TCOE India IEG Interim Evaluation Report of the TSDSI RIT

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# Introduction

This report contains the evaluation results received from TCOE proponents, which are reviewed and harmonized in TCOE meetings and used to summarize the evaluation results for quantitative assessment on TCOE INDIA RIT proposal. All evaluation results were generated by following the IMT‑2020 evaluation methodology as provided in ITU-R M.2412. Table 1 shows the different sources of the evaluation results correspond to contributors from the different affiliations.

Table 1 Sources for the evaluation results

|  |  |
| --- | --- |
| Source 1 | Center for Excellence in Wireless Technology (CeWiT) |
| Source 2 | Indian Institute of Technology Madras (IITM) |
| Source 3 | Indian Institute of Technology Hyderabad (IITH) |
| Source 4 | Indian Institute of Technology Kharagpur (IIT KGP) |
| Source 5 | Indian Institute of Sciences (IISC) |

# Evaluation summary

In this interim report, the following KPI has been evaluated for the TSDSI RIT based on RIT Submission from TSDSI ([IMT-2020/19](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0019)) along with the update ([5D/1301](https://www.itu.int/md/R15-WP5D-C-1301/en)).

|  |  |
| --- | --- |
| Test environment | Does the Evaluation Report indicate that the minimum technical performance requirements are met in the test environment? |
| Indoor Hotspot-eMBB | Partially Evaluated. Meets the requirement for the evaluated KPI. |
| Dense Urban-eMBB | Partially Evaluated. Meets the requirement for the evaluated KPI. |
| Rural-eMBB | Partially Evaluated. Meets the requirement for the evaluated KPI. |
| Urban Macro–mMTC | Not evaluated for this report |
| Urban Macro–URLLC | Partially evaluated. Meets the requirement for the evaluated KPI. |

The following KPI have been evaluated for this interim report.

|  |  |  |
| --- | --- | --- |
| Simulation | Analytical | Inspection |
| 1. Average spectral efficiency
2. 5th percentile user spectral efficiency
3. Mobility
4. Reliability
5. User Data Rate
6. Area traffic capacity
 | 1. Peak data rate
2. Peak spectral efficiency
3. User experienced data rate
4. Area traffic capacity
 | 1. Bandwidth
 |

The remaining KPI (connection density, control plane latency, user plane latency, mobility interruption time, energy efficiency and link budget templates) will be evaluated and presented in the final report.

In the next Table, the summary of the evaluated KPI is provided for quick reference. We observe that the RIT fulfills the requirements for the evaluated KPI. From the table we observe that the TSDSI RIT meets the requirements for all the KPI that have been evaluated.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Minimum technical performance requirements item (5.2.4.3.x), units, and ReportITU-R M.2410-0 section reference(1) | Category | Required value | Value obtained by the evaluation group | Requirement met? | Comments(3) |
|   | Usage scenario | Test environment | Downlink or uplink |  |  |  |   |
| 5.2.4.3.1Peak data rate (Gbit/s)(4.1) | eMBB | Not applicable | Downlink | 20 | 39.2 | Yes | 16 Component carriers  |
| Uplink | 10 | 20 | Yes |
| 5.2.4.3.2Peak spectral efficiency (bit/s/Hz)(4.2) | eMBB | Not applicable | Downlink | 30 | 48.9 | Yes |   |
| Uplink | 15 | 25 | Yes |
| 5.2.4.3.3User experienced data rate (Mbit/s)(4.3) | eMBB  | Dense Urban – eMBB | Downlink | 100 | 396 - 432 | Yes |   |
| Uplink | 50 | 228 - 296 | Yes |  |
| 5.2.4.3.45th percentile user spectral efficiency (bit/s/Hz)(4.4)  | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.84 | Yes | FDD Configuration A |
| 0.82 | Yes | TDD Configuration A |
| Uplink | 0.21 | 0.56 | Yes | FDD Configuration A |
| 0.61 | Yes | TDD Configuration A |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.89 | Yes | FDD Configuration A |
| 0.75 | Yes | TDD Configuration A |
| Uplink | 0.15 | 0.74 | Yes | FDD Configuration A |
| 0.65 | Yes | TDD Configuration A |
| eMBB | Rural – eMBB  | Downlink | 0.12 | 0.6 | Yes | FDD Configuration A |
| 1.19 | Yes | FDD Configuration B |
| 0.78 | Yes | FDD Configuration C |
| 0.55 | Yes | TDD Configuration A |
| 1.02 | Yes | TDD Configuration B |
| 1.05 | Yes | TDD Configuration C  |
| Uplink | 0.045 | 0.61 | Yes | FDD configuration A |
| 0.445 | Yes | FDD Configuration B |
| 0.32 | Yes | FDD Configuration C |
| 0.57 | Yes | TDD Configuration A |
| 0.43 | Yes | TDD Configuration B |
| 0.79 | Yes | TDD Configuration C  |
| 5.2.4.3.5Average spectral efficiency (bit/s/Hz/ TRxP)(4.5)   | eMBB | Indoor Hotspot – eMBB | Downlink | 9  | 9.8  | Yes | FDD Configuration A |
| 9.5 | Yes | TDD Configuration A |
| Uplink | 6.75  | 8.8 | Yes | FDD Configuration A |
| 7.01 | Yes | TDD Configuration A |
| eMBB  | Dense Urban – eMBB | Downlink | 7.8  | 11.5 | Yes | FDD Configuration A |
| 11.1 | Yes | TDD Configuration A |
| Uplink | 5.4  | 7.88 | Yes | FDD Configuration A |
| 7.05 | Yes | TDD Configuration A |
| eMBB | Rural – eMBB | Downlink | 3.3  | 6.3 | Yes | FDD configuration A |
| 8.24 | Yes | FDD Configuration B |
| 6.3 | Yes | FDD Configuration C |
| 5.8 | Yes | TDD Configuration A |
| 8.01 | Yes | TDD Configuration B |
| 7.47 | Yes | TDD Configuration C  |
| Uplink | 1.6  | 4.7 | Yes | FDD configuration A |
| 3.72 | Yes | FDD Configuration B |
| 4.13 | Yes | FDD Configuration C |
| 4.05 | Yes | TDD Configuration A |
| 3.51 | Yes | TDD Configuration B |
| 3.17 | Yes | TDD Configuration C  |
| 5.2.4.3.6Area traffic capacity (Mbit/s/m2)(4.6) | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 | 10.04 – 11.43 | Yes |   |
| 5.2.4.3.7User plane latency(ms)(4.7.1) | eMBB | Not applicable | Downlink  | 4  |  |  | NOT EVALUATED in this report |
| Uplink |  |  |
|  URLLC | Not applicable | Downlink | 1   |  |  |  NOT EVALUATED in this report  |
| Uplink  |  |  |
| 5.2.4.3.8Control plane latency (ms)(4.7.2) | eMBB | Not applicable | Not applicable  | 20 |  |  | NOT EVALUATED in this report |
| URLLC | Not applicable | Not applicable | 20 |  |  | NOT EVALUATED in this report |
| 5.2.4.3.9Connection density (devices/km2)(4.8) | mMTC | Urban Macro – mMTC | Uplink  | 1 000 000  |  |  | NOT EVALUATED in this report |
|  |  |   |
| 5.2.4.3.10Energy efficiency(4.9) | eMBB | Not applicable | Not applicable | Capability to support a high sleep ratio and long sleep duration |  |  | NOT EVALUATED in this report  |
| 5.2.4.3.11Reliability(4.10)  | URLLC | Urban Macro –URLLC  | Downlink   | 1-10−5 success probability of transmitting a layer 2 PDU (protocol data unit) of size 32 bytes within 1 ms in channel quality of coverage edge99.999% | 99.9994% - 99.9995% | Yes |  |
| Uplink  | 99.99998% - 99.99999% | Yes |  |
| 5.2.4.3.12Mobility classes(4.11) | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian | Stationary, Pedestrian | Yes |   |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian, Vehicular (up to 30 km/h) | Stationary, Pedestrian,Vehicular (up to 30 km/h) | Yes |   |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular | Pedestrian, Vehicular, High speed vehicular | Yes |   |
| 5.2.4.3.13MobilityTraffic channel link data rates (bit/s/Hz)(4.11) | eMBB | Indoor Hotspot – eMBB | Uplink | 1.5 (10 km/h) | 2.59 | Yes |   |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | 2.44  | Yes |  |
| eMBB | Rural – eMBB  | Uplink | 0.8 (120 km/h) | 2.53 | Yes | Configuration A |
| 0.45 (500 km/h) | 2.12  | Yes |
| 0.8 (120 km/h) | 2.80 | Yes | Configuration B |
| 0.45 (500 km/h) | 2.51 | Yes |
| 5.2.4.3.14Mobility interruption time (ms) (4.12) | eMBB and URLLC | Not applicable | Not applicable | 0 |  |  |  NOT EVALUATED in this report |
| 5.2.4.3.15Bandwidth and Scalability(4.13)  | Not applicable | Not applicable | Not applicable | At least 100 MHz | 800 MHz - 6.4 GHz | Yes |    |
| Up to 1 GHz |  | Yes |
| Support of multiple different bandwidth values | 3 - 13 different component carrier bandwidth values | Yes |
|   | (1) As defined in Report ITU-R M.2410-0.(2) According to the evaluation methodology specified in Report ITU-R M.2412-0.(3) Proponents should report their selected evaluation methodology of the Connection density, the channel model variant used, and evaluation configuration(s) with their exact values (e.g. antenna element number, bandwidth, etc.) per test environment, and could provide other relevant information as well. For details, refer to Report ITU-R M.2412-0, in particular, § 7.1.3 for the evaluation methodologies, § 8.4 for the evaluation configurations per each test environment, and Annex 1 on the channel model variants.(4) Refer to § 7.3.1 of Report ITU-R M.2412-0. |

