■ Signaling Implemented

■ No need to implement signaling due to mandatory w/o capability

■ Covered by RAN4 feature list

■ Not implemented due to FFS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | # | | Feature group | | Components | | Prerequisite feature groups  (listed in this sheet only) | | | Need for gNB to know whether the feature is supported by the UE (what happens if gNB does not know?) | Consequences if the feature  is not supported by the UE | | | | Type (see R2-1712078) | | Need of FDD/TDD differentiation | | | | Need of FR1/FR2 differentiation | | | | RAN5 implication | | | | Note | | | | Responsible WG | | | | 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 DL 2) CP -OFDM for UL | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1 | | | | Mandatory without capability signaling | | |  | |
|  | 0-2 | | DFT-S-OFDM waveform for UL | | Transform precoding for single-layer PUSCH | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1 | | | | Mandatory without capability signaling | | |  | |
|  | 0-3 | | DL modulation scheme | | 1) QPSK modulation 2) 16QAM modulation  3) 64QAM modulation for FR1 | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | RAN4 will check 64QAM modulation for FR2 | | | |  | | | | Mandatory without capability signaling | | |  | |
|  | 0-4 | | UL modulation scheme | | 1) QPSK modulation 2) 16QAM modulation | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Mandatory without capability signaling | | |  | |
|  | 0-5 | | pi/2-BPSK for PUSCH | | pi/2-BPSK for PUSCH | | 0-2 | | | Yes | pi/2-BPSK for PUSCH is not possible | | | | [Type 3]  RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | RAN4 will discuss if it is per band, common for all bands or FR1/2 | | | | RAN4 | | | |  | | |  | |
|  | 0-6 | | 64QAM for PUSCH | | 64QAM for PUSCH | |  | | | Yes | 64QAM for PUSCH is not possible | | | | [Type 3]  RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | RAN4 will discuss if it is per band or common for all bands | | | | RAN4 | | | |  | | |  | |
|  | 0-7 | | 256QAM for PDSCH | | 256QAM for PDSCH | |  | | | Yes | 256QAM for PDSCH is not possible | | | | [Type 3]  RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | RAN4 will discuss if it is per band or common for all bands | | | | RAN4 | | | |  | | |  | |
|  | 0-8 | | 256QAM for PUSCH | | 256QAM for PUSCH | |  | | | Yes | 256QAM for PUSCH is not possible | | | | [Type 3]  RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | RAN4 will discuss if it is per band or common for all bands | | | | RAN4 | | | |  | | |  | |
| Covered by #1-1 in the RAN4 feature list | 0-9 | | Subcarrier spacings and FFT size in conjunction with supportable BW with normal CP | | 1) 15kHz 2) 30 kHz 3) 60 kHz 4) 120 kHz | |  | | | Yes |  | | | | ~~Type 4~~ [Type 3]  RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | It is up to RAN4 decision Baseband processing (memory) in CA combination related as well as RF (SCS support is per band between sub6 and mmWave) | | | | RAN4 | | | |  | | |  | |
|  | 0-10 | | Extended CP | | Extended CP | | 0-9 (component 3; SCS60) | | | Yes |  | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1 | | | | Optional with capability signaling | | |  | |
| Covered by #1-7 in the RAN4 feature list | 0-11 | | pi/2-BPSK for PUCCH format 3/4 | | pi/2-BPSK for PUCCH format 3/4 | | 0-2 | | | Yes | pi/2-BPSK for PUCCH format 3/4 is not possible | | | | Type 3  RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | RAN4 will discuss if it is per band, common for all bands, or FR1/2 | | | | RAN4 | | | |  | | |  | |
| Covered by #2-7 in the RAN4 feature list | 0-12 | | Non-contiguous UL PRB CP-OFDM per CC | | When VRB-to-PRB mapping is used, PRB is after interleaving | | 0-1 | | | Yes |  | | | | RAN4 to decide | | RAN4 to decide | | | | RAN4 to decide | | | |  | | | | It is up to RAN4 to decide | | | | RAN4 | | | |  | | |  | |
|  | 0-13 | | Phase coherence across non-contiguous UL symbols in slot in the transmission of one channel | | Maintaining coherence during a single transmission of a single channel (PUSCH or PUCCH) with one or more symbol gap when   1. No power change across the gap 2. No Rx in the gap 3. No other Tx in the gap   No hop or RB allocation change across the gap | |  | | | Yes |  | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | | RAN1 needs further check components and specification support | | | | RAN1 | | | |  | | |  | |
| Covered by #1-9 in the RAN4 feature list | 0-14 | | [1-symbol GP for 120KHz SCS in unpaired spectrum] | | 1) Slot formats with 1-symbol GP(s) for 120KHz SCS in unpaired spectrum | |  | | | Yes |  | | | | Type 4 | | Applicable only to TDD | | | | Applicable only to FR2 | | | |  | | | | RAN4 to check whether this feature is included in their list | | | | RAN4 | | | |  | | |  | |
| 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] | |  | | | [Yes, or No] |  | | | | N.A. | | No need | | | | No need | | | |  | | | | RAN2 to check components 3 and 4 for SA and NSA applicability | | | | RAN1 | | | | Mandatory without capability signaling | | |  | |
|  | 1-1a | | [On demand based system information] | |  | |  | | | [Yes, or No] |  | | | |  | | [Yes] | | | | [No need] | | | |  | | | | RAN2 to check | | | | RAN2 | | | |  | | |  | |
|  | 1-3 | | SS block based SINR measurement (SS-SINR) | | 1) SS-SINR measurement | | 1-1 | | | Yes | Not support SS-SINR measurement | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-4 | | SS block based RLM | | 1) SS block based RLM | | 1-1 | | | Yes | Not support SS block based RLM | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-5 | | CSI-RS based RRM measurement with associated SS-block | | 1) CSI-RSRP measurement 2) CSI-RSRQ measurement | | 1-1, CSI-RS | | | Yes | Not support CSI-RSRP and CSI-RSRQ measurement | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-5a | | CSI-RS based RRM measurement without associated SS-block | | 1) CSI-RSRP measurement  2) CSI-RSRQ measurement  3) There is SS-block in the target frequency on which the RRM measurement is performed | | 1-1, CSI-RS | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-6 | | CSI-RS based RS-SINR measurement | | 1) CSI-SINR measurement | | 1-1 1-5 | | | Yes | Not support CSI-SINR measurement | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-7 | | CSI-RS based RLM | | 1) CSI-RS based RLM | | 1-1, CSI-RS | | | Yes | Not support CSI-RS based RLM | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-8 | | RLM based on a mix of SS block and CSI-RS signals | |  | | 1-4 and 1-7 | | | Yes | UE does not support RLM based on a mix of SS block and CSI-RS signals | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-9 | | CSI-RS based contention free RA for HO | |  | | 1-1 1-2, CSI-RS | | | Yes | UE does not support CSI-RS based contention free RA for HO | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 1-10 | | Support of SCell without SS/PBCH block | | 1) Support SCell without SS/PBCH block | | 1-1 | | | Yes | Not support SCell without SS/PBCH | | | | 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 | | | | RAN1 | | | |  | | |  | |
