# Avg, 5% Spectral Efficiency - InH eMBB test environment

DL/4GHz

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| **Technical configuration Parameters** | Reference value | | Intel | | LGE | Samsung | Nokia | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | | FDD | TDD | FDD | FDD | FDD | TDD | FDD |
| Network synchronization | Synchronized | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | | 10 MHz | 20 MHz | 10 MHz | 10 MHz | Aligned with reference | Aligned with reference | 10 MHz |
| Frame structure |  | | FDD: Full downlink | DSUUD | FDD: Full downlink | FDD: Full downlink | FDD: Full downlink | DSUUD | FDD: Full downlink |
| Transmission scheme | closed SU/MU-MIMO adaptation | | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | Closed-loop SU/MU-MIMO adaptation with zero forcing. | Closed-loop SU/MU-MIMO adaptation with zero forcing. | MU-MIMO |
| DL CSI measurement |  | | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | SRS-based | - |
| DL codebook |  | | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4beam, wb only, 8psk | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | Pseudo inverse of channel matrix |
| PRB bundling |  | | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | - |
| MU dimension |  | | Up to 12 layers | Up to 12 layers | Up to 12 layers | Up to 12 layers | Up to 12 users | Up to 8 users | Up to 12 layers |
| SU dimension |  | | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers | For 4Rx: Up to 2 layers (accroding to current Type II CSI) | For 4Rx: Up to 4 layers | Up to 1 layer per user | Up to 1 layer per user | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | | N/A | N/A | N/A | N/A | N/A | For UE 8 Tx ports: Non-precoded SRS, 8 SRS ports 4 symbols every 10ms | N/A |
| CSI feedback |  | | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slots; RI: every 5 slots; Subband based, 5 slot delay | CQI: every 10 slots; RI: every 10 slots Subband based, 5 slot delay | CQI : every 5ms |
| Interference measurement |  | | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | - |
| CBG | 1 | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay |  | | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  | | - | - | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  For 36TRxP:  - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 2,8)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  For 36TRxP:  - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 2,8)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  For 36TRxP:  - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 2,8)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  For 36TRxP:  - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 2,8)  (dH,dV) = (0.5, 0.5)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ | (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   (M,N,P,Mg,Ng; Mp,Np) = (1,4,2,1,1; 1,4) (dH,dV) = (0.5, - )λ | For 12TRxP:  (M,N,P,Mg,Ng; Mp,Np) = (1,4,2,1,1; 1,4) (dH,dV) = (0.5, - )λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ |
| Scheduling | PF | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation | Non-ideal | | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | ideal |
| **System configuration parameters** | Reference Value | |  |  |  |  |  |  |  |
| TRxP number per site | 1 | 3 | Aligned with reference | Aligned with reference |  | 1 | 1 | 1 | 1 / 3 |
| Mechanic tilt | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | 90° in LCS | 90° in LCS | Aligned with reference | Aligned with reference |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | | 1 | 1 |  | 1 |  |  | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0  The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | | Aligned with reference | Aligned with reference |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | No wrapping around | | Aligned with reference | Aligned with reference |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | | - | - |  | - | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | | - | - |  | - | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | | Aligned with reference | Aligned with reference |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | | - | - |  | - | - | - | - |
| Analog beam selection for interfering TRxP | - | | - | - |  | - | - | - | - |

UL/4GHz

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| **Technical configuration Parameters** | Reference value | | Intel | | LGE | Nokia | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR FDD** |
| Multiple access | OFDMA | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | | FDD | TDD | FDD | FDD | FDD |
| Network synchronization | Synchronized | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | | 10 MHz | 20 MHz | 10 MHz | 10 MHz | 10 MHz |
| Frame structure |  | | Full uplink | DSUUD | Full uplink | Full uplink | Full uplink |
| Transmission scheme | UL codebook based SU-MIMO / MU-MIMO | | UL MU-MIMO with rank adaptation | UL MU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation | Closed-loop UL MU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation |
| UL codebook |  | | For 4Tx: NR 4Tx codebook | For 4Tx: NR 4Tx codebook | For 2Tx: NR 2Tx codebook | For 4Tx: NR 4Tx codebook | For 4Tx: NR 4Tx codebook |
| MU dimension |  | | 12 layers at gNB; Max 4 layers at UE | 12 layers at gNB; Max 4 layers at UE | N/A | Up to 3 users | N/A |
| SU dimension |  | | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers | Up to 2 layers per user | For 4Tx: Up to 4 layers |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Up to 2 layers per user |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | | 4 port non-precoded SRS  (1 SRS resource) | 4 port non-precoded SRS  (1 SRS resource) | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | For UE 4Tx ports: Non-precoded SRS, 4 SRS ports 4 symbols every 10ms | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  For 36TRxP:  - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 2,8)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  For 36TRxP:  - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 2,8)  (dH,dV) = (0.5, 0.5)λ | 12TRP: For 16R, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;2,4)  (dH,dV) = (0.5, 0.5)λ | 12TRP: For 128R, (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;8,8)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4) For 36TRxP:   - For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ | 12TRP: For 2T, (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | 12TRP: For 4T, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=( 0.5, - )λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ |
| Max CBG number | 1 | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| UL re-transmission delay |  | |  |  | Next available UL slot after receiving retransmission indication | Next available UL slot after receiving retransmission indication |  |
| Scheduling | PF | | MU-PF | MU-PF | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | | Aligned with reference | Aligned with reference | Aligned with reference | MMSE | MMSE |
| Channel estimation |  | | Non-ideal | Non-ideal | Non-ideal | Non-ideal | ideal |
| Power control parameter |  | | For 12 TRxP: P0=-90, alpha = 0.9 For 36 TRxP: P0=-100, aplha=0.8 | For 12 TRxP: P0=-90, alpha = 0.9 For 36 TRxP: P0=-100, aplha=0.8 | P0=-102, alpha = 0.7 | P0=-95, alpha = 0.8 | P0=-60, alpha = 0.6 |
| Power backoff model |  | | Continuous RB allocation: follow TS 38.101 for FR1; Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1; Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1; Non-continuous RB allocation: additional 2 dB reduction | - | - |
| **System configuration parameters** | Reference Value | |  |  |  |  |  |
| TRxP number per site | 1 | 3 | Aligned with reference | Aligned with reference | Aligned with reference | 1 | Aligned with reference |
| Mechanic tilt | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | 90° in LCS | 90° in LCS | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | | 1 | 1 | 0 |  | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0  The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | No wrapping around | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | | - | - | - | - |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | | - | - | - | - |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | | - | - | - | - |  |
| Analog beam selection for interfering TRxP | - | | - | - | - | - |  |

DL/30GHz

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| **Technical configuration Parameters** | Reference value | | Intel | Samsung | Qualcomm | Ericsson | Korea Univ. |
| **NR TDD** | **NR TDD** | **NR TDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | | TDD | TDD | TDD | TDD | FDD |
| Network synchronization | Synchronized | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 60 kHz / 120 kHz, 14 OFDM symbol slot | | 120 kHz SCS, 14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot | 60 / 120 kHz SCS, 14 OFDM symbol slot | 60kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | 5.5% (for 80 MHz) | |  | 5.5% (for 80 MHz) | 5% (for 80 MHz) | 5.5% (for 80 MHz) | 5% (for 40 MHz) |
| Simulation bandwdith | 80 MHz | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 40MHz |
| UE antenna panel selection for data transmission and UE attachment | The UE panel with the best receive SNR is chosen for transmission and reception | | Aligned with reference | Two UE panels are used for transmission and reception | Aligned with reference | Aligned with reference | Aligned with reference |
| Frame structure |  | | DSUUD | DDDSU | DDDU | DDDSU | Full downlink |
| Transmission scheme | Analog beam selection based | | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | Closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | MU-MIMO |
| DL CSI measurement |  | | Non-precoded CSI-RS based | Precoded CSI-RS based, non-PMI | Non-Precoded CSI-RS based | Precoded CSI-RS based, non-PMI | - |
| DL codebook |  | | Type II, 4 beam, wb+sb, 8PSK | N/A | Ideal | N/A | Pseudo inverse of channel matrix |
| PRB bundling |  |  | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | - |
| MU dimension |  | | Up to 6 layers (**with PTRS transmitted**) | Up to 6 layers (with PTRS transmitted) | Up to 8 layers | Up to 6 layers (with PTRS transmitted) | Up to 12 layers |
| SU dimension |  | | For 2Rx with the best receive panel: Up to 2 layers | For 4Rx with the best receive panel: Up to 4 layers | Up to 2 layers | For 4Rx with the best receive panel: Up to 4 layers | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | | N/A | For UE 4 Tx ports in the best panel: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 2 symbols in every 10 slots | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports, 1 symbol every 2 UL slots | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 2 symbols in special slot for SRS, 8 PRBs per symbol | N/A |
| CSI feedback |  | | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI: every 25 slot; RI: every 25 slot, CRI: every 25 slot Subband based | CQI: every 8 slots; RI: every 8 slots, CRI: every 8 slots Subband based | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI : every 5ms |
| Interference measurement |  | | SU-CQI | SU-CQI;CSI-IM for inter-cell interference measurement | SU-CQI;CSI-IM for inter-cell interference measurement | SU-CQI;CSI-IM for inter-cell interference measurement | - |
| CBG | 1 | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay |  | | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  | |  | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 12 TRxP - 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ  For 36 TRxP - 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;2,8)  (dH,dV) = (0.5, 0.5)λ | For 12 TRxP - 8T, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;2,2)  (dH,dV) = (0.5, 0.5)λ | For 12 TRxP - (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1;2,2)  (dH,dV) = (0.5, 0.5)λ | For 12TRxP: 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ | 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 12TRxP: 8R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,2) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | 8R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,2) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0) |
| Scheduling | PF | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation | Non-ideal | | Non-ideal | Non-Ideal | Non-Ideal | Non-ideal | Ideal |
| **System configuration parameters** | Reference value | |  |  |  |  |  |
| TRxP number per site | 1 | 3 |  | Aligned with reference | Aligned with reference | Aligned with reference | 1 |
| Mechanic tilt | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | (According to Zenith angle in "Beam set at TRxP") | (According to Zenith angle in "Beam set at TRxP") | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | | 1 | 1 | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0  The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | No wrapping around | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | For direction of TRxP analog beam steering (in LCS): Azimuth angle φi = [-3\*pi/8, -1\*pi/8, 1\*pi/8, 3\*pi/8] Zenith angle θj =  [pi/4 3\*pi/4] for 1 TRxP/site;  [pi/2 3\*pi/4] for 3 TRxPs/site NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array.  Precoder for beam at (phai\_i, theta\_j) is given by equation 1 in Appendix 1 of RP-180524 (2D DFT beam) | | DFT Beam Selection with  2x Oversampling | Aligned with reference | DFT beam selection | Azimuth angle φi = [0], Zenith angle θj = [pi/2] | Aligned with reference |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | For direction of UE analog beam steering (in LCS): Azimuth angle φi = [-3\*pi/8, -pi/8, pi/8, 3\*pi/8]; Zenith angle θj = [pi/4, 3\*pi/4]; NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array. Precoder for beam at (φi, θj) is given by equation 1 in Appendix 1 of RP-180524 (2D DFT beam) | | DFT Beam Selection | Aligned with reference | DFT beam selection | Azimuth angle φi = [-pi/4, pi/4] Zenith angle θj = [pi/4, 3\*pi/4] for 1 TRxP/site; | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP with best analog beam pair, where the digital beamforming is not considered | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | Select the best beam pair among the set of DFT beams, based on the criteria of maximizing receive power after beamforming. | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Analog beam selection for interfering TRxP | Based on the analog beam selection according to scheduling results of non-serving TRxP | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Random selecting the random beams for non-serving TRxP |