# Average Spectral Efficiency and 5-percentile Spectral Efficiency

In this Section, we evaluate the ASE and fifth percentile SE for all the required test environments. As required by Report ITU-R M.2412, the average spectral efficiency and the 5th percentile user spectral efficiency are assessed jointly using the same simulation.

## Indoor Hotspot (InH) Test Environment

The RIT was evaluated for Configuration A, *i.e.,* a carrier frequency of 4 GHz for both FDD and TDD.

### Downlink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **InH - eMBB** |   |  |  |
| **Technical configuration Parameters** | Reference value |   |
|  |   |   | **FDD** | **TDD**  |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | 10 MHz | 20 MHz |
| Frame structure |   | FDD: Full downlink | DSUUD |
| Transmission scheme | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation |
| DL CSI measurement |   | Non-precoded CSI-RS based | Non-precoded CSI-RS based |
| DL codebook |   | Type I codebook; | Type I codebook; |
| PRB bundling |   | 4 PRBs | 4 PRBs |
| MU dimension |   | Up to 12 layers | Up to 12 layers |
| SU dimension |   | 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 |
| 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 | NA |
| CSI feedback |   | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  | CQI: every 5 slot; RI: every 5 slot, CRI: every 5 slotSubband based  |
| Interference measurement |   | SU-CQI;  | SU-CQI;  |
| CBG | 1 | Aligned with reference | Aligned with reference |
| ACK/NACK delay |   | 4 slots | The next available UL slot |
| Re-transmission delay |   | 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) | 12TRxP: For 32T, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4) (dH,dV) = (0.5, 0.5)λ | 12TRxP:For 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) | For 12TRxP:  - For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2)(dH,dV) = (0.5, NA )λ | For 12TRxP:  - For 4R, (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2)(dH,dV) = (0.5, NA)λ |
| Scheduling | PF | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation | Non-ideal | Non-ideal | Non-ideal |
|  |   |   |   |
| **System configuration parameters** | Reference Value |   |   |
| TRxP number per site | 1 | 3 | Aligned with reference | Aligned with reference |
| Mechanic tilt  | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference |
| Electronic tilt | 90° in LCS | 90° in LCS | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | Aligned with reference | Aligned with reference |
| Wrapping around method | No wrapping around | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Analog beam selection for interfering TRxP | - | - | - |

### Uplink Simulation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **InH - eMBB** |  |  |  |  |
| **Technical configuration Parameters** | Reference value |   |
|  |   |   | **NR FDD** | **NR TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | 10 MHz | 20 MHz |
| Frame structure |   | Full uplink  | DSUUD |
| Transmission scheme | UL codebook based SU-MIMO / MU-MIMO  | UL SU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation |
| UL codebook |   |  4Tx codebook |  4Tx codebook |
| MU dimension |   | N/A | N/A |
| SU dimension |   | 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 |
| 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 | Non-precoded SRS, 4 SRS ports (with 4 SRS resources);2 symbols for SRS in every 5 slots, | Non-precoded SRS, 4 SRS ports (with 4 SRS resources);2 symbols for SRS in every 5 slots, |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 12TRxP: For 32R, (M,N,P,Mg,Ng; Mp,Np) = (4,4,2,1,1;4,4) (dH,dV) = (0.5, 0.5)λ | 12TRxP:For 32R, (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) | 12TRxP:  (M,N,P,Mg,Ng; Mp,Np) = (1,2,2,1,1; 1,2); (dH, dV)=( 0.5, N/A)λ | 12TRxP:  (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 |
| UL re-transmission delay |   | Next available UL slot after receiving retransmission indication | Next available UL slot after receiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
| Power control parameter |   | P0=-76, alpha = 0.8 | P0=-76, alpha = 0.8 |
| Power backoff model |   | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction | Continuous RB allocation: follow T3.9038.101 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 |
| Mechanic tilt  | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference | Aligned with reference |
| Electronic tilt | 90° in LCS | 90° in LCS | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment | Based on RSRP from port 0The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | Aligned with reference | Aligned with reference |
| Wrapping around method | No wrapping around | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Analog beam selection for interfering TRxP | - | - | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

### Simulation Results

Average spectral efficiency for TDD configuration for the Indoor hotspot test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 9 [bit/s/Hz/TRxP] | 9.5 |
| Uplink | 6.75 [bit/s/Hz/TRxP] | 7.01 |

Average spectral efficiency for FDD configuration for the Indoor hotspot test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 9 [bit/s/Hz/TRxP] | 9.8 |
| Uplink | 6.75 [bit/s/Hz/TRxP] | 8.8 |
|  |  |  |

5th-percentile spectral efficiency for TDD configuration for the Indoor hotspot test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.3  | 0.82 |
| Uplink | 0.21 | 0.61 |

5th-percentile spectral efficiency for FDD configuration for the Indoor hotspot test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.3 | 0.84 |
| Uplink | 0.21 | 0.56 |

## Dense Urban Test Environment

The RIT was evaluated for Configuration A, *i.e.,* a carrier frequency of 4 GHz for both FDD and TDD.