|  | 1-11 | | Support of CSI-RS RRM measurement for SCell without SS/PBCH block | |  | | 1-10 | | | Yes |  | | | | Type 3 | | N. A. | | | | N.A. | | | |  | | | | RAN4 to check | | | |  | | | |  | | |  | |
|  | 1-12 | | E-UTRA RS-SINR measurement | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | [No need] | | | |  | | | | RAN2 to decide FR1/FR2 differentiation | | | |  | | | |  | | |  | |
| 2. MIMO | 2 -1 | | Basic PDSCH reception | | 1. Data RE mapping  2. Single layer transmission | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1 | | | | 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 reception  Note: candidate value will be decided after feature is completed. (note: this may not needed)  Time duration is defined counting from end of last symbol of PDCCH to beginning of the first symbol of PDSCH  Xi is the number of OFDM symbols, i is the index of SCS, l=1,2, corresponding to 60,120 kHz SCS. | | 2-1 | | | Yes |  | | | | Type-3 | | No need | | | | Applicable only for FR2 | | | |  | | | |  | | | | RAN1 | | | | Candidate 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 | | 2-1 | | | Yes | Only one layer is supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1 | | | | Candidate values: {1,2,4,8}  FFS on the minimal layers for different band or band combination. | | |  | |
|  | 2-4 | | TCI states for PDSCH | | 1. Support number of active TCI states per CC  2. maximum number of configured TCI states, | | 2-1 | | | Yes | Only one TCI state can be supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Component-1: Candidate value set: {1, 2, 4, 8 }  Component-2: candidate value set: {4, 8, 16, 32, 64}  FFS: mandatory value | | |  | |
|  | 2-5 | | Basic downlink DMRS  for scheduling type A | | 1. Support 1 symbol FL DMRS without additional symbol(s)  2. Support 1 symbol FL DMRS and 1 additional DMRS symbol  3. Support 1 symbol FL DMRS and 2 additional DMRS symbols for at least one port. | | 2-1 | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | conditioned to whether PDSCH scheduling type A is supported | | | |  | | | | Mandatory without UE capability(condition to scheduling capability) | | |  | |
|  | 2-6 | | Basic downlink DMRS  for scheduling type B | | 1. Support 1 symbol FL DMRS without additional symbol(s)  2. Support 1 symbol FL DMRS and 1 additional DMRS symbol | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | conditioned to whether PDSCH scheduling type B is supported | | | |  | | | | Mandatory without UE capability (condition to scheduling capability) | | |  | |
|  | 2-6 | | Support 1+2 DMRS (downlink) | | 1. Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port | | 2-6 | | | Yes | 1 FL + 2 additional DMRS for more than one port is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | Mandatory with UE capability signaling | | |  | |
|  | 2-7 | | Supported 2 symbols front-loaded DMRS(downlink) | | 1. Support 2 symbols FL-DMRS | | 2-5 | | | Yes | 2 FL DMRS is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 2-8 | | Supported 2 symbols front-loaded +2 symbols additional DMRS(downlink) | | 1. Support 2-symbol FL DMRS + one additional 2-symbols DMRS | | 2-5 | | | Yes | 2 FL DMRS + one additional 2-symbols DMRS is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 2-9 | | Support 1+3 DMRS symbols(downlink) | | 1. Support 1 symbol FL DMRS and 3 additional DMRS symbols | | 2-5 | | | Yes | 1 symbol FL DMRS and 3 additional DMRS symbols is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 2-10 | | Support DMRS type (downlink) | | Support DMRS {type 1, type 2} | |  | | | Yes | Only the mandatory DMRS type(s) are supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | RAN1 will further discuss which Type will be mandatory or both type will be mandatory | | |  | |
|  | 2-11 | | Downlink dynamic PRB bundling (downlink) | | 1. Support dynamic PRB bundling indication via DCI  Note: Support of semi-static PRB bundling--mandatory | | 2-1 | | | Yes | No support of dynamic PRB bundling | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 2-12 | | Basic PUSCH transmission | | Data RE mapping  Single layer (single Tx) transmission | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Mandatory without UE capability | | |  | |
|  | 2-13 | | PUSCH codebook coherency subset | | Proposal:  1. Supported codebook coherency subset type: Candidate value set: {non-coherent, partial/non-coherent, full/partial/non-coherent} | | 2-12 | | | Yes | Only non-coherent codebook subset is supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Candidate values: {non-coherent, partial-non-coherent, full-coherent} | | |  | |
|  | 2-14 | | Codebook based PUSCH MIMO transmission | | 1. Supported codebook based PUSCH MIMO with maximal number of supported layers | | 2-13 | | | Yes | Uplink codebook based MIMO (with >1 Tx port) transmission is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Candidate value: {no-codebook based MIMO, 1, 2, 4} | | |  | |
|  | 2-15 | | non-codebook based PUSCH transmission | | 1. Maximal number of supported layers (non-codebook transmission scheme): | | 2-12 | | | Yes | No support of non-codebook based PUSCH transmission | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Component-1 candidate values: {“No non-codebook based MIMO”, 1, 2, 4} | | |  | |
|  | 2-15a | | Association between CSI-RS and SRS | | Support association between NZP-CSI-RS and SRS resource set via RRC parameter “SRS-AssocCSIRS” | | 2-15 | | | Yes | Association between CSI-RS and SRS is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 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 | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | conditioned to whether PUSCH scheduling type A is supported | | | |  | | | | Mandatory without UE capability | | |  | |
