD-FDD) | 1) Simultaneous reception and transmission for inter band CA (TDD-TDD or TDD-FDD) | *simultaneousRxTxInterBandCA* | *CA-ParametersNR* | Type 3 (Per band combination) | No Need | No Need | For TDD-FDD and TDD-TDD band combinations for which simultaneous RxTx capability is agreed to be supported, corresponding capability indication must be set to “supported”.Band combinations for which simultaneous RxTx capability is mandatory are captured in TS 38.101-1, TS 38.101-2 and TS 38.101-3 | Mandatory/Optional support depends on band combination and captured in TS 38.101-1, TS 38.101-2 and TS 38.101-3 | Mandatory/Optional support depends on band combination and captured in TS 38.101-1, TS 38.101-2 and TS 38.101-3 |
| 2-6 | Asynchronous FDD-FDD intra-band EN-DC DC | Asynchronous FDD-FDD intra-band EN-DC | *asyncIntraBandENDC* | *MRDC-Parameters* | Type 3 (Per band combination) | Applicable only to FDD | Applicable only to FR1 |  | Optional | Optional |
| 2-7 | Almost contiguous UL CP-OFDM | 1) Support of almost contiguous UL CP-OFDM transmissions | *almostContiguousCP-OFDM-UL* | *Phy-ParametersFRX-Diff* | Type 4 | No need | Yes | RAN4 had defined the requirements for “Almost contiguous UL CP-OFDM” in Rel-15.  | Optional | Optional |
| 2-9 | UE power class | 1) Support of [non-default] FR1 UE power class2) Support of FR2 UE power class3) Support of FR1 UE power class for EN-DC4) Support of FR1 UE power class for NR-CA | *ue-PowerClass* | *BandNR* | Type 1 and Type 3 (see remarks column) | No Need | No Need | Capability signalling* FR1 UE power class ( Type 1 (per band))
* FR2 UE power class ( Type 1 (per band))
* FR1 UE power class for EN-DC (Type 3 (per band combination))
* FR1 UE power class for NR CA (Type 3 (per band combination))
 | Mandatory to report non-default power class if UE supports | Mandatory to report non-default power class if UE supports |
| *powerClass* | *BandCombination* |
|  | 2-10 | Simultaneous reception and transmission for SA SUL band combinations | 1) Simultaneous reception and transmission for SA SUL band combinations | *simultaneousRxTxSUL* | *CA-ParametersNR* | Type 3 (Per band combination) | No Need | No Need |  | Mandatory/Optional support depends on band combination and captured in TS 38.101-1 | Mandatory/Optional support depends on band combination and captured in TS 38.101-1 |
|  | 2-11 | Multiple frequency band indication | 1) Multiple frequency band indication | *N.A* | *N.A* | Type 4 | No Need | No Need | Per UE capability | Mandatory [with or without] capability | Mandatory without capability |
|  | 2-12 | Modified MPR behaviour | 1) Modified MPR behaviour | *modifiedMPR-Behaviour* | *BandNR* | Type 1 | No Need | No need | Per band capability | Optional | Optional |
|  | 2-13 | Multiple NS/P-Max | 1) Multiple NS/P-Max | *N.A* | *N.A* | Type 4 | No Need | No need | Per UE capability | Mandatory without capability | Mandatory without capability |
|  | 2-14 | Maximum uplink duty cycle for FR1 power class 2 UE | 1) Maximum percentage of uplink symbols can be scheduled within a certain evaluation period. The value range is {60%, 70%, 80%, 90%, 100%}. If the field is absent, 50% shall be applied. | *maxUplinkDutyCycle-PC2-FR1* | *BandNR* | Type 1 | No Need | Applicable only to FR1  | Per band capability.If this capability is absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than 50%, or this capability is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than this capability, apply all requirements for the default power class. The evaluation period is up to UE implementation, no less than one radio frame.UE do not need to do UL duty cycle calculation when it’s transmit power is below 23dBm and all the UL/DL configurations can be scheduled. | Optional | Optional |
|  | 2-15 | Power boosting for Pi/2 BPSK for power class 3 UE | 1) Power boosting for Pi/2 BPSK for power class 3 UE in TDD bands n40, n77, n78 and n79 with duty cycle less than 40% | *powerBoosting-pi2BPSK* | *BandNR* | Type 1 | Applicable only to TDD | Applicable only to FR1 | Per band capability |  | Optional |
| Baseband | 3-1 | Independent measurement gap configurations for FR1 and FR2 | 1) measurement gaps for FR1 and FR2 are configured independently | *independentGapConfig* | *MeasAndMobParametersMRDC-Common* | Type 4 | No Need | 　No Need |  | Optional | Optional |
| 3-2 | Simultaneous reception of data and SS block with different numerologies when UE conducts the serving cell measurement or intra-frequency measurement  | 1) Simultaneous reception of data and SS block with different numerologies when UE conducts the serving cell measurement or intra-frequency measurement | *simultaneousRxDataSSB-DiffNumerology* | *MeasAndMobParametersMRDC-FRX-Diff* | Type 4 | No Need | Yes |  | Optional | Optional |
|  | 3-3 | Short measurement gap | 1) Measurement gap patterns with short MGL (gap pattern#2, 3, 6, 7, 8, 10) are supported for E-UTRAN measurement. Gap patterns #6, 7, 8, 10 only apply to E-UTRAN measurement when MO includes both E-UTRAN and NR. | *N.A (existing LTE capabilities)* | *N.A (existing LTE capabilities)* | Type 4 | No need | No need | Per UE capability | Optional | Optional |
|  | 3-4 | SU-MIMO Interference Mitigation advanced receiver | 1) R-ML (reduced complexity ML) receivers with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2 with 2 RX antennas 2) R-ML (reduced complexity ML) receivers with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2, 3, and 4 with 4 RX antennas | *N.A* | *N.A* | Type 4 | No need | No need | UE supporting the feature is required to meet the Enhanced Receiver Type [TBD] requirements in TS 38.101-4 | Optional without capability signalling | Optional without capability signalling |