### Downlink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Dense Urban - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value for NR |   |   |
| **FDD** | **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full downlink | DSUUD |
| Transmission scheme | Closed SU/MU-MIMO adaptation | Aligned with reference | Aligned with reference |
| DL CSI measurement |   | Non-precoded CSI-RS based | Non-precoded CSI-RS based |
| DL codebook |   | Type I codebook | Type I codebook |
| PRB bundling |   | 4 PRBs | 4 PRBs |
| MU dimension |   |  Up to 12 layers |  Up to 12 layers |
| SU dimension |   | 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 |
| 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 |
| CSI feedback |   | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  |
| Interference measurement |   | SU-CQI;  | SU-CQI;  |
| Max CBG number | 1 | Aligned with reference | Aligned with reference |
| ACK/NACK delay | UE capability 1 | 4 slots | The next available UL slot |
| Re-transmission delay |   | 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) | 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) | 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 |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
|  |  |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | 105 degree | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP (formula (8.1-1) in TR36.873) from port 0 |

 | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - |
|  |  |  |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| Other system configuration parameters align with Report ITU M.2412 |  |  |

### Uplink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Dense Urban - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
| **FDD** | **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full uplink | DSUUD |
| Transmission scheme | UL codebook based SU-MIMO / MU-MIMO  | UL SU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation |
| UL codebook |   | For 4Tx: 4Tx codebook; | For 4Tx: 4Tx codebook; |
| MU dimension |   | N/A | N/A |
| SU dimension |   | 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 |
| 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 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) | 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; |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) | 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 |
| UL re-transmission delay |   | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
| Power control parameter |   | P0=-86, alpha = 0.8 | P0=-86, alpha = 0.8 |
| Power backoff model |   | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction |
|  |  |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | 105 degree | Aligned with reference | Aligned with reference |
| Handover margin (dB) |   | 0 | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP from port 0 |

 | Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - |

### Simulation Results

Average spectral efficiency for TDD configuration for the Dense Urban test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 7.8 [bit/s/Hz/TRxP] | 11.1 |
| Uplink | 5.4 [bit/s/Hz/TRxP] | 7.05 |

Average spectral efficiency for FDD configuration for the Dense Urban test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 7.8 [bit/s/Hz/TRxP] | 11.5 |
| Uplink | 5.4 [bit/s/Hz/TRxP] | 7.88 |

5th-percentile spectral efficiency for TDD configuration for the Dense Urban test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.225 | 0.75 |
| Uplink | 0.15 | 0.65 |

5th-percentile spectral efficiency for FDD configuration for the Dense Urban test environment

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.225 | 0.89 |
| Uplink | 0.15 | 0.74 |

## Rural Test Environment

The Rural Test Environment was evaluated for all the three configurations

### Config A

The RIT was evaluated for Rural e-MBB Configuration A, i.e., a carrier frequency of 700 MHz for both FDD and TDD.

#### Downlink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Rural - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
|  |   |  **FDD** |  **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization |   | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full downlink | DSUUD |
| Transmission scheme | Closed SU/MU-MIMO adaptation | closed SU-MIMO adaptation | closed SU/MU-MIMO adaptation |
| DL CSI measurement |   | Non-precoded CSI-RS based | Non-precoded CSI-RS based |
| DL codebook |   | Type I codebook ; | Type I codebook ; |
| PRB bundling |   | 4 PRBs | 4 PRBs |
| MU dimension |   | Up to 8 layers | Up to 8 layers |
| SU dimension |   | 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 |
| 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 |
| CSI feedback |   | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  |
| Interference measurement |   | SU-CQI | SU-CQI |
| CBG | 1 | Aligned with reference | Aligned with reference |
| ACK/NACK delay |   | 4 slots | The next available UL slot |
| Re-transmission delay |   | 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) | 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) | 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 |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-Ideal | Non-Ideal |
|  |  |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0 | Aligned with reference | Aligned with reference |
|
| Wrapping around method | Geographical distance based wrapping | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

#### Uplink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Rural - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
|  |   | **FDD** |  **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization |   | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full uplink | DSUUD |
| Transmission scheme |   | SU-MIMO with rank adaptation | SU-MIMO with rank adaptation |
| UL codebook |   | UL 2Tx Codebook | UL 2Tx Codebook |
| MU dimension |   | N/A | N/A |
| SU dimension |   | 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 |
| 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 | Non-precoded SRS, 2 SRS ports (with 1 SRS resource);2 symbols for SRS in every 5 slots. | Non-precoded SRS, 2 SRS ports (with 1 SRS resource);2 symbols for SRS in every 5 slots. |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 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) | 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 |
| UL re-transmission delay |   | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
| Power control parameter |   | P0=-76, alpha = 0.8 | P0=-76, alpha = 0.8 |
| Power backoff model |   | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction |
|   |   |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of RP-180524) from port 0 | Aligned with reference | Aligned with reference |
|
| Wrapping around method | Geographical distance based wrapping | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

#### Simulation Results

Average spectral efficiency for TDD configuration for the Rural-eMBB test environment, Configuration A (700 MHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA  |
| Downlink | 3.3 [bit/s/Hz/TRxP] | 5.8 |
| Uplink | 1.6 [bit/s/Hz/TRxP] | 4.05 |

Average spectral efficiency for FDD configuration for the Rural-eMBB test environment, Configuration A (700 MHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 3.3 [bit/s/Hz/TRxP] | 6.3 |
| Uplink | 1.6 [bit/s/Hz/TRxP] | 4.7 |

5th-percentile spectral efficiency for TDD configuration for the Rural-eMBB test environment, Configuration A (700 MHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.12 | 0.55 |
| Uplink | 0.045 | 0.57 |

5th-percentile spectral efficiency for FDD configuration for the Rural-eMBB test environment, Configuration A (700 MHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.12 | 0.6 |
| Uplink | 0.045 | 0.61 |

### Config B

The RIT was evaluated for Rural e-MBB Configuration B, i.e., a carrier frequency of 4 GHz for both FDD and TDD. The following simulation parameters were used for the evaluation.