|  | 2-16a | | Basic uplink DMRS  for scheduling type B | | 1. Support 1 symbol FL DMRS without additional symbol(s)  2. Support 1 symbol FL DMRS and 1 additional DMRS symbol | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | conditioned to whether PUSCH scheduling type B is supported | | | |  | | | | Mandatory without UE capability | | |  | |
|  | 2-16b | | Support 1+2 DMRS (uplink) | | 1. Support 1 symbol FL DMRS and 2 additional DMRS symbols for more than one port | | 2-6 | | | Yes | 1+2 DMRS for more than one port is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | Mandatory with UE capability signaling | | |  | |
|  | 2-17 | | Support DMRS type (uplink) | | Support DMRS {type 1, type 2 } | | 2-16 | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | At least type-1 is mandatory.  FFS on type-2 is mandatory or optional | | |  | |
|  | 2-18 | | Supported 2 symbols front-loaded DMRS (uplink) | | 1. Support 2 symbols FL-DMRS | | 2-16 | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS on whether it’s mandatory or optional | | |  | |
|  | 2-18a | | Supported 2 symbols front-loaded +2 symbols additional DMRS (uplink) | | 1. Support 2-symbol FL DMRS + one additional 2-symbols DMRS | | 2-16 | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS on whether it’s mandatory or optional | | |  | |
|  | 2-19 | | Support 1+3 uplink DMRS symbols(uplink) | | 1. Support 1 symbol FL DMRS and 3 additional DMRS symbols | | 2-16 | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS on whether it’s mandatory or optional | | |  | |
|  | 2-20 | | Beam correspondence | | 1. Support Beam correspondence | |  | | | Yes | Beam correspondence is not supported | | | | 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 at least for FR2] | | |  | |
|  | 2-21 | | Periodic beam report | | 1. Support report on PUCCH formats over 1 – 2 OFDM symbols once per slot  2. Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot | |  | | | Yes | No support of periodic L1-RSRP report | | | | Type 1 | | No need | | | | N.A. | | | |  | | | |  | | | |  | | | | Mandatory with UE capability at least for FR2  FFS: for FR1 | | |  | |
|  | 2-22 | | Aperiodic beam report | | 1. Support report on PUSCH | |  | | | Yes | No support of aperiodic L1-RSRP report | | | | Type 1 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | Mandatory with UE capability at least for FR2 | | |  | |
|  | 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) | |  | | | Yes | No support of PUCCH based SPS L1-RSRP report | | | | Type 1 | | N.A. | | | | Yes | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 2-23a | | Semi-persistent beam report on PUSCH | | 1. Support report on PUSCH | |  | | | Yes | No support of PUSCH based SPS L1-RSRP report | | | | Type 1 | | N.A. | | | | Yes | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 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 to measure L1-RSRP within a slot shall not exceed MB\_1  2. The max number of SSB/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 | | 2-21, 2-22 or 2-23 | | | Yes | RSRP measurement is not supported | | | | Type 1 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | Component-1, candidate value set for MB\_1 is {8, 16, 32, 64}  Support MB\_1 =8 is mandatory for at least for >6Ghz bands  Component-2, candidate value set for MB\_2 is {0, 4, 8, 16, 32, 64}  Component-3: candidate value set:  {“1 only”, “3 only”, “both 1 and 3”}  At least density of CSI-RS =3 is mandatory at least for FR2 | | |  | |
|  | 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. | | 2-24 | | | Yes | Beam reporting time capability is not known by gNB | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1/4 | | | | Candidate value set for X1 is {2, 4, [8]}  Candidate value set for X2 is {4,8, [14]}  Candidate value set for X3 is {7 or 8,14 or 15, 28}  RAN1 will further decide between 7 and 8 and between 14 and 15.  Candidate value set for X4, {14, 28, [42]} | | |  | |
|  | 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, | |  | | | Yes | Rx beam switching is not supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Support Rx beam switching is mandatory for bands at least > 6GHz  Componet-2: candidate value set {2, 3, 4, 5, 6, 7, 8} | | |  | |
|  | 2-27 | | Beam switching | | 1. Maximum number of Tx + Rx for UL beam changes a UE can conduct during a slot across the whole band CC .  This number is defined as per SCS (15 to 240 KHz)  Note: it is assumed that spec enable the possibility to restrict the same beam across intra-band CCs | | 2-24 | | | Yes. | No resetriction on the maximum number of Tx+Rx beam change for a slot | | | | Type 1 | | N.A. | | | | N.A | | | |  | | | |  | | | |  | | | | 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=1,2,3,4 corresponding to 15,30,60,120 kHz SCS.  FFS whether we need different number for CSI-RS with repetition ‘ON’ and ‘OFF’ | | 2-27 | | | Yes | Reporting beam switching timing is not supported | | | | Type1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Candidate values {14, 26, 28, [42], [280]} | | |  | |
|  | 2-29 | | Non-group based beam reporting | | 1. Support of non-group based RSRP reporting with N\_max reports, | | 2-24 | | | Yes | Non-group based beam reporting is not supported | | | | Type1 | | N.A | | | | N.A. | | | |  | | | |  | | | |  | | | | candidate value set is {1, 2,4} | | |  | |
|  | 2-29a | | Group based beam reporting | | 1. Support of beam group RSRP reporting for group of 2 beams | |  | | | Yes | Group based beam reporting is not supported | | | | Type1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 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). | |  | | | Yes | Uplink beam management is not supported | | | | Type1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Component-2, candidate value set is {8, 16, 32}  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. | |  | | | Yes | Beam failure recovery is not supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Component-1 candidate value set: {from 1 to 64}  Component-2 candidate: {from 1 to 64}  Component-3:  Candidate value set is: {from 1 to 256} | | |  | |
|  | 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 FR1  4. 8Tx codebook for FR1 when configured as wideband CSI report  5. 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 | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Mandatory without UE capability | | |  | |