UL/30GHz

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | | Intel | Ericsson | Samsung | Qualcomm | Korea Univ. |
| **NR TDD** | **NR TDD** | **NR TDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | | TDD | TDD | TDD | TDD | FDD |
| Network synchronization | Synchronized | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology | 60 kHz / 120 kHz, 14 OFDM symbol slot | | 120 kHz SCS, 14 OFDM symbol slot | 60 kHz SCS, 14 OFDM symbol slot | 120KHz  14 OFDM symbol slot | 120 KHz, 14 OFDM symbol slot | 120 KHz, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth |  | |  |  | 5.5% (for 80 MHz) | 5% (for 80 MHz) |  |
| Simulation bandwdith | 80 MHz | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| UE antenna panel selection for data transmission and UE attachment | The UE panel with the best receive SNR is chosen for transmission and reception | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Frame structure |  | | DSUUD | Full uplink | DDDSU | DDDU |  |
| Transmission scheme | Analog beam selection based | | UL MU-MIMO with rank adaptation | UL MU-MIMO with rank adaptation | UL MU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation |
| UL codebook |  | | For 4Tx with the best Tx panel: NR 4Tx codebook | 4Tx codebook | For 4Tx with the best Tx panel: NR 4Tx codebook | 2 Tx with best Tx Panel: Ideal | 2 Tx with best Tx Panel: Ideal |
| MU dimension |  | | Up to 6 Layers at gNB | Up to 4 Layers at gNB | Up to 6 layers at gNB | N/A | N/A |
| SU dimension |  | | For 4Tx with the best Tx panel: Up to 2 layers | For 4Tx with the best Tx panel: Up to 2 layers | For 4Tx with the best Tx panel: Up to 2 layers | Up to 2 layers | Up to 2 layers |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | | 4 port non-precoded SRS  (1 SRS resource) | 4 port non-precoded SRS | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 2 symbols in special slot for SRS, 8 PRBs per symbol | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports, 1 symbol every 2 UL slots | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 12 TRxP - 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;4,4)  (dH,dV) = (0.5, 0.5)λ  For 36 TRxP - 32T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;2,8)  (dH,dV) = (0.5, 0.5)λ | For 64R, (M,N,P,Mg,Ng; Mp,Np) = (4,32,2,1,1;1,32)  (dH,dV) = (0.5, 0.5)λ | For 12 TRxP - 8R, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;2,2)  (dH,dV) = (0.5, 0.5)λ | For 12 TRxP - (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1;1,1)  (dH,dV) = (0.5, 0.5)λ | For 12 TRxP - 8R, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;2,2)  (dH,dV) = (0.5, 0.5)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 8R, (M,N,P,Mg,Ng; Mp,Np) = (1,4,2,1,1; 1,4) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 4T, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1; 1,2) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ |
| Max CBG number | 1 | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| UL re-transmission delay |  | | Next available UL slot after receiving retransmission indication | Next available UL slot after receiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |
| Scheduling | PF | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Channel estimation |  | | Non-ideal | Non-ideal | Non-ideal | Non-ideal | ideal |
| Power control parameter |  | | For 12 TRxP: P0 = -70, alpha = 0.8 For 36 TRxP: P0 = -70, alpha = 0.7 | P0=-80, alpha = 0.9 | P0=-80, alpha = 0.8 |  | P0=-80, alpha = 0.8 |
| Power backoff model |  | | Contiguous RB allocation; Follow TS 38.101-2; Mean IOT<10dB | Non-contiguous RB allocation; Follow TS 38.101-2 | Continuous RB allocation | Continuous RB allocation | - |
| **System configuration parameters** | Reference value | |  |  |  |  |  |
| TRxP number per site | 1 | 3 |  |  | Aligned with reference | Aligned with reference | Aligned with reference |
| Mechanic tilt | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | (According to Zenith angle in "Beam set at TRxP") | (According to Zenith angle in "Beam set at TRxP") | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | | 1 | 3 | 0 | 0 |  |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0  The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | No wrapping around | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | For direction of TRxP analog beam steering (in LCS): Azimuth angle φi = [-3\*pi/8, -1\*pi/8, 1\*pi/8, 3\*pi/8] Zenith angle θj =  [pi/4 3\*pi/4] for 1 TRxP/site;  [pi/2 3\*pi/4] for 3 TRxPs/site NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array.  Precoder for beam at (phai\_i, theta\_j) is given by equation 1 in Appendix 1 of RP-180524 (2D DFT beam) | | DFT Beam Selection 2x Oversampling | DFT Beam Selection | Aligned with reference | DFT Beam selection | DFT Beam selection |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | For direction of UE analog beam steering (in LCS): Azimuth angle φi = [-3\*pi/8, -pi/8, pi/8, 3\*pi/8]; Zenith angle θj = [pi/4, 3\*pi/4]; NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array. Precoder for beam at (φi, θj) is given by equation 1 in Appendix 1 of RP-180524 (2D DFT beam) | | DFT Beam Selection | DFT Beam Selection | Aligned with reference | DFT Beam selection | DFT Beam selection |
| Criteria for selection for serving TRxP | Maximizing RSRP with best analog beam pair, where the digital beamforming is not considered | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | Select the best beam pair among the set of DFT beams, based on the criteria of maximizing receive power after beamforming. | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Analog beam selection for interfering TRxP | Based on the analog beam selection according to scheduling results of non-serving TRxP | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |

# Avg, 5% Spectral Efficiency - Dense Urban eMBB test environment

DL/4GHz

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| **Technical configuration Parameters** | Reference value for NR | Intel | | LGE | Samsung | Nokia | | Qualcomm | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | FDD | FDD | TDD | TDD | FDD | TDD | FDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 15KHz / 30kHz, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 30 kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz/30kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 54 RBs for 30 kHz SCS and 20 MHz BW | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | Aligned with reference | Aligned with reference | 10 MHz | Aligned with reference | Aligned with reference | Aligned with reference | TDD: 20 MHz | Aligned with reference | Aligned with reference | 10MHz |
| Frame structure |  | Full downlink | DSUUD | Full downlink | Full downlink | Full downlink | DSUUD | DDSU | Full downlink | DDDSU | Full downlink |
| Transmission scheme | Closed SU/MU-MIMO adaptation | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MU-MIMO | Aligned with reference | Aligned with reference | MU-MIMO |
| DL CSI measurement |  | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | SRS-based | CSI-RS based | Non-precoded CSI-RS based | Precoded CSI-RS based | - |
| DL codebook |  | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4beam, wb only, 8psk | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | N/A | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | Pseudo inverse of channel matrix |
| PRB bundling |  | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs |  | 4 PRBs | 4 PRBs | - |
| MU dimension |  | Up to 12 layers | Up to 12 layers | Up to 12 layers | Up to 12 layers | Up to 12 layers | Up to 8 layers | Upto 12 layers | Up to 12 layers | Up to 12 layers | Up to 12 layers |
| SU dimension |  | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers | For 4Rx: Up to 2 layers (according to current Type II CSI) | For 4Rx: Up to 4 layers | 1 layer | 1 layer |  | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | N/A | N/A | N/A | N/A | N/A | For 4 or 8 UE ports: Non-precoded SRS, 2 SRS ports, 4 symbols per frame | Non precoded SRS, 4 SRS ports, 1 symbol per S/U subframe | N/A | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 4 symbols per 5 slots for 15kHz SCS; 2 symbols per 5 slots for 30kHz SCS; | N/A |
| CSI feedback |  | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slots; RI: every 5 slots; Subband based , 5 slot delay | CQI: every 10 slots; RI: every 10 slots; Subband based, 5 slot delay | Every S/U subframe | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI : every 5ms |
| Interference measurement |  | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | - |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay | UE capability 1 | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | 1 slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  |  |  | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | 3 slots | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32Tx/8Rx: (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1;2,8) For 32Tx/4Rx: (M,N,P,Mg,Ng;Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32Tx/8Rx: (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1;2,8) For 32Tx/4Rx: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ; | For 128T: (M,N,P, Mg,Ng,Mp,Np) = (8, 16, 2, 1, 1, 4, 16) | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, 0.5)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 8Rx: (M,N,P,Mg,Ng; Mp,Np)= (1,4,2,1,1; 1,4) For 4Rx: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 8Rx: (M,N,P,Mg,Ng; Mp,Np)= (1,4,2,1,1; 1,4) For 4Rx: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4 R: (M, N, P, Mg, Ng, Mp, Np) = (1, 2, 2, 1, 1, 1, 2) | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, 0.5)λ |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MMSE-IRC | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Ideal |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | 105 degree | 102 degree | 102 degree | 102 degree | Aligned with reference | 100 degrees | 100 degrees | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 1 | 1 | 1 | 1 |  |  |  | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Radio-distance based wrapping | Radio-distance based wrapping | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - | - | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - | - | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - | - | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - | - | - | - | - |

UL/4GHz

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Nokia | Qualcomm | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | FDD | TDD | FDD | TDD | FDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology | 15KHz / 30kHz, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 30 KHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz/30kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz) TDD: 8.2% (51 RB for 30 kHz 20 MHz) TDD: 4.6% (106 RB for 15 kHz 20 MHz) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 54 RBs 30 KHz SCS for 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference | 10 MHz | 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference |
| Frame structure |  | Full uplink | DSUUD | Full uplink | Full uplink | DDSU | Full uplink | DDDSU | Full uplink |
| Transmission scheme | UL codebook based SU-MIMO / MU-MIMO | UL SU/MU-MIMO with rank adaptation | UL SU/MU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation | Closed-loop UL MU-MIMO with rank adaptation | UL codebook-based MU-MIMO | UL SU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation |
| UL codebook |  | For 4Tx: NR 4Tx codebook | For 4Tx: NR 4Tx codebook | For 2Tx: NR 2Tx codebook | For 4Tx: NR 4Tx codebook | NR R15 4 Tx codebook (fully-coherent) | NR R15 4 Tx codebook (fully-coherent) | NR R15 4 Tx codebook (fully-coherent) | For 4Tx: NR 4Tx codebook |
| MU dimension |  | Up to 12 layers at gNB | Up to 12 layers at gNB | N/A | Up to 6 users | Up to 12 layers at gNB | N/A | N/A | N/A |
| SU dimension |  | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers | For 2Tx: Up to 2 layers | Up to 2 layers per user | Up to 4 layers per user | Up to 4 layers per user | Up to 4 layers per user | Up to 4 layers per user |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | 4 port non-precoded SRS  (1 SRS resource) | 4 port non-precoded  (1 SRS resource) | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 2 SRS resources), 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | For UE 4Tx ports: Non-precoded SRS, 4 SRS ports 4 symbols every 10ms | Non precoded SRS, 4 SRS ports, 1 symbol per S/U subframe | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources); 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources); 2 symbols for SRS in every 5 slots, 8 PRBs per symbol |  |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 32R: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32R: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32R: (M,N,P,Mg,Ng; Mp,Np)= (8,8,2,1,1; 2,8) (dH, dV)=(0.5, 0.8)λ; | For 32R, (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1;2,8)  (dH,dV) = (0.5, 0.8)λ | 128R (M, N, P, Mg, Ng, Mp, Np) = (8, 16, 2, 1, 1, 4, 16) (dH, dV) = (0.5, 0.8)λ | For 32R: (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1; 2,8) (dH, dV)=(0.5, 0.8)λ | For 32R: (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1; 2,8) (dH, dV)=(0.5, 0.8)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (8,8,2,1,1; 1,8)  (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4T: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4T: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | For 4T, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=( 0.5, - )λ | 4T: (M, N, P, Mg, Ng, Mp, Np) = (1, 2, 2, 1, 1, 1, 2) | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) dH, dV)=( 0.5, N/A)λ; | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) dH, dV)=( 0.5, N/A)λ; | For 4T: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2)  (dH, dV)=( 0.5, N/A)λ |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| UL re-transmission delay |  | n+4 UL slot after reiving retransmission indication | n+4 UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after receiving retransmission indication | Next available UL slot after 2 slot processing delay | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | MMSE | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | ideal |
| Power control parameter |  | P0=-90, alpha = 0.8 | P0=-90, alpha = 0.8 | P0=-80, alpha = 0.7 | P0=-95, alpha = 0.8 | P0=-105.4, alpha = 0.9 | P0=-80, alpha = 0.8 | P0=-80, alpha = 0.8 | P0=-60, alpha = 0.6 |
| Power backoff model |  | Continuous RB allocation: follow TS 38.101 for FR1; Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1; Mean IOT<10dB | Non power backoff model | - | - | - | - | - |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | 105 degree | 102 degree | 102 degree | 102 degree | 100 degrees | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 1 | 1 | 0 |  |  | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - | - |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - | - |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - | - |  |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - | - |  |