#### Downlink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Rural - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
|  |   | **FDD** | **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPCMax code-block size=8448bit [with BP decoding] | Aligned with reference | Aligned with reference |
| Numerology | 15 kHz / 30 kHz,14 OFDM symbol slot | 15kHz 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full downlink | DSUUD |
| Transmission scheme | closed SU/MU-MIMO adaptation | Aligned with reference | Aligned with reference |
| DL CSI measurement |   | Non-precoded CSI-RS based | Non-precoded CSI-RS based |
| DL codebook |   | Type I codebook | Type I codebook |
| PRB bundling |   | 4 PRBs | 4 PRBs |
| MU dimension |   |  Up to 12 layers |  Up to 12 layers |
| SU dimension |   | 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 |
| 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 |
| CSI feedback |   | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  |
| Interference measurement |   | SU-CQI;  | SU-CQI;  |
| CBG | 1 | Aligned with reference | Aligned with reference |
| ACK/NACK delay |   | 4 slots | The next available UL slot |
| Re-transmission delay |   | 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) | 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) | 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 |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
|  |  |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 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 |
| Wrapping around method | Geographical distance based wrapping | - | - |
| 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) | - | Aligned with reference | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered  | - | - |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - |  |  |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

#### Uplink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Rural - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
|  |   | **FDD** | **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization | Synchronized | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPCMax code-block size=8448bit [with BP decoding] | Aligned with reference | Aligned with reference |
| Numerology | 15 kHz / 30 kHz,14 OFDM symbol slot | 15kHz 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full uplink | DSUUD |
| Transmission scheme |   | UL SU-MIMO with rank adaptation | UL SU-MIMO with rank adaptation |
| UL codebook |   | For 4Tx: 4Tx codebook; | For 4Tx: 4Tx codebook; |
| MU dimension |   | N/A | N/A |
| SU dimension |   | 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 |
| 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 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) | 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; |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) | 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 |
| UL re-transmission delay |   | Next available UL slot after reiving retransmission indication | Next available UL slot after reiving retransmission indication |
| Scheduling | PF | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
| Power control parameter |   | P0=-76, alpha = 0.8 | P0=-76, alpha = 0.8 |
| Power backoff model |   | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction |
|   |   |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | [100°] in LCS | Aligned with reference | Aligned with reference |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP |
|

 | Aligned with reference | Aligned with reference |
| Aligned with reference | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | - | - |
| 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) | - | Aligned with reference | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered  | - | - |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - |  |  |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

#### Simulation Results

Average spectral efficiency for TDD configuration for the Rural-eMBB test environment, Configuration B (4 GHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  | TCOE INDIA |
| Downlink | 3.3 [bit/s/Hz/TRxP] | 8.01 |
| Uplink | 1.6 [bit/s/Hz/TRxP] | 3.51 |

Average spectral efficiency for FDD configuration for the Rural-eMBB test environment, Configuration B (4 GHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 3.3 [bit/s/Hz/TRxP] | 8.24 |
| Uplink | 1.6 [bit/s/Hz/TRxP] | 3.72 |

5th-percentile spectral efficiency for TDD configuration for the Rural-eMBB test environment, Configuration B (4 GHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.12 | 1.02 |
| Uplink | 0.045 | 0.43 |

5th-percentile spectral efficiency for FDD configuration for the Rural-eMBB test environment, Configuration B (4 GHz)

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.12 | 1.19 |
| Uplink | 0.045 | 0.445 |

### Config C (LMLC)

The RIT was evaluated for Rural e-MBB LMLC configuration for both FDD and TDD.

#### Downlink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Rural - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
|  |   |  **FDD** |  **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization |   | Aligned with reference | Aligned with reference |
| Modulation | Up to 256 QAM | Aligned with reference | Aligned with reference |
| Coding on PDSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | 10 MHz | 20 MHz |
| Frame structure |   | Full downlink | DSUUD |
| Transmission scheme | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation | closed SU/MU-MIMO adaptation |
| DL CSI measurement |   | Non-precoded CSI-RS based | Non-precoded CSI-RS based |
| DL codebook |   | Type I codebook | Type 1 codebook |
| PRB bundling |   | 4 PRBs | 4 PRBs |
| MU dimension |   |  Up to 8 layers |  Up to 8 layers |
| SU dimension |   | 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 |
| 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 |
| CSI feedback |   | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  | PMI, CQI: every 5 slot; RI: every 5 slot;Subband based  |
| Interference measurement |   | SU-CQI;  | SU-CQI;  |
| CBG | 1 | Aligned with reference | Aligned with reference |
| ACK/NACK delay |   | 4 slots later | The next available UL slot |
| Re-transmission delay |   | 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) | 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) | 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 |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Non-ideal | Non-ideal |
|  |  |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | [96°] in LCS | 96 degree | 96 degree |
| Handover margin (dB) |  | 0 | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference | Aligned with reference |
|
| Wrapping around method | Geographical distance based wrapping | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

#### Uplink Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Rural - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |   |   |
|  |   |  **FDD** |  **TDD** |
| Multiple access | OFDMA | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | TDD |
| Network synchronization |   | Aligned with reference | Aligned with reference |
| Modulation | Up to 256QAM | Aligned with reference | Aligned with reference |
| Coding on PUSCH | LDPCMax code-block size=8448bit [with BP decoding] | 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 |
| 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 |
| Simulation bandwidth | FDD: 10 MHzTDD: 20 MHz | Aligned with reference | Aligned with reference |
| Frame structure |   | Full uplink | DSUUD |
| Transmission scheme |   | SU-MIMO with rank adaptation | SU-MIMO with rank adaptation |
| UL codebook |   | For 4Tx: 4Tx codebook | For 4Tx: 4Tx codebook |
| MU dimension |   | N/A | N/A |
| SU dimension |   | 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 |
| 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 | Non-precoded SRS, 2 SRS ports (with 1 SRS resource);2 symbols for SRS in every 5 slots. | Non-precoded SRS, 2 SRS ports (with 1 SRS resource);2 symbols for SRS in every 5 slots. |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 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) | 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 |
| UL re-transmission delay |   |   |   |
| Scheduling | PF | Aligned with reference | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | Ideal | Ideal |
| Power control parameter |   | P0=-76, alpha = 0.8 | P0=-76, alpha = 0.8 |
| Power backoff model |   | For 4Tx: Up t layers | Continuous RB allocation: follow T3.9038.101 for FR1;Non-continuous RB allocation: additional 2 dB reduction |
|  |  |   |   |
| **System configuration parameters** | Reference Value |   |   |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference | Aligned with reference |
| Electronic tilt | [96°] in LCS | 96 degree | 96 degree |
| Handover margin (dB) |  | 1 | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP from port 0 |
|

 | Aligned with reference | Aligned with reference |
|
| Wrapping around method | Geographical distance based wrapping | 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 |
| Criteria for analog beam selection for serving TRxP | - | - | - |
| Criteria for analog beam selection for interfering TRxP | - | - | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |  |