|  | 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)  2. Support report on PUCCH formats over 4 – 14 OFDM symbols once per slot (or piggybacked on a PUSCH) | |  | | | Yes | SP-CSI on PUCCH is not supported | | | | Type 4 | | No | | | | No | | | |  | | | |  | | | | RAN1 | | | | Optional | | |  | |
|  | 2-32b | | Semi-persistent CSI report on PUSCH | | 1. Support report on PUSCH | |  | | | Yes | SP-CSI on PUSCH is not supported | | | | Type 4 | | No | | | | No | | | |  | | | |  | | | | RAN1 | | | | Optional | | |  | |
|  | 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 CC  3. Supported max # of configured CSI-IM resources per CC | | 2-32 | | | Yes | CSI acquisition is not supported | | | | 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. | | | |  | | | | Component-1 candidate values: {from 1 to 32}  Component-2 candidate values: , further down-select between: Alt.1: {from 4 to 64}, Alt.2: {from 4 to 256}, Alt.3: {from 4 to 256}    Component-3: candidate values: {1,2,4,8,16,32} | | |  | |
|  | 2-33a | | PDSCH RE-mapping  Note: this FG will be moved to 5-x family | | 1. Supported max # of RE mapping patterns, each pattern can be described as a RS resource (including NZP/ZP CSI-RS and CRS) or a bitmap configured in 5-26/27 per OFDM symbol and per CC | |  | | | Yes | PDSCH RE mapping is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | candidate values: {X, 20} for FR1  {X, 20} for FR2  RAN will further determine the value of X (less than 20) | | |  | |
|  | 2-34 | | NZP-CSI-RS based interference measurement | | 1. Support NZP-CSI-RS based interference measurement | | 2-33 | | | Yes | NZP-CSI-RS based interference measurement is not supported | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 2-35 | | CSI report framework | | 1. Maximum number of periodic CSI report setting per BWP  2. Maximum number of aperiodic CSI report setting per BWP  3. Maximum number of semi-persistent CSI report setting per BWP  4. Minimum duration Zk,l (in symbols)for processing a CSI, *k* is level of CSI latency class, *i* is the index of SCS, *i*=1,2,3,4 corresponding to 15,30,60,120 kHz SCS.  5. UE can process X CSI report(s) simultaneously. CSI reports can be P/SP/A CSI and any latency class and codebook type.  FFS: whether X should also count the SRS precoder derivation in case of reciprocity based SRS Tx | | 2-34 | | | Yes | CSI report is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Component-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-4: candidate value Zk,l: FFS  Component-5:  FFS: candidate values: {from 5 to 32} | | |  | |
|  | 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) | | 2-35 | | | Yes | No additional Type I codebook configurations other than the basic CSI feedback (2-32) is supported | | | | Type 3 | | No need | | | |  | | | |  | | | | Note: simultaneously doesn’t mean in the same slot | | | |  | | | | Component-1: 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 is:  {from 2 to 256}  Component-2 candidate values:  {Mode-1, Mode-2}  Down-select:  Alt.1 Mode-1 as mandatory  Alt.2: Both Mode-1 and Mode-2 are mandatory (in this case, this component is not needed) | | |  | |
|  | 2-37 | | Support Semi-open loop CSI | | 1. Support Semi-open loop CSI report | | 2-35 | | | Yes | Semi-Open loop CSI report is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS | | |  | |
|  | 2-38 | | CSI report without PMI | | Support CSI report without PMI | | 2-35 | | | Yes | CSI report without PMI is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS | | |  | |
|  | 2-39 | | CSI report with CRI | | Support CSI report with CRI | | 2-35 | | | Yes | CSI report with CRI is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS | | |  | |
|  | 2-39a | | CSI report without CQI | | Support CSI report without CQI | | 2-35 | | | Yes | CSI report wihout CQI is not supported | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | FFS | | |  | |
|  | 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, Ng, | | 2-35 | | | Yes | multi-panel Type I codebook is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Note: simultaneously doesn’t mean in the same slot | | | |  | | | | Component-1 candidate values {4, 8, 12, 16, 24, 32}  Component-2 candidate values: Component-2 candidate values:  {Mode-1, Mode-2}  Down-select:  Alt.1 Mode-1 as mandatory  Alt.2: Both Mode-1 and Mode-2 are mandatory  Component-3:  Candidate value: {2,4} | | |  | |
|  | 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 | | 2-35 | | | Yes | Type II codebook is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Note: simultaneously doesn’t mean in the same slot | | | |  | | | | Component-1 , candidate values {4, 8, 12, 16, 24, 32}  Component-2, candidate values {2,3,4}  Component-3, candidate values set: {wideband, wideband/subband}  Component-4, candidate value set: {no restriction, subset restriction}, “no restriction” is mandatory and RAN1 hasn’t decide whether “subset restriction” is mandatory or not, if it’s mandatory then this component is not needed. | | |  | |
|  | 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 | | 2-41 | | | Yes | Type II SP-CSI feedback on long PUCCH is not supported | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | | Optional? | | |  | |
|  | 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 | |  | | | Yes | Type II codebook with port selection is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Note: simultaneously doesn’t mean in the same slot | | | |  | | | | Component-1 , candidate values {4, 8, 12, 16, 24, 32}  Component-2, candidate values set for “Lx” is {2,3,4}  Component-3, candidate values set: {wideband, wideband/subband} | | |  | |
|  | 2-44 | | Basic DL PTRS | | Support 1 port of PTRS | |  | | | Yes | DL PTRS is not supported | | | | Type 4 | | N.A. | | | | Yes | | | |  | | | |  | | | |  | | | | Mandatory with UE capability signaling for FR2  Optional for FR1 | | |  | |
|  | 2-45 | | Downlink 2Tx PTRS | | 1. Supported 2 ports of PTRS | | 2-44 | | | Yes | 2 ports of PTRS is not supported | | | | Type 1 | | N.A. | | | | N.A | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 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. | | 2-44 | | | Yes | Threshold recommendation is not supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Optional  FFS on the candidate value set for threshold set TSi | | |  | |
|  | 2-47 | | Basic UL PTRS | | Support 1 port of PTRS | |  | | | Yes | DL PTRS is not supported | | | | Type 4 | | N.A. | | | | Yes | | | |  | | | |  | | | |  | | | | Mandatory with UE capability signaling for FR2  FFS for FR1 | | |  | |