DL/30GHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson | Samsung | Qualcomm | Korea Univ. |
| **NR TDD** | **NR TDD** | **NR TDD** | **NR TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | TDD | TDD | TDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 60KHz / 120kHz, 14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth |  | 5.5% (for 80 MHz) | 5.5% (for 80 MHz) | 5% (for 80 MHz) | 5.5% |
| Simulation bandwidth | 80 MHz | Aligned with reference | 100MHz | 80MHz | 80 MHz |
| UE antenna panel selection for data transmission and UE attachment | The UE panel with the best receive SNR is chosen for transmission and reception | Two UE panels are used for transmission and reception | Aligned with reference | Aligned with reference | Aligned with reference |
| Frame structure |  | DDDSU | DDDSU | DDDU | Full downlink  (downlink only) |
| Transmission scheme | Analog beam selection based | Combined SU- and MU-MIMO | Combined SU- and MU-MIMO | SU/MU-MIMO adaptation | MU-MIMO |
| DL CSI measurement |  | Precoded CSI-RS based | Precoded CSI-RS based | Non-precoded CSI-RS based | - |
| DL codebook |  | N/A | N/A | N/A | Pseudo inverse of channel matrix |
| PRB bundling |  | 4 PRBs | 4 PRBs | 4 PRBs | - |
| MU dimension |  | Up to 6 layers | Up to 6 layers | Up to 2 layers | Up to 6 layers |
| SU dimension |  | Up to 2 layers | Up to 2 layers | Up to 2 layers | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | For UE two tx ports, prec-coded SRS, one symbol in 10 slots | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 2 symbols in special slot for SRS, 8 PRBs per symbol | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports | N/A |
| CSI feedback |  | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI: every 25 slot; RI: every 25 slot, CRI: every 25 slot Subband based | CQI: every 8 slot; RI: every 8 slot, CRI: every 8 slot Subband based | CQI: every 5 ms |
| Interference measurement |  | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | - |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay |  | The next available UL slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 128T, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 4,16) (dH, dV)=(0.5, 0.5)λ | For 8T, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,2,2; 1,1) (dH, dV)=(0.5, 0.5)λ (dg,H,dg,V) = (4.0, 2.0)λ | For 8T, (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1; 2,2) (dH, dV)=(0.5, 0.5)λ (dg,H,dg,V) = (4.0, 2.0)λ | For 8T, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,2,2; 1,1) (dH, dV)=(0.5, 0.5)λ (dg,H,dg,V) = (4.0, 2.0)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 2,4)  (dH, dV)=(0.5, 0.5)λ  (dg,H,dg,V) = (4.0, 2.0)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 2R, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | ideal |
| **System configuration parameters** | Reference value |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | (According to Zenith angle in "Beam set at TRxP") | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0  The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | For direction of TRxP analog beam steering (in LCS): Azimuth angle φi = [-5\*pi/16, -3\*pi/16, -pi/16, pi/16, 3\*pi/16, 5\*pi/16] Zenith angle θj = [5\*pi/8, 7\*pi/8] NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array. Precoder for beam at (φi, θj) is given by equation 1 in Appendix 1 of RP-180524 (2D DFT beam) | Aligned with reference | Aligned with reference | N/A | Aligned with reference |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | For direction of UE analog beam steering (in LCS): Azimuth angle φi = [-3\*pi/8, -pi/8, pi/8, 3\*pi/8]; Zenith angle θj = [pi/4, 3\*pi/4]; NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array. Precoder for beam at (φi, θj) is given by equation 1 in Appendix 1 (2D DFT beam) | Aligned with reference | Aligned with reference | N/A | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP with best analog beam pair, where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | Select the best beam pair among the limited set of DFT analog beams, based on the criteria of maximizing receive power after beamforming. | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for interfering TRxP | Based on the analog beam selection according to scheduling results of non-serving TRxP | Aligned with reference | Aligned with reference | Aligned with reference | Random  selecting  the random  beams for  non-serving  TRxP |

UL/30GHz

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| --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson | Samsung | Qualcomm | Korea Univ. |
| **NR TDD** | **NR TDD** | **NR TDD** | **NR TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Duplexing |  | TDD | TDD | TDD |  |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Numerology | 60KHz / 120kHz, 14 OFDM symbol slot | 120KHz  14 OFDM symbol slot | 120kHz SCS, 14 OFDM symbol slot | 120KHz  14 OFDM symbol slot |  |
| Guard band ratio on simulation bandwidth |  | 5.5% (for 80 MHz) | 5.5% (for 80 MHz) | 5% (for 80 MHz) |  |
| Simulation bandwidth | 80 MHz | Aligned with reference | 100MHz | Aligned with reference |  |
| UE antenna panel selection for data transmission and UE attachment | The UE panel with the best receive SNR is chosen for transmission and reception | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Frame structure |  | DDDSU | DDDSU | DDDU |  |
| Transmission scheme | UL codebook based SU-MIMO / MU-MIMO | UL SU-MIMO with rank adaptation | UL MU-MIMO with rank adaptation | SU/MU-MIMO adaptation |  |
| UL codebook |  | For 2Tx with the best Tx panel | N/A | 2Tx codebook |  |
| MU dimension |  | Up to 6 layers | up to 2 layer | Up to 2 layers |  |
| SU dimension |  | For 2Tx with the best Tx panel: Up to 2 layers | For 4Tx with the best Tx panel: Up to 4 layers | Up to 2 layers |  |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference |  |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | For UE 2 Tx ports: precoded SRS, 1 symbol for SRS in every 10 slots | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources), 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | For UE 2 Tx ports: non-precoded SRS, 1 symbol for SRS in every 2 UL slots |  |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 128R, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1; 4,16) (dH,dV) = (0.5, 0.5)λ | For 8T, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,2,2; 1,1) (dH, dV)=(0.5, 0.5)λ (dg,H,dg,V) = (4.0, 2.0)λ | For 2R, (M,N,P,Mg,Ng; Mp,Np) = (16,8,2,1,1; 1,1) (dH,dV) = (0.5, 0.5)λ |  |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 2,4) (dH, dV)=(0.5, 0.5)λ (dg,H,dg,V) = (4.0, 2.0)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (2,4,2,1,2; 1,1) (dH,dV) = (0.5, 0.5)λ (dg,V,dg,H) = (0, 0)λ | (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1; 1,1) (dH, dV)=(0.5, 0.5)λ (dg,H,dg,V) = (4.0, 2.0)λ |  |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference |  |
| UL re-transmission delay |  | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |  |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal |  |
| Power control parameter |  | alpha = 0.8 | P0=-80, alpha = 0.8 | N/A |  |
| Power backoff model |  |  | Continuous RB allocation: follow TS 38.101 in Section 6.2.2; Non-continuous RB allocation: additional 2 dB reduction | N/A |  |
| **System configuration parameters** | Reference value |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Electronic tilt | (According to Zenith angle in "Beam set at TRxP") | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Handover margin (dB) |  | 0 | 0 | 0 |  |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0  The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | For direction of TRxP analog beam steering (in LCS): Azimuth angle φi = [-5\*pi/16, -3\*pi/16, -pi/16, pi/16, 3\*pi/16, 5\*pi/16] Zenith angle θj = [5\*pi/8, 7\*pi/8] NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array. Precoder for beam at (φi, θj) is given by equation 1 in Appendix 1 of RP-180524 (2D DFT beam) | Aligned with reference | Aligned with reference | N/A |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | For direction of UE analog beam steering (in LCS): Azimuth angle φi = [-3\*pi/8, -pi/8, pi/8, 3\*pi/8]; Zenith angle θj = [pi/4, 3\*pi/4]; NOTE: (azimuth, zenith)=(0, pi/2) is the direction perpendicular to the array. Precoder for beam at (φi, θj) is given by equation 1 in Appendix 1 (2D DFT beam) | Aligned with reference | Aligned with reference | N/A |  |
| Criteria for selection for serving TRxP | Maximizing RSRP with best analog beam pair, where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Criteria for analog beam selection for serving TRxP | Select the best beam pair among the limited set of DFT analog beams, based on the criteria of maximizing receive power after beamforming. | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Criteria for analog beam selection for interfering TRxP | Based on the analog beam selection according to scheduling results of non-serving TRxP | Aligned with reference | Aligned with reference | Aligned with reference |  |
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# Avg, 5% Spectral Efficiency - Rural eMBB test environment

DL/700MHz

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Samsung | Qualcomm | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | FDD | TDD | FDD | TDD | FDD |
| Network synchronization |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 30 kHz SCS, 14 symbol OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15/30 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 54 RBs per 30 kHz SCS, 20MHz BW | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | TDD: 20 MHz | Aligned with reference | Aligned with reference | FDD: 10 MHz |
| Frame structure |  | Full downlink | DSUUD | Full downlink | Full downlink | DDSU | Full downlink | DDDSU | Full downlink |
| Transmission scheme | Closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | MU-MIMO | Aligned with reference | Aligned with reference | MU-MIMO |
| DL CSI measurement |  | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS | Non-precoded CSI-RS based | Precoded CSI-RS based, non-PMI | - |
| DL codebook |  | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB only, 8 PSK | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | Pseudo inverse of channel matrix |
| PRB bundling |  | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs |  | 4 PRBs | 4 PRBs |  |
| MU dimension |  | Up to 12 layers | Up to 12 layers | Up to 8 layers | Up to 8 layers | Up to 12 layers | Up to 8 layers | Up to 8 layers | Up to 8 layers |
| SU dimension |  | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers | For 2Rx and 4Rx: Up to 2 layers | For 2Rx: Up to 2 layers |  | For 2Rx: Up to 2 layers | For 2Rx: Up to 2 layers | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | N/A | N/A | N/A | N/A | Non-precoded CSI-RS, 4 SRS ports, 20 MHz SRS BW, SRS sent during the S/U slots only | N/A | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 2 SRS resources), 5ms period | N/A |
| CSI feedback |  | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | S/U slots | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI : every 5ms |
| Interference measurement |  | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | CSI-IM | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | - |
| CBG | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay |  | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | 1 slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  |  |  | the next available DL slot after receiving NACK | the next available DL slot after receiving NACK | 3 slots | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4) For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4) (dH, dV)=(0.5, 0.8)λ | For 16T (M,N,P,Mg,Ng,Mp,Np) = (4,8,2,1,1,1,8) | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4); (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4); (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4) (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 2R: (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,1) | For 2R: (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) | For 4 R: (M,N,P,Mg,Ng,Mp,Np) = (1,2,2,1,1,1,2) | For 2R: (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) | For 2R: (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) | For 2R: (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Ideal |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | 100 degree | 100 degree | 100 degree | 100 degree | 96 deg | 100 degree | 100 degree | 100 degree |
| Handover margin (dB) |  | 1 | 1 | 1 | 1 |  | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Radio-distance based | Radio-distance based | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - |  | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - |  | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - |  | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - |  | - | - | - |

UL/700MHz

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Qualcomm | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | TDD | FDD | TDD | FDD |
| Network synchronization |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 30 KHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15/30 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | 54 RBs per 30 kHz SCS, 20MHz BW | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference (20 MHz) | Aligned with reference | Aligned with reference | Aligned with reference |
| Frame structure |  | Full uplink | DDDSU | Full uplink | DDSU | Full uplink | DDDSU | Full uplink |
| Transmission scheme |  | closed loop SU/MU-MIMO with rank adapation | closed loop SU/MU-MIMO with rank adapation | SU-MIMO with rank adaptation | UL codebook-based MU-MIMO | SU-MIMO with rank adaptation | SU-MIMO with rank adaptation | SU-MIMO with rank adaptation |
| UL codebook |  | UL 4Tx Codebook | UL 4Tx Codebook | For 2Tx: NR 2Tx codebook | NR R15 4 Tx codebook (fully-coherent) | UL 2Tx Codebook | UL 2Tx Codebook | UL 2Tx Codebook |
| MU dimension |  | Up to 12 layers at gNB | Up to 12 layers at gNB | N/A | Up to 12 layers at gNB | N/A | N/A | N/A |
| SU dimension |  | For 4 Tx: Up to 4 layers | For 4 Tx: Up to 4 layers | For 2 Tx: Up to 2 layer | Up to 2 layer | For 2 Tx: Up to 2 layer | For 2 Tx: Up to 2 layer | For 2 Tx: Up to 2 layer |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | 4 port non-precoded SRS  (1 SRS resource) | 4 port non-precoded  (1 SRS resource) | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 1 SRS resources), 2 symbols for SRS in every 10 slots, | 2 Tx Ports: Non precoded SRS, 2 SRS ports, 1 symbol per S/U subframe | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 2 SRS resources), 2 symbols for SRS, 8 PRBs per symbol | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 2 SRS resources), 2 symbols for SRS, 8 PRBs per symbol |  |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 16R: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 16R: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ | 16R (M,N,P,Mg,Ng,Mp,Np) = (4, 8, 2, 1, 1, 1, 8) | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | 2T: (M, N, P, Mg, Ng, Mp, Np) = (1, 1, 2, 1, 1, 1, 1) | For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| UL re-transmission delay |  | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after 2 slot processing delay | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | ideal |
| Power control parameter |  | P0=-80, alpha = 0.7 | P0=-80, alpha = 0.7 | P0=-80, alpha = 0.7 | P0 = -96.4, alpha = 0.9 | P0=-76, alpha = 0.8 | P0=-76, alpha = 0.8 | P0=-80, alpha = 0.7 |
| Power backoff model |  | Continuous RB allocation: follow TS 38.101 for FR1;Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1; Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1; Non-continuous RB allocation:[R1-1806322] | - | - | - |  |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | 100 degree | 100 degree | 100 degree | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 1 | 1 | 1 |  | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - |  |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - |  |