#### Simulation Results

Average spectral efficiency for TDD configuration for the Rural-eMBB test environment, LMLC Configuration

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 3.3 [bit/s/Hz/TRxP] | 7.47 |
| Uplink | 1.6 [bit/s/Hz/TRxP] | 3.166 |

Average spectral efficiency for FDD configuration for the Rural-eMBB test environment, LMLC Configuration

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 3.3 [bit/s/Hz/TRxP] | 6.3 |
| Uplink | 1.6 [bit/s/Hz/TRxP] | 4.13 |

5th-percentile spectral efficiency for TDD configuration for the Rural-eMBB test environment, LMLC Configuration

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.12 | 1.05 |
| Uplink | 0.045 | 0.791 |

5th-percentile spectral efficiency for FDD configuration for the Rural-eMBB test environment, LMLC Configuration

|  |  |  |
| --- | --- | --- |
|  | ITU Requirement  |  TCOE INDIA |
| Downlink | 0.12 | 0.78 |
| Uplink | 0.045 | 0.32 |

# Mobility

Mobility is the maximum mobile station speed at which a defined QoS can be achieved (in km/h). The QoS is defined as normalized traffic channel link data rate. Channel model B is used for all the Mobility evaluations.

## Indoor Hotspot (InH) Test Environment

Evaluation configuration A (carrier frequency = 4 GHz) are applied for the evaluations of Indoor Hotspot – eMBB test environment.

### System Level Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Indoor Hotspot - eMBB** |  |  |  |
| **Technical configuration Parameters** | Reference value |  |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing | FDD/TDD | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology | 15 kHz / 30 kHz,14 OFDM symbol slot | 15 kHz SCS,14 OFDM symbol slot |
| Simulation bandwidth |   | 10MHz |
| Transmission scheme |   | UL MIMO |
| UL codebook |   | 4Tx codebook |
| MU dimension |   | N/A |
| SU dimension |   | Up to 4 layers |
| SRS transmission |   | 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) | 32R (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) | 4T (M,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2)(dH, dV)=(0.5, N/A)λ |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| Power control parameter |   | P0=-76, alpha = 0.8 |
| **SINR**  | Pre-processing | Aligned with reference |
|  |  |  |  |
|  |  |  |  |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 4 GHz |
| UE speeds of interest | **10km/h** | Aligned with reference |
| TRxP number per site | 1 | 3 | Aligned with reference |
| Mechanic tilt  | 180° in GCS (pointing to the ground) | [110°] in GCS | Aligned with reference |
| Electronic tilt | 90° in LCS | 90° in LCS | Aligned with reference |
| Handover margin (dB) |  |  | 1 |
| UT attachment | Based on RSRP from port 0The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels. | Aligned with reference |
| Wrapping around method | No wrapping around | Aligned with reference |
| Polarized antenna model | Model-2 in 3GPP document TR36.873 | 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 |
| Criteria for analog beam selection for serving TRxP | -  | - |
| Analog beam selection for interfering TRxP | -  | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |

### Link Level Simulation Parameters

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Reference value** |  |
| **4 GHz (FDD)** |
| Carrier frequency |   | 4GHz |
| Waveform | CP-OFDM | Aligned with reference |
| Duplexing |   | FDD |
| TDD frame structure |   | - |
| Evaluated service profiles | Full buffer best effort | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference |
| Number of users in simulation | 1 | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-i | NLOS: TDL-i |
| LOS: CDL/TDL-iv |   |
| UE speed | 10 km/h | Aligned with reference |
| Subcarrier spacing |   | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference |
| Antenna configuration at TRxP |   | 32R |
| Antenna configuration at UE |   | 1T |
| TXRU pattern at TRxP |   | Option 1: 0dBi Omni-directional |
| TXRU pattern at UE |   | Option 1: 0dBi Omni-directional |
| Transmission mode |   | SIMO |
| Transmission rank |   | Rank 1 |
| UL precoder |   | - |
| TRxP receiver type | MMSE-IRC | Aligned with reference |
| Channel estimation |   | LMMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference |
| Data allocation |   | 14 symbol slots, with 25 RB allocated |
| Channel coding scheme | LDPC | Aligned with reference |
| Link adaptation |   | Yes |
| HARQ |   | Max 4 HARQ tansmissions |
| DMRS configuration |   | 2 symbols DMRS |
| Other overhead |   | No SRSNo PUCCH |

### Simulation Results

Mobility in Indoor Hotspot– eMBB for Configuration A with 12 TRXP

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Schema | Duplexing Scheme | Mobility | Sub-carrier spacing (kHz) | Channel | ITU RequirementBits/Hz | TCOE INDIA |
| 1x32 SIMO, OFDMA | FDD | 10Km/h | 15 KHz SCS | NLOS | 1.5 | 2.59 |

## Dense Urban Test Environment

Evaluation configuration A (carrier frequency = 4 GHz) are applied for the evaluations of Dense Urban – eMBB test environment.

### System Level Simulation Parameters

|  |  |  |
| --- | --- | --- |
| **Technical configuration Parameters** | Reference value | 4 GHz |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology | 15KHz / 30kHz,14 OFDM symbol slot | 15kHz SCS,14 OFDM symbol slot |
| Simulation bandwdith |   | 10MHz |
| Transmission scheme |   | UL MIMO |
| UL codebook |   | 4Tx codebook |
| MU dimension |   | N/A |
| SU dimension |   | Up to 4 layers |
| SRS transmission |   | 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) | 32R (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) | 4T (M,P,Mg,Ng; Mp,Np)= (1,2,2,1,1; 1,2)(dH, dV)=(0.5, N/A)λ |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| Power control parameter |   | P0=-86, alpha = 0.8 |
| **SINR**  | Pre-processing SINR as in Section 2.1.1 in 3GPP document R1-1805643 | Aligned with reference |
|  |  |  |
|  |  |  |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 4 GHz |
| UE speeds of interest | **30km/h** | Aligned with reference |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 105 degree |
| Handover margin (dB) |  | 0 |
| UT attachment | Based on RSRP (formula as shown in Appendix 3 of 3GPP document RP-180524) from port 0 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Polarized antenna model | Model-2 in 3GPP document TR36.873 | 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 |
| Criteria for analog beam selection for serving TRxP | - | - |
| Analog beam selection for interfering TRxP | - | - |
| Other system configuration parameters align with Report ITU-R M.2412 |  |

### Link Level Simulation Parameters

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Reference value** |  |
| **4 GHz (FDD)** |
| Carrier frequency |   | 4GHz |
| Waveform | CP-OFDM | Aligned with reference |
| Duplexing |   | FDD |
| TDD frame structure |   | - |
| Evaluated service profiles | Full buffer best effort | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference |
| Number of users in simulation | 1 | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-iii | TDL-iii |
| LOS: CDL/TDL-v | - |
| UE speed | 30 km/h | Aligned with reference |
| Subcarrier spacing |   | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference |
| Antenna configuration at TRxP |   | 8R |
| Antenna configuration at UE |   | 1T |
| TXRU pattern at TRxP |   | 0dBi Omni |
| TXRU pattern at UE |   | 0dBi Omni |
| Transmission mode |   | SIMO |
| Transmission rank |   | Rank 1 |
| UL precoder |   | N/A |
| TRxP receiver type | MMSE-IRC | Aligned with reference |
| Channel estimation |   | MMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference |
| Data allocation |   | 14 symbol slots, with 25 RB allocated |
| Channel coding scheme | LDPC | Aligned with reference |
| Link adaptation |   | Yes |
| HARQ |   | max. 4 HARQ tansmissions |
| DMRS configuration |   | 2 symbols DMRS |
| Other overhead |   | No SRSNo PUCCH |