|  | 2-48 | | Uplink PTRS | | 1. Supported 2 ports of PTRS | | 2-47 | | | Yes | Uplink PTRS is not supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Optional | | |  | |
|  | 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. | | 2-47 | | | Yes | Threshold recommendation is not supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Optional  FFS on the candidate value set for threshold set TSi | | |  | |
|  | 2-50 | | Basic TRS | | 1. Support of TRS (mandatory)  2. All the periodicity are supported. | |  | | |  |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Mandatory without UE 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 simultaneously  4. Max # of TRS resource sets configured to UE per CC  5. Max # of TRS resource sets configured to UE across CCs | | 2-50 | | | Yes | TRS is not supported | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Component-1:  candidate values set: {BWP, min(52,BWP), both}  Component-2:  candidate values {1,2}  Component-3: Candidate value set: {1 to 8}  Component-4: Candidate value set: {1 to 64}  Component-5: Candidate value set: {1 to 128} | | |  | |
|  | 2-52 | | Basic SRS | | 1. Support 1 port SRS transmission  2. Support periodic/aperiodic SRS transmission  3. Support SRS Frequency intra/inter-slot hopping within BWP  4. At least one SRS resource per CC for aperiodic and periodic separately | |  | | |  |  | | | |  | |  | | | |  | | | |  | | | |  | | | |  | | | | Mandatory without UE capability | | |  | |
|  | 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 slot  3. Maximum number of periodic SRS resources (configured to UE) per BWP 4. Maximum number of periodic SRS resources (configured to UE) per BWP per slot  5. Maximum number of semi-persistent SRS resources (configured to UE) per BWP 6. Maximum number of semi-persistent SRS resources (configured to UE) per BWP per slot  7. Maximum number of SRS port per resource | | 2-52 | | | Yes | No more than one periodic and one aperiodic SRS resources per CC are supported and no SP-SRS is supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | 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 0, 1 , 2, 4, 8, 16} }  Component-6 candidate value: {0,1, 2,3,4,5, 6}  Component-7 candidate values: {1, 2, 4} | | |  | |
|  | 2-54 | | SRS transmission | | 1. Minimum time interval, N in unit of symbols, between DCI triggering and A-SRS transmission, | | 2-53 | | | Yes |  | | | | Type 1 | | No need | | | | N.A. | | | |  | | | | Note: there is a minimal timing (42 symbols) between A-CSI-RS reception and updating of A-SRS precoding | | | |  | | | | candidate value range is the same as that of N2 plus 42. | | |  | |
|  | 2-54a | | Simultaneous SRS Tx | | 1. Maximum number of simultaneous transmitted SRS resources per CC at one symbol,  FFS whether to break this FG into different SRS purposes | |  | | | Yes | Only one SRS resource can be transmitted at a given time | | | | Type 1 | | No need | | | | N.A. | | | |  | | | |  | | | |  | | | | Candidate Value Set:  {1, 2, 3, 4} | | |  | |
|  | 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, | | 2-53 | | | Yes | SRS Tx Switch is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Component-2 is agreed with conditioned to RAN4’s decision.— | | | | RAN1/4 | | | | Component-1 is a list of TRx pairs, candidates are {1T2R, 1T4R, 2T4R, 1T4R/2T4R}  Component-2: Candidate value set:, {yes, no}, | | |  | |
|  | 2-56 | | SRS carrier switch | | 1. Report inter-cell switching time capability | | 2-53 | | | Yes | SRS carrier switch is not supported | | | | Type 1 | | No need | | | | N.A. | | | |  | | | |  | | | | RAN1/4 | | | | candidate values set is up to RAN4 | | |  | |
|  | 2-57 | | Support low latency CSI feedback | | Support low latency CSI feedback | |  | | | Yes | Low latency CSI is not supported | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | | RAN1 | | | | Optional | | |  | |
| 3.DL control channel and procedure | 3-1 | Basic DL control channel | | | | 1) One UE-specific 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  - Single TCI state for a CORESET configuration  2) CSS and USS configurations for unicast PDCCH transmission per BWP per cell  - PDCCH aggregation levels 1, 2, 4, 8, 16  - 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 without dedicated RRC configuration and for type 0, 0A, and 2, the monitoring occasion can be any OFDM symbol(s) of a slot  3) Monitoring DCI formats 0\_0, 1\_0, 0\_1, 1\_1  4) Number of PDCCH blind decodes per slot with a given SCS follows Case 1-1 table  5) Processing one unicast DCI scheduling DL [and one unicast DCI scheduling UL] per slot per scheduled CC  6) Processing one of RA-RNTI or SI-RNTI or P-RNTI or C-RNTI in a slot per scheduled CC | |  | | Yes | | |  | | N.A. | | | N.A. | | | N.A | | |  | | | |  | | | |  | | | | Mandatory without capability signaling | | | | |  |
|  | 3-1a’ | | 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 | |  | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Mandatory with capability signaling | | |  | |
|  | 3-2 | | Unicast PDCCH monitoring following Case 1-2 | | - For unicast PDCCH, monitoring occasion is within a single span of 3 OFDM symbols within a slot  - Number of PDCCH blind decodes per slot with a given SCS follows Case 1-2 table for 15kHz SCS | |  | | | Yes |  | | | | Type 4 | | No need | | | | Applicable only to FR1 | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 3-3 | | More than one  CORESET configurations per BWP in addition to CORESET0 | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 3-4 | | More than one TCI state configurations per CORESET | |  | |  | | | Yes |  | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 3-5 | | For type 1 with dedicated RRC configuration, type 3, and UE-SS,, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 | |  | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 3-5a | | For type 1 with dedicated RRC configuration, type 3, and UE-SS,, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2 with a DCI gap | | For type 1 with dedicated RRC configuration, type 3 and UE-SS, monitoring occasion can be any OFDM symbol(s) of a slot for Case 2, with minimum time separation between two unicast DCIs for a same UE as   * 2OFDM symbols for 15kHz * 4OFDM symbols for 30kHz * 7OFDM symbols for 60kHz with NCP   14OFDM symbols for 120kHz | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 3-6 | | Dynamic SFI monitoring and dynamic UL/DL determination | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 3-7 | | Precoder-granularity of CORESET size | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