DL/4GHz

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Samsung | Nokia | | Qualcomm | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | FDD | FDD | TDD | TDD | FDD | TDD | FDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15/30 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 54 RBs per 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | 10 MHz | 20 MHz | 10 MHz | 10 MHz | Aligned with reference | Aligned with reference | 20 MHz | 10 MHz | 20 MHz | FDD: 10 MHz |
| Frame structure |  | Full downlink | DSUUD | Full downlink | Full downlink | Full downlink | DSUUD | DDSU | Full downlink | DDDSU | Full downlink |
| Transmission scheme | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | Aligned with reference | Aligned with reference | MU-MIMO | Aligned with reference | Aligned with reference | MU-MIMO |
| DL CSI measurement |  | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | SRS-Based | CSI-RS based | Non-precoded CSI-RS based | Precoded CSI-RS based, non-PMI | - |
| DL codebook |  | Type II codebook; 4beam, wb+sb, 8psk | Type II codebook; 4beam, wb+sb, 8psk | Type II codebook; 4beam, wb only, 8psk | Type II codebook; 4beam, wb+sb, 8psk | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | N/A | Type II codebook; 4beam, wb+sb, 8psk | N/A | Pseudo inverse of channel matrix |
| PRB bundling |  | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs |  | 4 PRBs | 4 PRBs |  |
| MU dimension |  | Up to 12 layers | Up to 12 layers | Up to 8 layers | Up to 12 layers | Up to 12 layers | Up to 8 layers | Upto 12 layers | Up to 12 layers | Up to 12 layers | Up to 12 layers |
| SU dimension |  | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers | For 4Rx: Up to 2 layers; | For 4Rx: Up to 4 layers | 1 layer | 1 layer |  | For 4Rx: Up to 2 layers | For 4Rx: Up to 4 layers | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | N/A | N/A | N/A | N/A | N/A | For UE 8 Tx ports: Non-precoded SRS, 2 SRS ports, 4 symbols per frame | Non-precoded SRS transmitted during S/U slots only, 4 ports, 20 MHz | N/A | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports, 2 symbols per 5 slots; | N/A |
| CSI feedback |  | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based , 5 slot delay | CQI: every 20 slots; RI: every 20 slots; Subband based, 5 slot delay | Every S/U slot | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI : every 5ms |
| Interference measurement |  | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | CSI-IM | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | - |
| CBG | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay |  | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | 1 slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  |  |  | the next available DL slot after receiving NACK | the next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | 3 slots | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 128 T: (M,N,P,Mg,Ng,Mp,Np) = (4,32,2,1,1,2,32) | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ | For 32T: (M,N,P,Mg,Ng; Mp,Np) = (8,8,2,1,1;2,8) (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 8R: (M,N,P,Mg,Ng; Mp,Np)= (1,4,2,1,1; 1,4) (dH, dV)=(0.5, N/A)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np)= (1,4,2,1,1; 1,4) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng,Mp,Np) = (1,2,2,1,1,1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Ideal |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | 100 degree | 100 degree | 100 degree | Aligned with reference | 100 degrees | 100 degrees | 96 deg | 100 degree | 100 degree | 100 degree |
| Handover margin (dB) |  | 1 | 1 | 1 | 1 |  |  |  | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Radio-distance based | Radio-distance based | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - |  | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - |  | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - |  | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - |  | - | - | - |

UL/4GHz

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Nokia | Qualcomm | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | FDD | TDD | FDD | TDD | FDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 30 KHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15/30 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 54 RBs per 30 kHz SCS, 20MHz BW | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference | 10 MHz | 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference |
| Frame structure |  | Full uplink | DSUUD | Full uplink | Full uplink | DDSU | Full uplink | DDDSU | Full uplink |
| Transmission scheme |  | SU/MU-MIMO with rank adaptation | SU/MU-MIMO with rank adaptation | SU-MIMO with rank adaptation | Closed-loop UL MU-MIMO with rank adaptation | UL codebook-based MU-MIMO | SU-MIMO | SU-MIMO | SU-MIMO |
| UL codebook |  | 4T UL Codebook | 4T UL Codebook | For 2Tx: NR 2Tx codebook | For 4Tx: NR 4Tx codebook | NR R15 4 Tx codebook (fully-coherent) | NR R15 4 Tx codebook (fully-coherent) | NR R15 4 Tx codebook (fully-coherent) | For 4Tx: NR 4Tx codebook |
| MU dimension |  | Up to 12 layers at gNB | Up to 12 layers at gNB | N/A | Up to 6 users | Up to 12 layers at gNB | N/A | N/A | N/A |
| SU dimension |  | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers | For 2 Tx: Up to 2 layer | Up to 2 layers per user | Up to 2 layers per user | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | 4 port non-precoded SRS  (1 SRS resource) | 4 port non-precoded  (1 SRS resource) | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 1 SRS resources), 2 symbols for SRS in every 10 slots, | For UE 4Tx ports: Non-precoded SRS, 4 SRS ports 4 symbols every 10ms | 2 Tx Ports: Non precoded SRS, 2 SRS ports, 1 symbol per S/U subframe | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources); 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources); 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 32R: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32R: (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16) (dH, dV)=(0.5, 0.8)λ | For 32R: (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1; 2,8) (dH, dV)=(0.5, 0.8)λ | For 32R, (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;1,16)  (dH,dV) = (0.5, 0.8)λ | 128R (M, N, P, Mg, Ng, Mp, Np) = (8, 16, 2, 1, 1, 4, 16) (dH, dV) = (0.5, 0.8)λ | For 32R: (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1; 2,8) (dH, dV)=(0.5, 0.8)λ | For 32R: (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1; 2,8) (dH, dV)=(0.5, 0.8)λ | For 16R: (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1; 1,8)  (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 1T: (M, N, P, Mg, Ng; Mp, Np) = (1,1,1,1,1; 1,1) (dH, dV)=( N/A, N/A)λ For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | For 4T, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=( 0.5, - )λ | 2T: (M, N, P, Mg, Ng, Mp, Np) = (1, 1, 2, 1, 1, 1, 1) | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) dH, dV)=( 0.5, N/A)λ; | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) dH, dV)=( 0.5, N/A)λ; | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) dH, dV)=( 0.5, N/A)λ; |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| UL re-transmission delay |  | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after receiving retransmission indication | Next available UL slot after 2 slot processing delay | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after receiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | MMSE | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal |  |
| Power control parameter |  | P0=-70, alpha = 0.6 | P0=-70, alpha = 0.6 | P0=-80, alpha = 0.7 | P0=-95, alpha = 0.8 | P0=-105.4, alpha = 0.9 | P0=-60, alpha = 0.6 | P0=-60, alpha = 0.6 | P0=-60, alpha = 0.6 |
| Power backoff model |  | Continuous RB allocation: follow TS 38.101 for FR1;Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1;Mean IOT<10dB | Continuous RB allocation: follow TS 38.101 for FR1; Non-continuous RB allocation:[R1-1806322] | - | - | - | - | - |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | 100 degree | 100 degree | 100 degree | 100 degrees | Aligned with reference | 100 degree | 100 degree | 100 degree |
| Handover margin (dB) |  | 1 | 1 | 1 |  |  | 0 | 0 |  |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - | - |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - | - |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - | - |  |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - | - |  |

DL/LMLC

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Samsung | Nokia | | Ericsson | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | TDD | FDD | FDD | FDD | TDD | FDD | TDD | FDD |
| Network synchronization |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15/30 kHz SCS, 14 OFDM symbol slot | 15kHz SCS, 14 OFDM symbol slot |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | 10 MHz | 20 MHz | Aligned with reference | 10 MHz | Aligned with reference | Aligned with reference | 10 MHz | 20 MHz | FDD: 10 MHz |
| Frame structure |  | Full downlink | DSUUD | Full downlink | Full downlink | Full downlink | DSUUD | Full downlink | DDDSU | Full downlink |
| Transmission scheme | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | Aligned with reference | Aligned with reference | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | MU-MIMO |
| DL CSI measurement |  | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | Non-precoded CSI-RS based | SRS-Based | Non-precoded CSI-RS based | Precoded CSI-RS based, non-PMI | - |
| DL codebook |  | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB only, 8 PSK | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | Type II codebook; 4 beams, WB+SB amplitude quantization, 8 PSK phase quantization | N/A | Pseudo inverse of channel matrix  precoding |
| PRB bundling |  | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | 4 PRBs | - |
| MU dimension |  | Up to 12 layers | Up to 12 layers | Up to 8 layers | Up to 8 layers | Up to 12 layers | Up to 8 layers | Up to 8 layers | Up to 8 layers | Up to 8 layers |
| SU dimension |  | For 4Rx: Up to 4 layers | For 4Rx: Up to 4 layers | For 2Rx and 4Rx: Up to 2 layers | For 4Rx: Up to 4 layers | 1 layer | 1 layer | For 4Rx: Up to 2 layers | For 4Rx: Up to 4 layers | - |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | - |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | N/A | N/A | N/A | N/A | N/A | For UE 4Tx ports: Non-precoded SRS, 2 SRS ports 4 symbols every 10ms | N/A | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports, 2 symbols per 5 slots | N/A |
| CSI feedback |  | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based, 5 slot delay | CQI: every 10 slots; RI: every 10 slots, Subband based, 5 slot delay | PMI, CQI: every 5 slot; RI: every 5 slot; Subband based | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slot Subband based | CQI : every 5ms |
| Interference measurement |  | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | SU-CQI; CSI-IM for inter-cell interference measurement | - |
| CBG | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| ACK/NACK delay |  | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | The next available UL slot | - |
| Re-transmission delay |  |  |  | the next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | The next available DL slot after receiving NACK | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4) (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4) (dH, dV)=(0.5, 0.8)λ | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 16T: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4); (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4); (dH, dV)=(0.5, 0.8)λ | For 8T: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1;1,4) (dH, dV)=(0.5, 0.8)λ |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 2R: (M,N,P,Mg,Ng; Mp,Np) = (1,1,2,1,1; 1,1) For 4R: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,1) | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ | For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=(0.5, N/A)λ |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | MMSE |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Ideal |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt | [96°] in LCS | 96 degree | 96 degree | 100 degree | Aligned with reference | 96 degrees | 96 degrees | Aligned with reference | Aligned with reference | 96 degrees |
| Handover margin (dB) |  | 1 | 1 | 1 | 1 |  |  | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Radio-distance based | Radio-distance based | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - | - | - | - |

UL/LMLC

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Intel | | LGE | Nokia | Ericsson | | | Korea Univ. |
| **NR FDD** | **NR TDD** | **NR FDD** | **NR FDD** | **NR TDD** | **NR FDD** | **NR TDD** | **NR FDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Duplexing |  | FDD | TDD | FDD | FDD | TDD | FDD | TDD |  |
| Network synchronization |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Coding on PUSCH | LDPC Max code-block size=8448bit  [with BP decoding] | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Numerology | 15 kHz / 30 kHz, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15 kHz SCS, 14 OFDM symbol slot | 15/30 kHz SCS, 14 OFDM symbol slot |  |
| Guard band ratio on simulation bandwidth | FDD: 6.4% (for 10 MHz bandwidth) TDD: 8.2% (51 RB for 30kHz SCS and 20 MHz bandwidth) TDD: 4.6% (106 RB for 15kHz SCS and 20 MHz bandwidth) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Simulation bandwdith | FDD: 10 MHz TDD: 20 MHz | Aligned with reference | Aligned with reference | Aligned with reference | 10 MHz | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Frame structure |  | Full uplink | DSUUD | Full uplink | Full uplink | Full uplink | Full uplink | DDDSU |  |
| Transmission scheme |  | SU/MU-MIMO with rank adaptation | SU/MU-MIMO with rank adaptation | SU-MIMO with rank adaptation | Closed-loop UL MU-MIMO with rank adaptation | SU-MIMO with rank adaptation | SU-MIMO with rank adaptation | SU-MIMO with rank adaptation |  |
| UL codebook |  | For 4Tx: NR 4Tx codebook | For 4Tx: NR 4Tx codebook | For 2Tx: NR 2Tx codebook | For 4Tx: NR 4Tx codebook | UL 4Tx Codebook | For 4Tx: NR 4Tx codebook | For 4Tx: NR 4Tx codebook |  |
| MU dimension |  | Up to 12 layers at gNB | Up to 12 layers at gNB | N/A | Up to 6 users | N/A | N/A | N/A |  |
| SU dimension |  | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers | For 2 Tx: Up to 2 layer | Up to 2 layers per user | Up to 2 layer | For 4Tx: Up to 4 layers | For 4Tx: Up to 4 layers |  |
| Codeword (CW)-to-layer mapping | For 1~4 layers, CW1; For 5 layers or more, two CWs | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| SRS transmission | Companies to Report: • Precoded or non-precoded SRS transmission; • SRS switch or not for 1T4R/2T4R/1T2R • SRS bandwidth • Number of OFDM symbols within 1 slot for SRS transmission per UE | 4 port non-precoded SRS  (1 SRS resource) | 4 port non-precoded  (1 SRS resource) | For UE 2 Tx ports: Non-precoded SRS, 2 SRS ports (with 1 SRS resources), 2 symbols for SRS in every 10 slots, | For UE 4Tx ports: Non-precoded SRS, 2 SRS ports 4 symbols every 10ms | For UE 4Tx ports: Non-precoded SRS, 4 SRS ports 4 symbols every 10ms | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources); 2 symbols for SRS in every 5 slots, 8 PRBs per symbol | For UE 4 Tx ports: Non-precoded SRS, 4 SRS ports (with 4 SRS resources); 2 symbols for SRS in every 5 slots, 8 PRBs per symbol |  |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ | For 16R: (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8) (dH, dV)=(0.5, 0.8)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ | For 16R, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8)  (dH,dV) = (0.5, 0.8)λ | For 64R, (M,N,P,Mg,Ng; Mp,Np) = (4,8,2,1,1;1,8)  (dH,dV) = (0.5, 0.8)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ | For 8R: (M,N,P,Mg,Ng; Mp,Np) = (8,4,2,1,1; 1,4) (dH, dV)=(0.5, 0.8)λ |  |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | For 1T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,1,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | For 4T: (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) | For 2T: (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1) (dH, dV)=( N/A, N/A)λ | For 4T, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2) (dH, dV)=( 0.5, - )λ | For 8T, (M,N,P,Mg,Ng; Mp,Np) = (1,4,2,1,1; 1,4) (dH, dV)=( 0.5, - )λ | For 4T: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=( 0.5, N/A)λ | For 4T: (M,N,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2) (dH, dV)=( 0.5, N/A)λ |  |
| Max CBG number | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| UL re-transmission delay |  |  |  | Next available UL slot after reiving retransmission indication | Next available UL slot after receiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |  |
| Scheduling | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference | Aligned with reference | MMSE | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Channel estimation |  | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal | Non-ideal |  |
| Power control parameter |  | P0=-100, alpha = 0.8 | P0=-100, alpha = 0.8 | P0=-90, alpha = 0.7 | P0=-95, alpha = 0.8 | P0=-80, alpha = 0.8 | P0=-76, alpha = 0.8 | P0=-76, alpha = 0.8 |  |
| Power backoff model |  | Continuous RB allocation: follow TS 38.101 for FR1; Non-continuous RB allocation: additional 2 dB reduction | Continuous RB allocation: follow TS 38.101 for FR1; Non-continuous RB allocation: additional 2 dB reduction | Continuous RB allocation: follow TS 38.101 for FR1; Non-continuous RB allocation:[R1-1806322] | - | N/A | - | - |  |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |  |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Electronic tilt | [96°] in LCS | 96 degree | 96 degree | 100 degree | 96 degrees | 92 deg | Aligned with reference | Aligned with reference |  |
| Handover margin (dB) |  | 1 | 1 | 1 |  | 3 | 0 | 0 |  |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | - | - | - | - | - | - |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - | - |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |  |
| Criteria for analog beam selection for serving TRxP | - | - | - | - | - | - | - | - |  |
| Criteria for analog beam selection for interfering TRxP | - | - | - | - | - | - | - | - |  |

# Mobility – InH eMBB

SLS Assumptions

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | | Ericsson 4GHz | Nokia 4GHz | Intel 4GHz 12 TRxP | Intel 4GHz 36 TRxP | | Intel 30GHz 12 TRxP | | Intel 30GHz 36 TRxP | | Samsung (30GHz) | | LGE (4 GHz) | |
| Multiple access | OFDMA | |  | Aligned with reference | CP-OFDM | CP-OFDM | | CP-OFDM | | CP-OFDM | | Aligned with reference | | Aligned with reference | |
| Duplexing |  | |  | FDD | FDD | FDD | | TDD | | TDD | | FDD | | FDD | |
| Modulation | Up to 256QAM | |  | Aligned with reference | 16QAM | 16QAM | | 16QAM | | 16QAM | | up to 64QAM | | Aligned with reference | |
| Numerology |  | | 15kHz for LTE, 30kHz for NR | 15 kHz | 15/30 kHz | 15/30 kHz | | 60/120 kHz | | 60/120 kHz | | 120kHz | | 15 kHz SCS | |
| Simulation bandwdith |  | | 10MHz | 10MHz | 10 MHz | 10 MHz | | 10MHz | | 10MHz | | 100MHz | | 10MHz | |
| Transmission scheme |  | | UL SIMO | UL MIMO | UL SIMO | UL SIMO | | UL SIMO | | UL SIMO | | UL SIMO | | UL SIMO | |
| UL codebook |  | |  | Codebook-based | - | - | | - | | - | | N/A | | N/A | |
| MU dimension |  | |  | Up to 3 users | N/A | N/A | | N/A | | N/A | | N/A | | N/A | |
| SU dimension |  | | 1 layer | Up to 2 layers | 1 Layer | 1 Layer | | 1 Layer | | 1 Layer | | 2 layer | | 1 layer | |
| SRS transmission |  | |  | 4 Tx SRS ports, non-precoded |  |  | |  | |  | | non-precoded | | Non-precoded, 1T SRS port | |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | (8,8,2) | 1R, (8,8,2,1,1; 8,8) | 8R, (8,8,2,1,1;2,2) | 8R, (16,4,2,1,1;2,2) | | 8R, (4,4,2,1,1;2,2) | | 8R, (8,4,2,1,1;2,2) | | 8R(4,8,2,1,1;2,2) | | 8R, (4,4,2,1,1; 1,4) | |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | | 1T | 1T, (1,2,2,1,1; 1,2) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | | 2T, (1,1,2,1,1;1,1) | | 2T, (1,1,2,1,1;1,1) | | 4T(2,4,2,1,2; 1,1) | | 1T, (1,1,1,1,1; 1,1) | |
| Scheduling | PF | | RR | PF | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | PF | | Aligned with reference | |
| Receiver | MMSE-IRC | | MRC | MMSE | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | |
| Power control parameter |  | | Alpha = 1, SNR target 15dB | Aplha = 0.8, P0 = -95dBm | α = 0.9, P0 = -90 dBm | α = 0.9, P0 = -90 dBm | | α = 0.8, P0 = -70 dBm | | α = 0.7, P0 = -80 dBm | | Aplha = 0.8, P0 = -80 dBm | | α = 0.9, P0 = -90 dBm | |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | |  |  | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | |
| **System configuration parameters** | Reference Value | |  |  |  |  | |  | |  | |  | |  | |
| Carrier frequency for evaluation |  | | 4HGz | 4 GHz | 4 GHz | 4 GHz | | 30 GHz | | 30 GHz | | 30GHz | | 4 GHz | |
| UE speeds of interest | 10km/h | |  | Aligned with reference | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | |
| TRxP number per site | 1 | 3 | Aligned with reference | 1 | 1 | 1 | | 1 | | 1 | | 1 | | Aligned with reference | |
| Mechanic tilt | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | |
| Electronic tilt | 90° in LCS | 90° in LCS | Aligned with reference | Aligned with reference | 110° | DFT beams | | DFT beams | | DFT beams | |  | | Aligned with reference | |
| Handover margin (dB) |  |  |  |  |  |  | |  | |  | | 0dB | | 0 | |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 |  | Aligned with reference | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | |
| Wrapping around method | No wrapping around | No wrapping around |  | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference |
| Polarized antenna model | Model-2 in TR36.873 | Model-2 in TR36.873 |  | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) | - | - | Wideband eigen beamforming | - | - | | - | | - | | - | | Aligned with reference | | Aligned with reference |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - |  | - | - | | - | | - | | - | | Aligned with reference | | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | |  | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - | - |  | Aligned with reference | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference |
| Analog beam selection for interfering TRxP | - | - |  | - | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference | | Aligned with reference |

LLS Assumptions

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Reference value** | Ericsson | **Nokia** | Intel 4GHz 12 TRxP | Intel 4GHz 36 TRxP | Intel 30GHz SCS 60 kHz (12/36 TRxP) | Intel 30GHz SCS 120 kHz (12/36 TRxP) | Samsung | **LGE** |
|  |  | **4 GHz (FDD)** | **4 GHz (FDD)** | **30 GHz (FDD)** | **30 GHz (FDD)** | **30 GHz (FDD)** | **4 GHz** |
| Carrier frequency |  | 4GHz | 4GHz | 4GHz | 4GHz | 30GHz | 30GHz | 30GHz | 4GHz |
| Waveform | CP-OFDM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD / TDD | FDD / TDD | FDD | FDD | TDD | TDD | FDD | FDD |
| TDD frame structure |  |  |  |  |  |  |  |  | - |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 50 MHz | 100MHz | Aligned with reference |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-i | TDL I | TDL-i | TDL-i | TDL-i | TDL-i | TDL-i | NLOS: CDL-i | NLOS: CDL-i |
| LOS: CDL/TDL-iv | TDL IV | TDL-iv | - | - | - | - | LOS: CDL-iv | LOS: CDL-iv |
| UE speed | 10 km/h | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Subcarrier spacing |  | 15kHz for LTE, 30kHz for NR | 30 kHz | 15/30 kHz | 15/30 kHz | 60 kHz | 120 kHz | 120 kHz | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |  | 2R | 1R | 8R, (8,8,2,1,1;2,2) | 8R, (16,4,2,1,1;2,2) | 8R, (4,4,2,1,1;2,2) | 8R, (8,4,2,1,1;2,2) | 8R(4,8,2,1,1;2,2) | 8R, (4,4,2,1,1; 1,4) |
| Antenna configuration at UE |  | 1T | 1T | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 4T(2,4,2,1,2; 1,1) | 1T, (1,1,1,1,1; 1,1) |
| TXRU pattern at TRxP |  | Omni, 0dBi | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | Option 1: 0dBi Omni-directional |
| TXRU pattern at UE |  | Omni, 0dBi | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | Option 1: 0dBi Omni-directional |
| Transmission mode |  | SIMO | SISO | SIMO | SIMO | SIMO | SIMO | SIMO | SIMO |
| Transmission rank |  | Rank 1 | Rank 1 | Rank 1 | Rank 1 | Rank 1 | Rank 1 | Rank 1 | Rank 1 |
| UL precoder |  |  |  | - | - | - | - | - | - |
| TRxP receiver type | MMSE-IRC |  |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Channel estimation |  |  | MMSE | MMSE | MMSE | MMSE | MMSE | MMSE | MMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Data allocation |  |  |  | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 12 RB allocated | 14 symbol slots, with 12 RB allocated | 14 symbol slots, with 10 RB allocated |
| Channel coding scheme | LDPC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link adaptation |  | Yes | Yes | No | No | No | No | No | Yes |
| HARQ |  |  | max. 4 HARQ tansmissions | no HARQ | no HARQ | no HARQ | no HARQ | no HARQ | Max 4 HARQ tansmissions |
| DMRS configuration |  |  | 2 symbols DMRS, Config. 1 with 3dB power boost | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | 2 symbol DMRS (front loaded and one additional) with configuration type 2 | 2 symbol DMRS (front loaded and one additional) |
| Other overhead |  |  | FDD: 1 symbol TDD: 3 symbols | No SRS No PUCCH | No SRS No PUCCH | No SRS No PUCCH | No SRS No PUCCH | 1 symbol overhead | - SRS: 2 symbols per 5 slots  - PUCCH :2 RB in 10MHz bandwidth |