### Simulation Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Schema | Duplexing Scheme | Mobility | Sub-carrier spacing (kHz) | Channel | ITU RequirementBits/Hz | TCOE INDIA |
| 1x8 SIMO, OFDMA | FDD | 30Km/h | 15 KHz SCS | NLOS | 1.2 | 2.44 |

## Rural Test Environment

### Config A

The evaluation results of mobility for FDD for evaluation configuration A for mobility class of 120 Kmph and 500 Kmph are provided in Table 4.1.3.3.1.3 for Configuration A of Rural Scenario

#### System Level Simulation Parameters

|  |  |  |
| --- | --- | --- |
| **Technical configuration Parameters** | Reference value |  |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology |   | 15 kHz SCS,14 OFDM symbol slot |
| Simulation bandwdith |   | 10MHz |
| Transmission scheme |   | UL MIMO |
| UL codebook |   | UL 2Tx Codebook |
| MU dimension |   | N/A |
| SU dimension |   | 2 layer max |
| SRS transmission |   | Non-precoded SRS, 2 SRS ports (with 1 SRS resource);2 symbols for SRS in every 5 slots. |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 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) | 2T (M,N,P,Mg,Ng; Mp,Np)= (1,1,2,1,1; 1,1)(dH, dV)=( N/A, N/A)λ |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| Power control parameter |   | P0=-76, alpha = 0.8 |
| **SINR**  | Pre-processing  | Aligned with reference |
|  |  |  |
|  |  |  |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 700MHz |
| UE speeds of interest | **120km/h, 500km/h** | Aligned with reference |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 96 degree |
| Handover margin (dB) |  | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Polarized antenna model | Model-2 in 3GPP document TR36.873 | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered  | Aligned with reference |
| Other system configuration parameters align with Report ITU-R M.2412 |  |

#### Link Level Simulation Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Reference value** |  |  |
| **700 MHz, 120km/h** | **700 MHz, 500km/h** |
| Carrier frequency |   | 700 MHz | 700 MHz |
| Waveform | CP-OFDM | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | FDD |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference | Aligned with reference |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-iii | NLOS: TDL-iii | NLOS: TDL-iii |
| LOS: CDL/TDL-v | - | - |
| UE speed | 120km/h, 500km/h | 120 km/h | 500 km/h |
| Subcarrier spacing |   | 15 kHz | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |   | 4R | 4R |
| Antenna configuration at UE |   | 1T | 1T |
| TXRU pattern at TRxP |   | 0dBi Omni | 0dBi Omni |
| TXRU pattern at UE |   | 0dBi Omni | 0dBi Omni |
| Transmission mode |   | SIMO | SIMO |
| Transmission rank |   | Rank 1 | Rank 1 |
| UL precoder |   | - | - |
| TRxP receiver type | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | MMSE | MMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference | Aligned with reference |
| Data allocation |   | 14 symbol slots, with 25 RB allocated | 14 symbol slots, with 25 RB allocated |
| Channel coding scheme | LDPC | LDPC | LDPC |
| Link adaptation |   | Yes | Yes |
| HARQ |   | Max 4 HARQ transmissions | Max 4 HARQ transmissions |
| DMRS configuration |   | 2 symbol DMRS | 2 symbol DMRS |
| Other overhead |   | No SRSNo PUCCH | No SRSNo PUCCH |

#### Simulation Results

Mobility in Rural – eMBB for Configuration A (700 MHz)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Schema | Duplexing Scheme | Mobility | Sub-carrier spacing (kHz) | Channel | ITU RequirementBits/Hz | TCOE INDIA |
| 1x4 SIMO, OFDMA | FDD | 120Km/h | 15 KHz SCS | NLOS | 0.8 | 2.53 |
| 1x4 SIMO, OFDMA | FDD | 500Km/h | 15 KHz SCS | NLOS | 0.45 | 2.12 |

### Config B

The evaluation results of mobility for FDD for evaluation configuration A for mobility class of 120 Kmph and 500 Kmph are provided in Table 4.1.3.3.2.3 for Configuration B of Rural Scenario

#### System Level Simulator Parameters

|  |  |  |
| --- | --- | --- |
| **Technical configuration Parameters** | Reference value | 4GHz |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology |   | 15 kHz SCS,14 OFDM symbol slot |
| Simulation bandwdith |   | 10MHz |
| Transmission scheme |   | UL MIMO |
| UL codebook |   | UL 4Tx Codebook |
| MU dimension |   | N/A |
| SU dimension |   | 4 layer max |
| SRS transmission |   | Non-precoded SRS, 4 SRS ports (with 1 SRS resource);2 symbols for SRS in every 5 slots. |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 32R (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) | 4T (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 |
| Receiver | MMSE-IRC | Aligned with reference |
| Power control parameter |   | P0=-76, alpha = 0.8 |
| **SINR**  | Pre-processing SINR | Aligned with reference |
|  |  |  |
|  |  |  |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 4 GHz |
| UE speeds of interest | **120km/h, 500km/h** | Aligned with reference |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 100 degree |
| Handover margin (dB) |  | 0 |
| UT attachment | Based on RSRP (formula (8.1-1) in TR36.873) from port 0 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Polarized antenna model | Model-2 in 3GPP document TR36.873 | Aligned with reference |
| Criteria for selection for serving TRxP | Maximizing RSRP where the digital beamforming is not considered  | Aligned with reference |
| Other system configuration parameters align with Report ITU-R M.2412 |  |