| 4.UL control channel and procedure | 4-1 | | Basic UL control channel | | 1) PUCCH format 0 over [1]-2 OFDM symbols once per slot with FH  3) PUCCH format 1 over [4] – 14 OFDM symbols once per slot with frequency-hopping  5) One SR configuration per PUCCH group  6) HARQ-ACK transmission once per slot with its resource/timing determined by using the DCI  7) Multiplexing of SR and HARQ-ACK on a PUCCH  8) HARQ-ACK piggyback on PUSCH  9) Semi-static beta-offset configuration for HARQ-ACK | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | RAN4 to check feasibility of frequency hopping for PUCCH formats for FR2 | | | |  | | | | 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 | |  | | | Yes |  | | | | Type 4 | | Yes | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-3 | | PUCCH format 2 over 1 – 2 OFDM symbols once per slot with FH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | | Mandatory with capability signaling | | |  | |
|  | 4-4 | | PUCCH format 3 over 4 – 14 OFDM symbols once per slot with FH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | | Mandatory with capability signaling | | |  | |
|  | 4-5 | | PUCCH format 4 over 4 – 14 OFDM symbols once per slot with FH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | | Mandatory with capability signaling | | |  | |
|  | 4-6 | | Non-frequency hopping for PUCCH formats 0 and 2 | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-7 | | Non-frequency hopping for PUCCH format 1, 3, and 4 | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-10 | | Dynamic HARQ-ACK codebook | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | | RAN1 understanding is that at least one of 4-10 and 4-11 is set to ‘1’ | | | | RAN1 | | | | Mandatory with capability signaling | | |  | |
|  | 4-11 | | Semi-static HARQ-ACK codebook | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | | Mandatory with capability signaling | | |  | |
|  | 4-12 | | HARQ-ACK spatial bundling for PUCCH or PUSCH per PUCCH group | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
| Already implemented in R2-1804072 | 4-13 | | More than one SR configurations per PUCCH group | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | | RAN2 to check | | | | RAN1 and RAN2 | | | |  | | |  | |
| Covered by MIMO capabilities | 4-14  Will be discussed in MIMO | | P-CSI reporting piggybacked on a PUSCH | |  | |  | | | Yes |  | | | | [Type 4] | | [No need] | | | | [No need] | | | |  | | | | This is considered as the basic CSI features | | | | RAN1 | | | |  | | |  | |
| Covered by MIMO capabilities | 4-15  Will be discussed in MIMO | | PUCCH transmission carrying SP-CSI reporting (or piggybacked on a PUSCH) | |  | |  | | | Yes |  | | | | [Type 4] | | [No need] | | | | [No need] | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
| Covered by MIMO capabilities | 4-16  Will be discussed in MIMO | | PUSCH transmission carrying SP-CSI reporting | |  | |  | | | Yes |  | | | | [Type 4] | | [No need] | | | | [No need] | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  |  | |  | |  | |  | | | Yes |  | | | | [Type 4] | | [No need] | | | | [No need] | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
| Covered by MIMO capabilities | 4-18  Will be discussed in MIMO | | More than one CSI reporting on one channel once per slot | |  | |  | | | Yes |  | | | | [Type 4] | | [No need] | | | | [No need] | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-19 | | SR/HARQ-ACK/CSI multiplexing once per slot using a PUCCH (or piggybacked on a PUSCH) | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-20 | | UCI code-block segmentation | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | | Mandatory with capability signaling | | |  | |
|  | 4-21 | | Dynamic beta-offset configuration and indication for HARQ-ACK and/or CSI | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-22 | | 1 long PUCCH format and 1 short PUCCH format in the same slot | | 1) 1 long PUCCH format and 1 short PUCCH format in the same slot | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
|  | 4-22a | | 2 PUCCH transmissions in the same slot which are not covered by 4-22 and 4-2 | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 4-23 | | Repetitions for PUCCH format 1, 3,and 4 over multiple slots with K = 1, 2, 4, 8 | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | | [Mandatory with capability signaling] | | |  | |
|  | 4-24 | | PUCCH-spatialrelationinfo indication by a MAC CE per PUCCH resource | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | | RAN1 | | | |  | | |  | |
| 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 interleaving  2) Time-domain resource allocation  - [2 – 14] OFDM symbols for PDSCH [1-14] OFDM symbols for PUSCH once 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 and type B3) TBS determination  4) Nominal UE processing time for N1 and N2 (Capability #1)  5) HARQ process operation with configurable number of DL/UL HARQ processes of up to 16  6) Cell specific RRC configured UL/DL assignment  7) Dynamic UL/DL determination based on L1 scheduling DCI with cell specific RRC configured UL/DL assignment  8) Intra-slot frequency-hopping for PUSCH scheduled by Type 1 before RRC connection | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | Note: If UE is configured with more than 8 HARQ processes, RAN4 continue to discuss the impact of 16 HARQ processes | | | | RAN1 | | | | 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 | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | RAN1 needs to check component | | | | RAN1 | | | |  | | |  | |
|  | 5-2 | | RA Type 0 for PUSCH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-3 | | Dynamic switching between RA Type 0 and RA Type 1 for PDSCH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-4 | | Dynamic switching between RA Type 0 and RA Type 1 for PUSCH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-6 | | PDSCH mapping type A with less than 7 OFDM symbols | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | | [Mandatory with capability signaling] | | |  | |
|  | 5-6a | | PDSCH mapping type B | |  | |  | | |  |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | | Mandatory with capability signaling | | |  | |