# Mobility – Dense Urban eMBB

SLS Assumptions

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson | Nokia | Intel 4GHz Numerology 0/Numerology 1 | Intel 30GHz Numerology 2 | Intel 30GHz Numerology 3 | LGE 4 GHz | Samsung 30GHZ |
| Multiple access | OFDMA |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  |  | FDD | FDD | FDD | FDD | FDD | FDD |
| Modulation | Up to 256QAM |  | Aligned with reference | 16QAM | 16QAM | 16QAM | Aligned with reference | Aligned with reference |
| Numerology |  |  | 15 kHz | 15 kHz/ 30kHz | 60 kHz | 120kHz | 15 kHz SCS | 120kHz |
| Simulation bandwdith |  |  | 10MHz | 6 PRBs | 6 PRBs | 12 PRBs | 10MHz | 100MHz |
| Transmission scheme |  |  | UL MIMO | UL SIMO | UL SIMO | UL SIMO | UL SIMO | UL SU-MIMO |
| UL codebook |  |  | Codebook-based | N/A | N/A | N/A | N/A | N/A |
| MU dimension |  |  | Max 3 users | N/A | N/A | N/A | N/A | N/A |
| SU dimension |  |  | Max 2 layers | Max 2 layers | Max 2 layers | Max 2 layers | 1 layer | Max 2 layers |
| SRS transmission |  |  | 4Tx SRS ports, non-precoded |  |  |  | Non-precoded, 1T SRS port |  |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 8x8x2 | 32R, (16,8,2,1,1; 2,8) 32R, (8,8,2,1,1; 2,8) | 8R, (16,2,2,1,1;2,2) | 8R, (16,2,2,1,1;2,2) | 8R, (16,2,2,1,1;2,2) | 8R, (8,4,2,1,1; 1,4) | 8R, (4,8,2,2,2;1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 1T | 4R, (1,2,2,1,1; 1,2) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 1T, (1,1,1,1,1; 1,1) | 4T, (2,4,2,1,2; 1,1) |
| Scheduling | PF | RR | PF | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | MRC | MMSE | MMSE-Block | MMSE-Block | MMSE-Block | Aligned with reference | Aligned with reference |
| Power control parameter |  | Alpha = 1.0, SNR target 15dB | Aplha = 0.8, P0 = -95 dBm | α = 0.9, P0 = -90dBm | α = 0.7, P0 = -80dBm | α = 0.7, P0 = -80dBm | [0.9,-86] | [0.8,-80] |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 |  | Post-processed SINR | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |  |
| Carrier frequency for evaluation |  |  | 4 GHz | 4GHz | 30GHz | 30GHz | 4 GHz | 30 GHz |
| UE speeds of interest | 30km/h |  | Aligned with reference | Indoor users: 3km/h Outdoor users (in-car): 30 km/h | Indoor users: 3km/h Outdoor users (in-car): 30 km/h | Indoor users: 3km/h Outdoor users (in-car): 30 km/h | Aligned with reference | Indoor users: 3km/h Outdoor users (in-car): 30 km/h |
| TRxP number per site | 3 |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) |  | Aligned with reference |  |  |  | Aligned with reference | Aligned with reference |
| Electronic tilt |  |  | 100 degrees | Single beam 102 degree downtilt | DFT beams | DFT beams | 105 degree |  |
| Handover margin (dB) |  |  |  |  |  |  | 1 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Polarized antenna model | Model-2 in TR36.873 |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) |  |  | - | - | - | - | Aligned with reference | Aligned with reference |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - |  | - | - | - | - | Aligned with reference | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP | - |  | - | Maximizing RSRP | Maximizing RSRP | Maximizing RSRP | Aligned with reference | Aligned with reference |
| Analog beam selection for interfering TRxP | - |  | - | Random selection | Random selection | Random selection | Aligned with reference | Aligned with reference |

LLS Assumptions

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Reference value** | **Nokia** | **Intel Numerology 0/1** | **Intel Numeology 2** | **Intel Numerology 3** | **LGE** | **Samsung** |
|  | **4 GHz (FDD)** | **30 GHz (FDD)** | **30 GHz (FDD)** | **4 GHz** | **30 GHz (FDD)** |
| Carrier frequency |  | 4GHz | 4GHz | 30GHz | 30GHz | 4 GHz | 30GHz |
| Waveform | CP-OFDM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD / TDD | FDD | TDD | TDD | FDD | FDD |
| TDD frame structure |  |  |  |  |  | - |  |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference | Aligned with reference | Aligned with reference | 50 MHz | Aligned with reference | 100MHz |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-iii | TDL-iii | TDL-iii | TDL-iii | TDL-iii | NLOS: CDL-iii | NLOS: CDL-iii |
| LOS: CDL/TDL-v | - | - | - | - | LOS: CDL-v | LOS: CDL-v |
| UE speed | 30 km/h | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Subcarrier spacing |  | 30 kHz | 15/30 kHz | 60 kHz | 120 kHz | 15 kHz | 120kHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |  | 1R | 8R, (16,2,2,1,1;2,2) | 8R, (16,2,2,1,1;2,2) | 8R, (16,2,2,1,1;2,2) | 8R, (8,4,2,1,1; 1,4) | 8R, (4,8,2,2,2;1,1) |
| Antenna configuration at UE |  | 1T | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 1T, (1,1,1,1,1; 1,1) | 4T, (2,4,2,1,2; 1,1) |
| TXRU pattern at TRxP |  | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional |
| TXRU pattern at UE |  | 0dBi Omni | 0dBi Omni | 0dBi Omni | 0dBi Omni | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional |
| Transmission mode |  | SISO | SIMO | SIMO | SIMO | SIMO | MIMO |
| Transmission rank |  | Rank 1 | Rank 1 | Rank 1 | Rank 1 | Rank 1 | Rank 1 |
| UL precoder |  |  | - | - | - | - | - |
| TRxP receiver type | MMSE-IRC |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Channel estimation |  | MMSE | MMSE | MMSE | MMSE | MMSE | MMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Data allocation |  |  | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 12 RB allocated | 14 symbol slots, with 10 RB allocated | 14 symbol slots, with 12 RB allocated |
| Channel coding scheme | LDPC | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link adaptation |  | Yes | No | No | No | Yes | No |
| HARQ |  | max. 4 HARQ tansmissions | no HARQ | no HARQ | no HARQ | Max 4 HARQ tansmissions | no HARQ |
| DMRS configuration |  | 2 symbols DMRS, Config. 1 with 3dB power boost | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | 2 symbol DMRS (front loaded and one additional) | 2 symbol DMRS (front loaded and one additional) |
| Other overhead |  | FDD: 1 symbol TDD: 3 symbols | No SRS No PUCCH | No SRS No PUCCH | No SRS No PUCCH | - SRS: 2 symbols per 5 slots  - PUCCH :2 RB in 10MHz bandwidth | No SRS No PUCCH |

# Mobility – Rural eMBB

SLS Assumptions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson | Nokia (4 GHz) | Intel (700 MHz) | Intel  (4GHz) | LGE |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | CP-OFDM | CP-OFDM | Aligned with reference |
| Duplexing |  |  | FDD | FDD | FDD | FDD |
| Modulation | Up to 256QAM |  | Aligned with reference | QPSK | QPSK | Aligned with reference |
| Numerology |  |  | 15 kHz | 15/30 kHz | 15/30 kHz | 15 kHz SCS |
| Simulation bandwdith |  |  | 10MHz | 10 MHz | 10 MHz | For FDD: 10MHz |
| Transmission scheme |  |  | UL MIMO | UL SIMO | UL SIMO | UL SIMO |
| UL codebook |  |  | Codebook based | - | - | N/A |
| MU dimension |  |  | 6 users max | N/A | N/A | N/A |
| SU dimension |  | 1 layer | 2 layers max | 1 Layer | 1 Layer | 1 layer |
| SRS transmission |  |  | 4Tx SRS ports, non-precoded |  |  | Non-precoded, 1T SRS port |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 8x4x2 | 32R, (8,16,2,1,1; 1,16) | 8R, (8,2,2,1,1;2,2) | 8R, (16,2,2,1,1;2,2) | 4R, (8,2,2,1,1; 1,2) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 1T | 4T, (1,2,2,1,1; 1,2) | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 1T, (1,1,1,1,1; 1,1), |
| Scheduling | PF | RR | PF | Aligned with reference | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC |  | MMSE | Aligned with reference | Aligned with reference | Aligned with reference |
| Power control parameter |  | Alpha = 1.0, SNR target 10dB | Aplha = 0.8, P0 = -95 dBm | α = 0.9, P0 = -90 dBm | α = 0.9, P0 = -90 dBm | [0.8,-80] |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 |  | Post-processed SINR | Aligned with reference | Aligned with reference | Aligned with reference |
| **System configuration parameters** | Reference Value |  |  |  |  |  |
| Carrier frequency for evaluation |  |  | 4 GHz | 4 GHz | 4 GHz | 700 MHz, 4GHz |
| UE speeds of interest | **120km/h, 500km/h** |  | 120 km/h | Aligned with reference | Aligned with reference | Indoor users: 3 km/h  Outdoor users (in-car): 120 km/h; |
| TRxP number per site | 3 |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt |  |  | 100 degrees | 100° | 100° | 100 degree |
| Handover margin (dB) |  |  |  |  |  | 1 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Polarized antenna model | Model-2 in TR36.873 |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered |  | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |

LLS Assumptions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **Reference value** | **Nokia** | **Intel** | **Intel** | **LGE** |
| NR, 4 GHz | NR, 700 MHz | NR, 4 GHz | **NR** |
| Carrier frequency |  | 4 GHz | 700 MHz | 4 GHz | 700 MHz, 4 GHz |
| Waveform | CP-OFDM | Aligned with reference | CP-OFDM | CP-OFDM | CP-OFDM |
| Duplexing |  | FDD / TDD | FDD | FDD | FDD |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | QPSK | QPSK | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-iii | TDL-iii | UL SIMO | UL SIMO | NLOS: CDL-iii |
| LOS: CDL/TDL-v | TDL-v | - | - | CDL-v |
| UE speed | 120km/h, 500km/h | Aligned with reference | N/A | N/A | 120km/h |
| Subcarrier spacing |  | 30 kHz | 15/30 kHz | 15/30 kHz | 15 kHz, 30GHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |  | 1R | 8R, (8,8,2,1,1;2,2) | 8R, (16,4,2,1,1;2,2) | 4R, (8,2,2,1,1; 1,2) |
| Antenna configuration at UE |  | 1T | 2T, (1,1,2,1,1;1,1) | 2T, (1,1,2,1,1;1,1) | 1T, (1,1,1,1,1; 1,1) |
| TXRU pattern at TRxP |  | 0dBi Omni | 0dBi Omni | 0dBi Omni | Option 1: 0dBi Omni-directional |
| TXRU pattern at UE |  | 0dBi Omni | 0dBi Omni | 0dBi Omni | Option 1: 0dBi Omni-directional |
| Transmission mode |  | SISO | SISO | SISO | SIMO |
| Transmission rank |  | Rank 1 | Rank 1 | Rank 1 | Rank 1 |
| UL precoder |  |  |  |  | - |
| TRxP receiver type | MMSE-IRC |  |  |  | Aligned with reference |
| Channel estimation |  | MMSE | MMSE | MMSE | MMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Data allocation |  |  | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 6 RB allocated | 14 symbol slots, with 12 RB allocated |
| Channel coding scheme | LDPC | Aligned with reference | Aligned with reference | Aligned with reference | LDPC |
| Link adaptation |  | Yes | No | No | Yes |
| HARQ |  | max. 4 HARQ tansmissions | no HARQ | no HARQ | Max 4 HARQ tansmissions |
| DMRS configuration |  | 4 symbols DMRS, Config. 1 with 3dB power boost | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | NR Type 1 DMRS symbol position [3rd, 6th, 9th, 12th] No FDM with data, 3dB power boosting | 2 symbol DMRS (front loaded and one additional) |
| Other overhead |  | FDD: 1 symbols TDD: 3 symbols | No SRS No PUCCH | No SRS No PUCCH | - SRS: 2 symbols per 5 slots  - PUCCH :2 RB in 10MHz bandwidth |

# Reliability – Urban Macro URLLC

DL/SLS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Nokia 700 MHz | Nokia 4 GHz | Intel 700 MHz | Intel 4 GHz | Ericsson 700 MHz | Ericsson 4 GHz |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | FDD | FDD | FDD | FDD | FDD |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology |  | 15kHz | 15kHz | 15kHz | 15kHz | 30 kHz | 30 kHz |
| Simulation bandwdith |  | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 20 MHz | 20 MHz |
| DLTransmission scheme |  | SU-MIMO with rank 1 with WB EBF | SU-MIMO with rank 1 with WB EBF | Single port | Single port | N/A | N/A |
| DL codebook |  | N/A | N/A | N/A | N/A | N/A | N/A |
| DL MU dimension |  | N/A | N/A | N/A | N/A | N/A | N/A |
| DL SU dimension |  | 1 | 1 | 1 | 1 | N/A | N/A |
| SRS transmission |  | Ideal | Ideal | Ideal | Ideal | N/A | N/A |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 16Tx, (4,8,2,1,1; 1,8) | 32Tx, (8,16,2,1,1; 1,16) | 2Tx, (8,4,2,1,1; 1,1) | 2Tx, (8,4,2,1,1; 1, 1) | 32Tx, (8,4,2,1,1; 4,4) | 64Tx, (8,8,2,1,1; 4,8) NOTE: For FDD, Beamformed CSI-RS is used to enable e.g., 32Tx codebook measurement |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 4Rx, (1,2,2,1,1; 1,2) | 8Rx, (1,4,2,1,1; 1,4) | 2Rx, (1,1,2,1,1; 1,1) | 4Rx, (1,1,2,1,1; 1,2) | 2Rx,(1,1,2,1,1;1,1) | 2Rx,(1,1,2,1,1;1,1) |
| Scheduling | PF | Aligned with reference | Aligned with reference | Round Robin | Round Robin | N/A | N/A |
| Receiver | MMSE-IRC | MMSE | MMSE | MMSE | MMSE | Aligned with reference | Aligned with reference |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Post-processed SINR | Post-processed SINR | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |
| Carrier frequency for evaluation |  | 700 MHz | 4GHz | 700 MHz | 4GHz | 700 MHz | 4 GHz |
| TRxP number per site | 3 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt |  | 99 degrees | 99 degrees | 99 degrees | 99 degrees | 99 degrees | 99 degrees |
| Handover margin (dB) | 1 |  |  | 0 | 0 | 0 | 0 |
| UT attachment | |  | | --- | | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Polarized antenna model | Model-2 in TR36.873 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) |  | - | - | - | - |  |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - |  |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP |  | - | - | - | - |  |  |
| Criteria for analog beam selection for interfering TRxP |  | - | - | - | - |  |  |