#### Link Level Simulator Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Reference value** |  |  |
| **4GHz, 120km/h** | **4GHz, 500km/h** |
| Carrier frequency |   | 4 GHz | 4 GHz |
| Waveform | CP-OFDM | Aligned with reference | Aligned with reference |
| Duplexing |   | FDD | FDD |
| Evaluated service profiles | Full buffer best effort | Aligned with reference | Aligned with reference |
| Simulation bandwidth | 10 MHz | Aligned with reference | Aligned with reference |
| Number of users in simulation | 1 | Aligned with reference | Aligned with reference |
| Link-level Channel model | NLOS: CDL/ TDL-iii | NLOS: TDL-iii | NLOS: TDL-iii |
| LOS: CDL/TDL-v | - | - |
| UE speed | 120km/h, 500km/h | 120 km/h | 500 km/h |
| Subcarrier spacing |   | 15 kHz | 15 kHz |
| Symbols number per slot | 14 | Aligned with reference | Aligned with reference |
| Antenna configuration at TRxP |   | 8R | 8R |
| Antenna configuration at UE |   | 1T | 1T |
| TXRU pattern at TRxP |   | 0dBi Omni | 0dBi Omni |
| TXRU pattern at UE |   | 0dBi Omni | 0dBi Omni |
| Transmission mode |   | SIMO | SIMO |
| Transmission rank |   | Rank 1 | Rank 1 |
| UL precoder |   | - | - |
| TRxP receiver type | MMSE-IRC | Aligned with reference | Aligned with reference |
| Channel estimation |   | MMSE | MMSE |
| Number of subcarriers per PRB | 12 | Aligned with reference | Aligned with reference |
| Data allocation |   | 14 symbol slots, with 25 RB allocated | 14 symbol slots, with 25 RB allocated |
| Channel coding scheme | LDPC | LDPC | LDPC |
| Link adaptation |   | Yes | Yes |
| HARQ |   | Max 4 HARQ transmissions | Max 4 HARQ transmissions |
| DMRS configuration |   | 2 symbol DMRS | 2 symbol DMRS |
| Other overhead |   | No SRSNo PUCCH | No SRSNo PUCCH |

#### Simulation Results

Mobility in Rural – eMBB for Configuration B (4GHz)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Schema | Duplexing Scheme | Mobility | Sub-carrier spacing (kHz) | Channel | ITU RequirementBits/Hz | TCOE INDIA |
| 1x8 SIMO, OFDMA | FDD | 120Km/h | 15 KHz SCS | NLOS | 0.8 | 2.80 |
| 1x8 SIMO, OFDMA | FDD | 500Km/h | 15 KHz SCS | NLOS | 0.45 | 2.51 |

# Reliability

Reliability is the success probability of transmitting a layer 2/3 packet within a required maximum time, which is the time it takes to deliver a small data packet from the radio protocol layer 2/3 SDU ingress point to the radio protocol layer 2/3 SDU egress point of the radio interface at a certain channel quality. Reliability is evaluated under Urban Macro – URLLC test environment.

## Configuration A

In configuration A (carrier frequency = 4 GHz), both UL and DL are evaluated. Channel Model B is considered.

### System Level Simulations Parameters for DL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCDL** |  |  |
| **Technical configuration Parameters** | Reference value | 4 GHz |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology |   | 30 kHz SCS,14 OFDM symbol slot |
| Simulation bandwdith |   | 10 MHz |
| DLTransmission scheme |   | DL SU-MIMO with rank adaptation |
| DL codebook |   | Type I Codebook |
| DL MU dimension |   | N/A |
| DL SU dimension |   | Up to 2 layers |
| SRS transmission |   | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 2Tx, (8,1,2,1,1; 1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) | 2Rx, (1,1,2,1,1; 1,1) |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| **SINR**  | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Aligned with reference |
|  |  |   |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 4GHz |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 99 degree |
| Handover margin (dB) |  | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP from port 0 |

 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Polarized antenna model |

|  |
| --- |
| Model-2 in 3GPP document TR36.873 |

 | 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 |
| Criteria for analog beam selection for serving TRxP |   | - |
| Criteria for analog beam selection for interfering TRxP |   | - |

### Link Level Simulations Parameters for DL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCDL** |  |  |
| **Technical configuration Parameters** | Reference value | 4 GHz |
| Carrier frequency for evaluation |   | 4 GHz |
| Waveform |   | CP-OFDM |
| Numerology |   | 30 kHz SCS |
| Simulation bandwdith |   | 10 MHz |
| Channel model | TDL-iii(NLOS),TDL-v(LOS) | Aligned with reference |
| Scaled delay spread | 363ns(NLOS),93 ns(LOS) | Aligned with reference |
| UE Speed |   | 3km/h |
| Number of symbols per slot |   | 14 |
| Antenna configuration at TRxP |   | 2Tx |
| Antenna configuration at UE |   | 2Rx |
| TXRU pattern at TRxP |   | 0dBi Omni-directional |
| TXRU pattern at UE |   | 0dBi Omni-directional |
| PDSCH Transmission mode |   | DL SU-MIMO with rank 1 |
| Channel estimation |   | Non-ideal |
| PDCCH transmission scheme |   | DCI format 1-0. 64bit payload includes CRC. Aggregation level = 16 |
| PDSCH Modulation and coding |   | LDPCMCS #0 from 64 QAM table(QPSK, CR = 120/1024) |
| Packet size  |   | 256bit |
| DMRS configuration |   | Type 1 ,2 symbol DMRS |

### System Level Simulations Parameters for UL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCUL** |  |  |
| **Technical configuration Parameters** | Reference value | 4GHz |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology |   | 30kHz SCS |
| Simulation bandwdith |   | 10 MHz |
| UL Transmission scheme |   | UL MIMO with rank adaptation |
| UL codebook |   | 2 port UL codebook |
| UL MU dimension |   | N/A |
| UL SU dimension |   | Up to 2 layers |
| SRS transmission |   | Non-precoded SRS, 2 SRS ports (with 2 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) | 16Rx, (8,8,2,1,1; 1,4) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) | 2Tx, (1,1,1,1,2; 1,1) |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| UL power control parameter |   | P0=-86, alpha = 0.8 |
| **SINR**  | Pre-processing SINR | Aligned with reference |
|  |  |   |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 4 GHz |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 100 degree |
| Handover margin (dB) |  | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP (formula as shown in Appendix 3 of 3GPP document RP-180524) from port 0 |

 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Minimum distance of TRxP and UE | d2D\_min=10m  | Aligned with reference |
| Polarized antenna model | Model-2 in 3GPP document TR36.873 | 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 |
| Criteria for analog beam selection for serving TRxP |   | - |
| Criteria for analog beam selection for interfering TRxP |   | - |

### Link Level Simulations Parameters for UL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCUL** |  |  |
| **Technical configuration Parameters** | Reference value | 4 GHz |
| Carrier frequency for evaluation |   | 4 GHz |
| Waveform |   | CP-OFDM |
| Numerology |   | 30 kHz SCS |
| Simulation bandwdith |   | 10 MHz |
| Channel model | TDL-iii(NLOS),TDL-v(LOS) | Aligned with reference |
| Scaled delay spread | 363ns(NLOS),93 ns(LOS) | Aligned with reference |
| UE Speed |   | 3km/h |
| Number of symbols per slot |   | 14 |
| Antenna configuration at TRxP |   | 16 Rx |
| Antenna configuration at UE |   | 1 Tx |
| TXRU pattern at TRxP |   | 0dBi Omni-directional |
| TXRU pattern at UE |   | 0dBi Omni-directional |
| Data Transmission mode |   | SIMO |
| Channel estimation |   | Non-ideal |
| PUCCH transmission scheme |   | - |
| PUSCH modulation and coding |   | LDPCMCS #0 from 64 QAM table(QPSK, CR = 120/1024) |
| Packet size  |   | 256bit |
| DMRS configuration |   | Type 1, 2 symbol DMRS |

### Simulation Results

Reliability evaluation for configuration A in Downlink

|  |  |  |  |
| --- | --- | --- | --- |
| **Scheme and antenna configuration** | **Sub-carrier spacing [kHz]** | **ITU****Requirement**  | **Channel condition** |
| **Number of samples** | **Reliability** |
| 2x2 SU-MIMO  | 30  | 99.999% | NLOS | 1 | > 99.9995% |

Reliability evaluation for configuration A in Uplink

|  |  |  |
| --- | --- | --- |
| **Scheme and antenna configuration** | **Sub-carrier spacing [kHz]** | **ITU****Requirement**  |
| **Channel condition** | **Number of samples** | **Reliability** |
| 2x16 SIMO, OFDMA | 30  | 99.999% | NLOS | 1 | >99.99998% |

## Configuration B

For reliability with configuration B (carrier frequency = 700 MHz), uplink and downlink are evaluated.