|  | 5-7 | | Interleaving for VRB-to-PRB mapping for PDSCH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-8 | | Interleaving for VRB-to-PRB mapping for PUSCH | |  | | 0-12 | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-9 | | Intra-slot frequency-hopping for PUSCH except for PUSCH scheduled by Type 1 before RRC connection | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | | Mandatory with capability signaling | | |  | |
|  | 5-10 | | Inter-slot frequency hopping for PUSCH | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-11 | | Up to 2 unicast PDSCHs per slot for different TBs | | 1. PDSCH(s) for Msg. 4 is included | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Up to 2 unicast PDSCHs per slot in FDM is not supported  This capability is necessary for each SCS | | | |  | | | |  | | |  | |
|  | 5-11a | | Up to 7 unicast PDSCHs per slot for different TBs | |  | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Up to 7 unicast PDSCHs per slot in FDM is not supported  This capability is necessary for each SCS | | | |  | | | |  | | |  | |
|  | 5-12 | | Up to 2 PUSCHs per slot for different TBs | |  | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Up to 2 unicast PUSCHs per slot in FDM is not supported  This capability is necessary for each SCS | | | |  | | | |  | | |  | |
|  | 5-12a | | Up to 7 PUSCHs per slot for different TBs | |  | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | Up to 7 unicast PUSCHs per slot in FDM is not supported  This capability is necessary for each SCS | | | |  | | | |  | | |  | |
|  | 5-13 | | Type 1 configured PUSCH repetitions within a slot | | 1) K = 2, 4, 8 times repetitions with RV sequences | | 5-19 | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-14 | | Type 1 configured PUSCH repetitions over multiple slots | | 1) K = 2, 4, 8 times repetitions with RV sequences | | 5-19 | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-15 | | Type 2 configured PUSCH repetitions within a slot | | 1) K = 2, 4, 8 times repetitions with RV sequences | | 5-20 | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-16 | | Type 2 configured PUSCH repetitions over multiple slots | | 1) K = 2, 4, 8 times repetitions with RV sequences | | 5-20 | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-17 | | PUSCH repetitions over multiple slots | | 1) K = 2, 4, 8 times repetitions | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-17a | | PDSCH repetitions over multiple slots | | 1) K = 2, 4, 8 times repetitions | |  | | | Yes |  | | | | Type 4 | | No need | | | |  | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-18 | | DL SPS | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-19 | | Type 1 Configured UL grant | | 1) K = 1 | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-20 | | Type 2 Configured UL grant | | 1) K = 1 | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-21 | | Pre-emption indication for DL | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-22 | | CBG-based re-transmission for DL using CBGTI | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-23 | | CBGFI for CBG-based re-transmission for DL | |  | | 5-22 | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-24 | | Dynamic HARQ-ACK codebook using sub-codebooks for CBG-based re-transmission for DL | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-25 | | CBG-based re-transmission for UL using CBGTI | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-26 | | Semi-static rate-matching resource set configuration for DL | | 1) Bitmap 1/2/3 | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-27 | | Dynamic rate-matching resource set configuration for DL | | 1) Bitmap 1/2/3 | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-28 | | Rate-matching around LTE CRS | |  | |  | | | Yes |  | | | | Type 4 | | No need | | | | No need | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 5-25 | | LBRM for PUSCH | | Limited buffer rate matching in UL | |  | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | |  | | |  | |
| 6. CA/DC, BWP, SUL | 6-1 | | Basic BWP operation | | 1) 1 UE-specific RRC configured DL BWP per carrier  2) 1 UE-specific RRC configured UL BWP per carrier  2) RRC reconfiguration of any parameters related to BWP | |  | | | Yes |  | | | | N.A. | | N.A. | | | | N.A. | | | |  | | | | This feature should be mandatory for at least BWPs which is the same as the set of specified channel BW  RAN4 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] | | |  | |
|  | 6-2 | | Type A BWP adaptation with same numerology | | 1) Up to 2 UE-specific RRC configured DL BWPs per carrier  2) Up to 2 UE-specific RRC configured UL BWPs per carrier  3) Active BWP switching by DCI and timer  4) Same numerology for all the UE-specific RRC configured BWPs per carrier  5) Same common search space for 2 BWPs per carrier  6) BW of each BWP includes BW of the same initial DL BWP if there is an initial DL BWP in a carrier | | 6-1 | | | Yes | Type A BWP adaptation with same numerology is not possible | | | | Type 1 | | N.A | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-3 | | Type B BWP adaptation with same numerology | | 1) Up to 4 UE-specific RRC configured DL BWPs per carrier  2) Up to 4 UE-specific RRC configured UL BWPs per carrier  3) Active BWP switching by DCI and timer  4) Same numerology for all the UE-specific RRC configured BWPs per carrier | | 6-1 | | | Yes | Type B BWP adaptation with same numerology is not possible | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-4 | | BWP adaptation with different numerologies | | 1) Up to 4 UE-specific RRC configured DL BWPs per carrier  2) Up to 4 UE-specific RRC configured UL BWPs per carrier  3) Active BWP switching by DCI and timer  4) More than one numerologies for the UE-specific RRC configured BWPs per carrier  5) Same numerology between DL and UL per cell except for SUL at a given time | | 6-1 | | | Yes | BWP adaptation with different numerologies is not possible | | | | Type 1 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | | Optional with capability signaling | | |  | |
| Covered by the NR CA band combination signalling | 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] | |  | | | Yes |  | | | | 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. | | | |  | | | |  | | |  | |
|  | 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 | | 6-5 | | | Yes |  | | | | Type 4 | | No need | | | | Yes | | | |  | | | |  | | | |  | | | |  | | |  | |