DL/LLS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Nokia 700 MHz | Nokia 4 GHz | Intel 700 MHz | Intel 4 GHz | Ericsson 700 MHz | Ericsson 4 GHz |
| Carrier frequency for evaluation |  | 700 MHz | 4 GHz | 700 MHz | 4 GHz | 700 MHz | 4 GHz |
| Waveform |  | CP-OFDM | CP-OFDM | CP-OFDM | CP-OFDM | CP-OFDM | CP-OFDM |
| Numerology |  | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS |
| Simulation bandwdith |  | 10 MHz | 10 MHz | 40 MHz | 40 MHz | 20 MHz | 20 MHz |
| Channel model | TDL-iii(NLOS),TDL-v(LOS) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | TDL-C | TDL-C |
| Scaled delay spread | 363ns(NLOS),93 ns(LOS) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | 300ns | 300ns |
| UE Speed |  | 3km/h | 3km/h | 3km/h | 3km/h | 3km/h | 3km/h |
| Number of symbols per slot |  | 7 | 7 | 7 | 7 | PDSCH duration of 7 symbols | PDSCH duration of 4 symbols |
| Antenna configuration at TRxP |  | 1 Tx | 1 Tx | 2 Tx | 2 Tx | 2 Tx | 2 Tx |
| Antenna configuration at UE |  | 1 Rx | 1 Rx | 2 Rx | 4 Rx | 2 Rx | 2 Rx |
| TXRU pattern at TRxP |  | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional |
| TXRU pattern at UE |  | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional |
| PDSCH Transmission mode |  | SU-MIMO with rank 1 | SU-MIMO with rank 1 | Precoder cycling 65 PRB | Precoder cycling 65 PRB | SU-MIMO with rank 1 | SU-MIMO with rank 1 |
| Channel estimation |  | Realistic | Realistic | Realistic | Realistic | Realistic | Realistic |
| PDCCH transmission scheme |  | DCI format 1-0. 39bit payload includes CRC. Aggregation level = 16 | DCI format 1-0. 39bit payload includes CRC. Aggregation level = 16 | DCI format 1-0. 40 bit payload plus 24 bit CRC. Aggregation level = 16 Precoder cycling TX diversity 1 symbol CORESET | DCI format 1-0. 40 bit payload plus 24 bit CRC. Aggregation level = 16 Precoder cycling TX diversity 1 symbol CORESET | DCI format 1-0. 64 bits including CRC. Aggregation level =~~16~~ 8 | DCI format 1-0. 64 bits including CRC. Aggregation level =~~16~~ 8 |
| PDSCH Modulation and coding |  | LDPC, QPSK | LDPC, QPSK | LDPC MCS #0 from Low SE 64 QAM table (QPSK, CR = 30/1024) | LDPC MCS #0 from Low SE 64 QAM table (QPSK, CR = 30/1024) | LDPC, Table 3, MCS ~~2~~ 3 | LDPC, Table 3 MCS6 |
| Packet size |  | 256bit | 256bit | 256bit | 256bit | 256bit | 256bit |
| DMRS configuration |  | 1 symbol DMRS, Config. 1, 3 dB power boost | 1 symbol DMRS, Config. 1, 3 dB power boost | 1 symbol DMRS, Type 1 | 1 symbol DMRS, Type 1 | Type 2, 2 symbols DMRS | Type 2, 1 symbol DMRS |

UL/SLS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Nokia 700 MHz | Nokia 4 GHz | Intel 700 MHz | Intel 4 GHz | Ericsson 700 MHz | Ericsson 4 GHz |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Duplexing |  | FDD | FDD | FDD | FDD | FDD | FDD |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Numerology |  | 15kHz | 15kHz | 15kHz | 15kHz | 30 kHz SCS | 30 kHz SCS |
| Simulation bandwdith |  | 10 MHz | 10 MHz | 48 PRB @ 15 kHz SCS for each UE | 48 PRB @ 15 kHz SCS for each UE | 20 MHz | 20 MHz |
| UL Transmission scheme |  | SU-MIMO with rank 1 with WB EBF | SU-MIMO with rank 1 with WB EBF | Single port | Single port | N/A | N/A |
| UL codebook |  | N/A | N/A | N/A | N/A | N/A | N/A |
| UL MU dimension |  | N/A | N/A | N/A | N/A | N/A | N/A |
| UL SU dimension |  | 1 | 1 | 1 | 1 | N/A | N/A |
| SRS transmission |  |  |  |  |  | N/A | N/A |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 16Rx, (4,8,2,1,1; 1,8) | 32Rx, (8,16,2,1,1; 1,16) | 8Rx, (8,1,2,1,1; 1,4) | 8Rx, (8,4,2,1,1; 1,4) | 8Rx, (4,2,2,1,1; 2,2) | 8Rx, (2,4,2,1,1; 1,4) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 4Tx, (1,2,2,1,1; 1,2) | 8Tx, (1,4,2,1,1; 1,4) | 1Tx, (1,1,1,1,1; 1,1) | 1Tx, (1,1,1,1,1; 1,1) | 2Tx,(1,1,2,1,1;1,1) | 2Tx,(1,1,2,1,1;1,1) |
| Scheduling | PF | Aligned with reference | Aligned with reference | Round Robin | Round Robin | N/A | N/A |
| Receiver | MMSE-IRC | MMSE | MMSE | MMSE | MMSE | Aligned with reference | Aligned with reference |
| UL power control parameter |  | Alpha 0,8 P0=-95 dBm | Alpha 1,0 P0=-113 dBm | Alpha 1.0 P0=-111.44 dBm | Alpha 1.0 P0=-116.44 dBm | Alpha 1,0 P0=-106 dBm | Alpha 1,0 P0=-106 dBm |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Post-processed SINR | Post-processed SINR | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
|  |  |  |  |  |  |  |  |
| **System configuration parameters** | Reference Value |  |  |  |  |  |  |
| Carrier frequency for evaluation |  | 700 MHz | 4GHz | 700 MHz | 4GHz | 700 MHz | 4 GHz |
| TRxP number per site | 3 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt |  | 90 degree | 90 degree | 98 degree | 98 degree | 99 degree | 99 degree |
| Handover margin (dB) | **1** |  |  | 0 | 0 | 0 | 0 |
| UT attachment | |  | | --- | | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Minimum distance of TRxP and UE | d2D\_min=10m | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Polarized antenna model | Model-2 in TR36.873 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) |  | - | - | - | - | - | - |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - | - | - | - | - | - | - |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Criteria for analog beam selection for serving TRxP |  | - | - | - | - | - | - |
| Criteria for analog beam selection for interfering TRxP |  | - | - | - | - | - | - |

UL/LLS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Nokia 700 MHz | Nokia 4 GHz | Intel 700 MHz | Intel 4 GHz | Ericsson 700 MHz | Ericsson 4 GHz |
| Carrier frequency for evaluation |  | 700 MHz | 4 GHz | 700 MHz | 4 GHz | 700 MHz | 4 GHz |
| Waveform |  | CP-OFDM | CP-OFDM | CP-OFDM | CP-OFDM | CP-OFDM | CP-OFDM |
| Numerology |  | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS | 30 kHz SCS |
| Simulation bandwdith |  | 10 MHz | 10 MHz | 40 MHz | 40 MHz | 20 MHz | 20 MHz |
| Channel model | TDL-iii(NLOS),TDL-v(LOS) | Aligned with reference | Aligned with reference | TDL-C | TDL-C | TDL-C | TDL-C |
| Scaled delay spread | 363ns(NLOS),93 ns(LOS) | Aligned with reference | Aligned with reference | 300ns | 300ns | 300ns | 300ns |
| UE Speed |  | 3km/h | 3km/h | 3km/h | 3km/h | 3km/h | 3km/h |
| Number of symbols per slot |  | 7 | 7 | 7 | 7 | PUSCH duration of ~~7~~ 4 symbols | PUSCH duration of 4 symbols |
| Antenna configuration at TRxP |  | 1 Tx | 1 Tx | 1 Tx | 1 Tx | 2 Rx | 2 Rx |
| Antenna configuration at UE |  | 1 Rx | 1 Rx | 8 Rx | 8 Rx | 2 Tx | 2 Tx |
| TXRU pattern at TRxP |  | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional |
| TXRU pattern at UE |  | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional | 0dBi Omni-directional |
| Data Transmission mode |  | SU-MIMO with rank 1 | SU-MIMO with rank 1 | Single port 24 PRB | Single port 24 PRB | SU-MIMO with rank 1 | SU-MIMO with rank 1 |
| Channel estimation |  | Realistic | Realistic | Realistic | Realistic | Realistic | Realistic |
| PUCCH transmission scheme |  | SISO | SISO | SIMO Single-shot | SIMO Single-shot | - | - |
| PUSCH modulation and coding |  | LDPC, QPSK | LDPC, QPSK | LDPC MCS #4 from Low SE 64 QAM table (QPSK, CR = 78/1024) | LDPC MCS #4 from Low SE 64 QAM table (QPSK, CR = 78/1024) | LDPC, Table 3 MCS 1 | LDPC, Table 3 MCS 6 |
| Packet size |  | 256bit | 256bit | 256bit | 256bit | 256bit | 256bit |
| DMRS configuration |  | 1 symbol DMRS, Config. 1, 3 dB power boost | 1 symbol DMRS, Config. 1, 3 dB power boost | 1 symbol DMRS, Config. 1, 3 dB power boost | 1 symbol DMRS, Config. 1, 3 dB power boost | Type 2, 2 symbols DMRS | Type 2, 1 symbol DMRS |

# Connection Density (Non-full buffer) – Urban Macro mMTC

SLS/1732m

|  |  |  |  |
| --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson NB-IoT | Ericsson LTE-M |
| Data transmission procedure | 1. Early data transmission 2. RRC Resume | RRC Resume, data after Msg5, RRC Connection Release | RRC Resume, data after Msg5, RRC Connection Release |
| Multiple access |  | DL: OFDMA UL: SC-FDMA | DL: OFDMA UL: SC-FDMA |
| Duplexing |  | HD FDD | HD FDD |
| Numerology |  | 15 kHz SCS | 15 kHz SCS |
| Simulation bandwdith |  | 180kHz | 1.08MHz |
| Transmission scheme |  | UL SIMO | UL SIMO |
| UL codebook |  | 1Tx | 1Tx |
| MU dimension |  | N/A | N/A |
| SU dimension |  | 1 | 1 |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) |
| Scheduling |  | Round-Robin | Round-Robin |
| Receiver | MMSE-IRC | MMSE | MMSE |
| Power control parameter |  | UL SINR target of 10 dB | UL SINR target of 10 dB |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). |
|  |  |  |  |
|  |  |  |  |
| **System configuration parameters** | Reference Value |  |  |
| Carrier frequency for evaluation | 1 layer (Macro) with 700 MHz | Aligned with reference | Aligned with reference |
| Simulation bandwidth |  | 180kHz | 1.08MHz |
| TRxP number per site | 3 | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt |  | Conf A: 93°  Conf A: 99° | Conf A: 93°  Conf A: 99° |
| Handover margin (dB) |  | 2 | 2 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Single tone(15kHz) | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Radio distance based | Radio distance based |
| Polarized antenna model | Model-2 in TR36.873 | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) |  |  |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - |  |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Strongest cell based on RSRP | Strongest cell based on RSRP |
| Criteria for analog beam selection for serving TRxP | - |  |  |
| Analog beam selection for interfering TRxP | - |  |  |
| PRACH configuration |  | CE 0: 2 rep, 160 ms periodicity CE 1: 8 rep, 640 ms periodicity,  -126 dBm CE threshold CE 2: 32 rep, 2560 ms periodicity,  -136 dBm CE threshold | CE 0: 1 rep, 10 ms periodicity CE 1: 4 rep, 40 ms periodicity,  -122 dBm CE threshold CE 2: 16 rep, 160 ms periodicity,  -130 dBm CE threshold CE 3: 64 rep, 640 ms periodicity,  -138 dBm CE threshold |
| PUSCH scheduling unit |  | Flexible according to 3GPP specificatons | Flexible according to 3GPP specificatons |
| UL DMRS |  | According to 3GPP specificatons | According to 3GPP specificatons |

SLS/500m

|  |  |  |  |
| --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson NB-IoT | Ericsson LTE-M |
| Data transmission procedure | 1. Early data transmission 2. RRC Resume | RRC Resume, data after Msg5, RRC Connection Release | RRC Resume, data after Msg5, RRC Connection Release |
| Multiple access |  | DL: OFDMA UL: SC-FDMA | DL: OFDMA UL: SC-FDMA |
| Duplexing |  | HD FDD | HD FDD |
| Numerology |  | 15 kHz SCS | 15 kHz SCS |
| Simulation bandwdith |  | 180kHz | 1.08MHz |
| Transmission scheme |  | UL SIMO | UL SIMO |
| UL codebook |  | 1Tx | 1Tx |
| MU dimension |  | N/A | N/A |
| SU dimension |  | 1 | 1 |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) |
| Scheduling |  | Round-Robin | Round-Robin |
| Receiver | MMSE-IRC | MMSE | MMSE |
| Power control parameter |  | UL SINR target of 10 dB | UL SINR target of 10 dB |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). |
|  |  |  |  |
|  |  |  |  |
| **System configuration parameters** | Reference Value |  |  |
| Carrier frequency for evaluation | 1 layer (Macro) with 700 MHz | Aligned with reference | Aligned with reference |
| Simulation bandwidth |  | 180kHz | 1.08MHz |
| TRxP number per site | 3 | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt |  | Conf A: 93°  Conf A: 99° | Conf A: 93°  Conf A: 99° |
| Handover margin (dB) |  | 2 | 2 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Strongest cell based on RSRP | Strongest cell based on RSRP |
| Wrapping around method | Geographical distance based wrapping | Radio distance based | Radio distance based |
| Polarized antenna model | Model-2 in TR36.873 | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) |  |  |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - |  |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Strongest cell based on RSRP | Strongest cell based on RSRP |
| Criteria for analog beam selection for serving TRxP | - |  |  |
| Analog beam selection for interfering TRxP | - |  |  |
| PRACH configuration |  | CE 0: 2 rep, 160 ms periodicity CE 1: 8 rep, 640 ms periodicity,  -126 dBm CE threshold CE 2: 32 rep, 2560 ms periodicity,  -136 dBm CE threshold | CE 0: 1 rep, 10 ms periodicity CE 1: 4 rep, 40 ms periodicity,  -122 dBm CE threshold CE 2: 16 rep, 160 ms periodicity,  -130 dBm CE threshold CE 3: 64 rep, 640 ms periodicity,  -138 dBm CE threshold |
| PUSCH scheduling unit |  | Flexible according to 3GPP specificatons | Flexible according to 3GPP specificatons |
| UL DMRS |  | According to 3GPP specificatons | According to 3GPP specificatons |

# Connection Density (Full buffer) – Urban Macro mMTC

SLS/1732m

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson NB-IoT | Ericsson LTE-M | Ericsson NR | Intel eMTC | Intel NR |
| Multiple access |  | Single-tone SC-FDMA | SC-FDMA | OFDMA | DFT-S-OFDM | OFDMA |
| Duplexing |  | FDD | FDD | FDD | FDD | FDD |
| Numerology |  | 15 kHz SCS | 15 kHz SCS | 15 kHz SCS | 15 kHz SCS | 15 kHz SCS |
| Transmission scheme |  | UL SIMO | UL SIMO | UL SIMO | UL SIMO | UL SIMO |
| UL codebook |  | 1Tx | 1Tx | 1Tx | 1Tx | 1Tx |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) |
| Scheduling |  | No scheduling active in full buffer simulations. | No scheduling active in full buffer simulations. | No scheduling active in full buffer simulations. | Full buffer | Full buffer |
| Receiver | MMSE-IRC | MRC | MRC | MRC | Aligned with reference | Aligned with reference |
| Power control parameter |  | Alpha = 1.0, SNR target 3dB | Alpha = 1.0, SNR target = 3dB | Alpha = 1.0, SNR target = 3dB | α=1, P\_0=-113 dBm | α=1, P\_0=-113 dBm |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Aligned with reference | Aligned with reference |

LLS/1732m

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Reference value** | **Ericsson** | **Ericsson** | **Ericsson** | **Intel** | **Intel** |
| **NB-IoT** | **LTE-M** | **NR** | **eMTC** | **NR** |
| Physical channel |  | **NPUSCH F1** | **PUSCH** | **PUSCH** | **PUSCH** | **PUSCH** |
| Carrier frequency |  | 700 MHz | 700 MHz | 700 MHz | 700 MHz | 700 MHz |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwidth | Up to 50 MHz (for ISD = 1732 m) | 15kHz | 180kHz | 180kHz | 180kHz | 180kHz |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link-level Channel model |  | TDL-iii | TDL-iii | TDL-iii | TDL-iii | TDL-iii |
| UE speed | 3 km/h | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Subcarrier spacing |  | 15 kHz | 15 kHz | 15 kHz | 15 kHz | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |  | 2R | 2R | 2R | 2R | 2R |
| Antenna configuration at UE |  | 1T | 1T | 1T | 1T | 1T |
| TXRU pattern at TRxP |  | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional |
| TXRU pattern at UE |  | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional |
| Transmission mode |  | SIMO | SIMO | SIMO | SIMO | SIMO |
| Transmission rank |  | 1 | 1 | 1 | 1 | 1 |
| UL precoder |  |  |  |  | - | - |
| TBS |  | 256 | 144, 256 | 32, 42, 48, 64, 80, 104, 144, 168, 184 | 32, 144, 256 | 32, 64, 144, 184 |
| Modulation order |  | QPSK-π/4 | QPSK, 16QAM | QPSK | QPSK (for 32/144), 16QAM (for 256) | QPSK |
| Number of Resource units |  | 2,3,4,5,6,8,10 | N/A | N/A | N/A | N/A |
| Number of repetition |  | 1,2,4,8,16 | 1,2,4,8,16,32 | 1 | 1 | 1 |
| TRxP receiver type | MMSE-IRC | MMSE | MMSE | MMSE | Aligned with reference | Aligned with reference |
| Channel estimation |  | Realistic | Realistic | Realistic | MMSE | MMSE |
| Channel coding scheme |  | Turbo code | Turbo code | LDPC code | Turbo code | LDPC code |
| DMRS configuration |  | According to 3GPP specifications. | According to 3GPP specifications. | According to 3GPP specifications. | According to 3GPP specifications. | According to 3GPP specifications. |

SLS/500m

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Technical configuration Parameters** | Reference value | Ericsson NB-IoT | Ericsson LTE-M | Ericsson NR | Intel eMTC | Intel NR |
| Multiple access |  | Single-tone SC-FDMA | SC-FDMA | OFDMA | DFT-S-OFDM | OFDMA |
| Duplexing |  | FDD | FDD | FDD | FDD | FDD |
| Numerology |  | 15 kHz SCS | 15 kHz SCS | 15 kHz SCS | 15 kHz SCS | 15 kHz SCS |
| Transmission scheme |  | UL SIMO | UL SIMO | UL SIMO | UL SIMO | UL SIMO |
| UL codebook |  | 1Tx | 1Tx | 1Tx | 1Tx | 1Tx |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels in a column; - Ng: Number of panels in a row; - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) | 2R, (8,1,2,1,1; 1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) - M: Number of vertical antenna elements within a panel, on one polarization - N: Number of horizontal antenna elements within a panel, on one polarization - P: Number of polarizations - Mg: Number of panels; - Ng: default: 1 - Mp: Number of vertical TXRUs within a panel, on one polarization - Np: Number of horizontal TXRUs within a panel, on one polarization | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) | 1T, (1,1,1,1,1; 1,1) |
| Scheduling |  | No scheduling active in full buffer simulations. | No scheduling active in full buffer simulations. | No scheduling active in full buffer simulations. | Full buffer | Full buffer |
| Receiver | MMSE-IRC | MRC | MRC | MRC | Aligned with reference | Aligned with reference |
| Power control parameter |  | Alpha = 1.0, SNR target 10dB | Alpha = 1.0, SNR target = 3dB | Alpha = 1.0, SNR target = 3dB | α=1, P\_0=-103 dBm | α=1, P\_0=-103 dBm |
| **SINR** | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Total received wanted power, divided by total received interference and noise (over all antenna elements and configured signal bandwitdh). | Aligned with reference | Aligned with reference |
| **System configuration parameters** | Reference Value |  |  |  |  |  |
| Carrier frequency for evaluation | 1 layer (Macro) with 700 MHz | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| TRxP number per site | 3 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Mechanic tilt | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Electronic tilt |  | 99° in GCS | 99° in GCS | 99° in GCS | 99° in GCS | 99° in GCS |
| Handover margin (dB) |  | 0 | 0 | 0 | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Radio distance based wrapping | Radio distance based wrapping | Radio distance based wrapping | Aligned with reference | Aligned with reference |
| Polarized antenna model | Model-2 in TR36.873 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Beam set at TRxP (Constraints for the range of selective analog beams per TRxP) |  |  |  |  |  |  |
| Beam set at UE (Constraints for the range of selective analog beams for UE) | - |  |  |  |  |  |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered | Strongest cell based on RSRP | Strongest cell based on RSRP | Strongest cell based on RSRP | RSRP based cell selection | RSRP based cell selection |
| Criteria for analog beam selection for serving TRxP | - |  |  |  | RSRP based DFT beam selection | RSRP based DFT beam selection |
| Analog beam selection for interfering TRxP | - |  |  |  |  |  |
| PUSCH scheduling unit |  | Single tone (15kHz) | 1 PRB (180kHz) | 1 PRB (180kHz) | 180kHz | 180kHz |

LLS/500m

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Reference value** | **Ericsson** | **Ericsson** | **Ericsson** | **Intel** | **Intel** |
| **NB-IoT** | **LTE-M** | **NR** | **eMTC** | **NR** |
| Physical channel |  | **NPUSCH F1** | **PUSCH** | **PUSCH** | **PUSCH** | **PUSCH** |
| Carrier frequency |  | 700 MHz | 700 MHz | 700 MHz | 700 MHz | 700 MHz |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Simulation bandwidth | Up to 10 MHz (for ISD = 500 m) | 15kHz | 180kHz | 180kHz | 180kHz | 180kHz |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Link-level Channel model |  | TDL-iii | TDL-iii | TDL-iii | TDL-iii | TDL-iii |
| UE speed | 3 km/h | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Subcarrier spacing |  | 15 kHz | 15 kHz | 15 kHz | 15 kHz | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |  | 2R | 2R | 2R | 2R | 2R |
| Antenna configuration at UE |  | 1T | 1T | 1T | 1T | 1T |
| TXRU pattern at TRxP |  | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional |
| TXRU pattern at UE |  | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional | Option 1: 0dBi Omni-directional |
| Transmission mode |  | SIMO | SIMO | SIMO | SIMO | SIMO |
| Transmission rank |  | 1 | 1 | 1 | 1 | 1 |
| UL precoder |  |  |  |  | - | - |
| TBS |  | 256 | 144, 256 | 32, 42, 48, 64, 80, 104, 144, 168, 184 | 32, 144, 256 | 32, 64, 144, 184 |
| Modulation order |  | QPSK-π/4 | QPSK, 16QAM | QPSK | QPSK (for 32/144), 16QAM (for 256) | QPSK |
| Number of Resource units |  | 2,3,4,5,6,8,10 | N/A | N/A | N/A | N/A |
| Number of repetition |  | 1,2,4,8,16 | 1,2,4,8,16,32 | 1 | 1 | 1 |
| TRxP receiver type | MMSE-IRC | MMSE | MMSE | MMSE | Aligned with reference | Aligned with reference |
| Channel estimation |  | Realistic | Realistic | Realistic | MMSE | MMSE |
| Channel coding scheme |  | Turbo code | Turbo code | LDPC code | Turbo code | LDPC code |
| DMRS configuration |  | According to 3GPP specifications. | According to 3GPP specifications. | According to 3GPP specifications. | According to 3GPP specifications. | According to 3GPP specifications. |