| Covered by the NR CA band combination signalling | 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 time]  3) One PUCCH group  4) Single TAG | | [6-5] | | | Yes |  | | | | 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. | | | |  | | | |  | | |  | |
|  | 6-7 | | Two PUCCH group | | 1) Same numerology across carriers for data/control channel [at a given time] | | 6-5, 6-6 | | |  |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-8 | | Different numerology across PUCCH groups | |  | | 6-5, 6-7 | | |  |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-9 | | Different numerologies across carriers within the same PUCCH group | | 1) Same numerology between DL and UL per carrier for data/control channel at a given time | | 6-5 | | |  |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-10 | | Cross carrier scheduling | | 1) Cross carrier scheduling with CIF | | 6-5, 6-6 | | | Yes | Cross carrier scheduling is not possible | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
| 2, 3, 4 TAGs | 6-11 | | Number of supported TAGs | | Need of multiple capability question about the resolution here | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-12 | | Support 2 simultaneous UL transmissions for problematic cases | | Delete [1) Case 1: DL-reference UL/DL configuration defined for LTE-FDD-SCell in LTE-TDD-FDD CA with LTE-TDD-PCell] [2) Case 2: Release 15 LTE-FDD HARQ timing] [3) UL offset for Case 1 based HARQ feedback] | |  | | | Yes | 2 simultaneous UL transmissions are not supported for problematic cases | | | | Type 2 | |  | | | |  | | | |  | | | | RAN2/4 to decide  This is a UE feature for LTE for a LTE/NR dual connectivity UE | | | | RAN2/4 | | | |  | | |  | |
|  | 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-Pcell 2) HARQ subframe offset | |  | | | Yes |  | | | | Type 2 | | Yes | | | | Yes | | | |  | | | | This is a UE feature for LTE for a LTE/NR dual connectivity UE | | | |  | | | |  | | |  | |
| Covered by #1-12 in the RAN4 feature list | 6-15 | | 7.5kHz UL raster shift | | 7.5kHz UL raster shift | |  | | | Yes |  | | | |  | | [No need] | | | | [No need] | | | |  | | | |  | | | | RAN4 | | | |  | | |  | |
| Covered by the NR CA band combination signalling | 6-16 | | Supplemental uplink | | ~~Initial access and RRC connected operation on SUL carrier (incl 7.5kHz configurable shift)~~ 1) RACH, PUSCH, PUCCH, SRS operations in a band combination including SUL 2) Supplemental uplink with same numerology between SUL and non SUL carriers | | 6-15 | | | Yes | ~~The UE will not be able to access or operate on a SUL carrier~~ UE will not be able to perform the RACH/PUSCH/PUCCH/SRS operation in a band combination including SUL | | | | 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. | | | |  | | | |  | | |  | |
| Covered by #2-2 in the RAN4 feature list | 6-17 | | Supplemental uplink with different numerologies between SUL and non SUL carriers | | Numerology other than that of associated DL | | 6-16 | | | Yes | The UE will not be able to access or operate on a SUL carrier | | | | 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. | | | |  | | | |  | | |  | |
|  | 6-18 | | Supplemental uplink with dynamic switch | | DCI based selection of PUSCH carrier | | 6-16 | | | Yes |  | | | | 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 | |  | | 6-16 | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
| Covered by #2-4 and 2-5 in the RAN4 feature list | 6-20 | | Simultaneous reception and transmission on different carriers for each band combination | |  | |  | | | Yes |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | | RAN4 to check if there is duplicate future in their capability or not. If not, this capability is to be defined | | | |  | | | |  | | |  | |
|  | 6-21 | | DL search space sharing for CA | |  | |  | | |  |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
|  | 6-22 | | UL search space sharing for CA | |  | |  | | |  |  | | | | Type 3 | | N.A. | | | | N.A. | | | |  | | | |  | | | |  | | | |  | | |  | |
| 7. Channel coding | 7-1 | | Channel coding | | 1) LDPC encoding and associated functions for data on DL and UL 2) Polar encoding and associated functions for PBCH, DCI, and UCI 3) Coding for very small blocks | |  | | | Yes | UE will not be able to transmit or receive data or control | | | | N.A. | | No need | | | |  | | | |  | | | |  | | | | RAN1 | | | | 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. | | EN-DC | Yes | | |  | | | Type 2 | | Yes | | | Yes | | |  | | | |  | | | | RAN | | | |  | | | |  | | |
| Covered by #6-13 | 8-2 | | | Operation A with single UL Tx case 1 | |  | | EN-DC | Yes | | |  | | Type 2 | | Yes | | | Yes | | |  | | | |  | | | |  | | | | Mandatory with capability signaling conditioned that UE does not support dynamic power sharing, optional for UEs supporting dynamic power sharing | | | |  | | | |
| Mandatory w/o capability??? | 8-2 | | | Basic power control operation | | 1) Accumulated power control mode for closed loop 2) 1 TPC command loop for PUSCH, PUCCH respectively 3) One or multiple DL RS configured for pathloss estimation 4) One or multiple p0-alpha values configured for open loop PC 5) PUSCH power control  6) PUCCH power control  7) PRACH power control  8) SRS power control  10) PHR | |  | Yes | | |  | | Type 4 | | No need | | | No need | | |  | | | |  | | | |  | | | |  | | | |  | | | |
|  | 8-3 | | | TPC-PUSCH-RNTI | | Specific group DCI message for TPC commands for PUSCH | |  | Yes | | |  | | Type 4 | | No need | | | Yes | | |  | | | |  | | | |  | | | |  | | | |  | | | |
|  | 8-4 | | | TPC-PUCCH-RNTI | | Specific group DCI message for TPC commands for PUCCH | |  | Yes | | |  | | Type 4 | | No need | | | Yes | | |  | | | |  | | | |  | | | |  | | | |  | | | |
|  | 8-5 | | | TPC-SRS-RNTI | | Specific group DCI message for TPC commands for SRS | |  | Yes | | |  | | Type 4 | | No need | | | Yes | | |  | | | |  | | | |  | | | |  | | | |  | | | |
|  | 8-6 | | | Absolute TPC command mode | | Absolute TPC command mode | |  | Yes | | |  | | Type 4 | | No need | | | Yes | | |  | | | |  | | | |  | | | |  | | | |  | | | |
|  | 8-7 | | | UL power control with 2 PUSCH closed loops | | Two different TPC loops | |  | Yes | | |  | | Type 4 | | Yes | | | Yes | | |  | | | |  | | | |  | | | | Mandatory with capability signaling | | | |  | | | |
|  | 8-8 | | | UL power control with 2 PUCCH closed loops | | Two different TPC loops | |  | Yes | | |  | | Type 4 | | Yes | | | Yes | | |  | | | |  | | | |  | | | | Mandatory with capability signaling | | | |  | | | |