### System Level Simulations Parameters for DL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCDL** |  |  |
| **Technical configuration Parameters** | Reference value | 700 MHz |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology |   | 30 kHz SCS,14 OFDM symbol slot |
| Simulation bandwdith |   | 10 MHz |
| DLTransmission scheme |   | DL SU-MIMO with rank adaptation |
| DL codebook |   | Type I Codebook |
| DL MU dimension |   | N/A |
| DL SU dimension |   | Up to 2 layers |
| SRS transmission |   | - |
| Antenna configuration at TRxP | (M, N, P, Mg, Ng; Mp, Np) | 2Tx, (8,1,2,1,1; 1,1) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) | 2Rx, (1,1,2,1,1; 1,1) |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| **SINR**  | Pre-processing SINR as in Section 2.1.1 in R1-1805643 | Aligned with reference |
|  |  |   |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 700 MHz |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 100 degree |
| Handover margin (dB) |  | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP from port 0 |

 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Polarized antenna model |

|  |
| --- |
| Model-2 in 3GPP document TR36.873 |

 | 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 |
| Criteria for analog beam selection for serving TRxP |   | - |
| Criteria for analog beam selection for interfering TRxP |   | - |

### Link Level Simulations Parameters for DL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCDL** |  |  |
| **Technical configuration Parameters** | Reference value | 700 MHz |
| Carrier frequency for evaluation |   | 700 MHz |
| Waveform |   | CP-OFDM |
| Numerology |   | 30 kHz SCS |
| Simulation bandwdith |   | 10 MHz |
| Channel model | TDL-iii(NLOS),TDL-v(LOS) | Aligned with reference |
| Scaled delay spread | 363ns(NLOS),93 ns(LOS) | Aligned with reference |
| UE Speed |   | 3km/h |
| Number of symbols per slot |   | 14 |
| Antenna configuration at TRxP |   | 2 Tx |
| Antenna configuration at UE |   | 2 Rx |
| TXRU pattern at TRxP |   | 0dBi Omni-directional |
| TXRU pattern at UE |   | 0dBi Omni-directional |
| PDSCH Transmission mode |   | DL SU-MIMO with rank 1 |
| Channel estimation |   | Non-ideal |
| PDCCH transmission scheme |   | DCI format 1-0. 64bit payload includes CRC. Aggregation level = 8 |
| PDSCH Modulation and coding |   | LDPCMCS #0 from 64 QAM table(QPSK, CR = 120/1024) |
| Packet size  |   | 256bit |
| DMRS configuration |   | Type 1 ,2 symbol DMRS |

### System Level Simulations Parameters for UL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCUL** |  |  |
| **Technical configuration Parameters** | Reference value | 700 MHz |
| Multiple access | OFDMA | Aligned with reference |
| Duplexing |   | FDD |
| Modulation | Up to 256QAM | Aligned with reference |
| Numerology |   | 30 kHz SCS |
| Simulation bandwdith |   | 10 MHz |
| UL Transmission scheme |   | UL MIMO with rank adaptation |
| UL codebook |   | 2 port UL codebook |
| UL MU dimension |   | N/A |
| UL SU dimension |   | Up to 2 layers |
| SRS transmission |   | Non-precoded SRS, 2 SRS ports (with 2 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) | 8Rx, (8,4,2,1,1; 1,4) |
| Antenna configuration at UE | (M, N, P, Mg, Ng; Mp, Np) | 2Tx, (1,1,1,1,2; 1,1) |
| Scheduling | PF | Aligned with reference |
| Receiver | MMSE-IRC | Aligned with reference |
| UL power control parameter |   | P0=-86, alpha = 0.8 |
| **SINR**  | Pre-processing SINR  | Aligned with reference |
|  |  |   |
| **System configuration parameters** | Reference Value |   |
| Carrier frequency for evaluation |   | 700 MHz |
| TRxP number per site | 3 | Aligned with reference |
| Mechanic tilt  | 90° in GCS (pointing to horizontal direction) | Aligned with reference |
| Electronic tilt |   | 100 degree |
| Handover margin (dB) |  | 0 |
| UT attachment |

|  |
| --- |
| Based on RSRP from port 0 |

 | Aligned with reference |
| Wrapping around method | Geographical distance based wrapping | Aligned with reference |
| Minimum distance of TRxP and UE | d2D\_min=10m  | Aligned with reference |
| Polarized antenna model | Model-2 in 3GPP document TR36.873 | 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 |
| Criteria for analog beam selection for serving TRxP |   | - |
| Criteria for analog beam selection for interfering TRxP |   | - |

### Link Level Simulations Parameters for UL

|  |  |  |
| --- | --- | --- |
| **Urban Macro - URLLCUL** |  |  |
| **Technical configuration Parameters** | Reference value | 700 MHz |
| Carrier frequency for evaluation |   | 700 MHz |
| Waveform |   | CP-OFDM |
| Numerology |   | 30 kHz SCS |
| Simulation bandwdith |   | 10 MHz |
| Channel model | TDL-iii(NLOS),TDL-v(LOS) | Aligned with reference |
| Scaled delay spread | 363ns(NLOS),93 ns(LOS) | Aligned with reference |
| UE Speed |   | 3km/h |
| Number of symbols per slot |   | 14 |
| Antenna configuration at TRxP |   | 8 RX |
| Antenna configuration at UE |   | 1 Tx |
| TXRU pattern at TRxP |   | 0dBi Omni-directional |
| TXRU pattern at UE |   | 0dBi Omni-directional |
| Data Transmission mode |   | SIMO |
| Channel estimation |   | Non-ideal |
| PUCCH transmission scheme |   | - |
| PUSCH modulation and coding |   | LDPCMCS #0 from 64 QAM table(QPSK, CR = 120/1024) |
| Packet size  |   | 256bit |
| DMRS configuration |   | Type 1, 2 symbol DMRS |

### Simulation Results

Reliability evaluation for configuration B in Downlink

|  |  |  |  |
| --- | --- | --- | --- |
| **Scheme and antenna configuration** | **Sub-carrier spacing [kHz]** | **ITU****Requirement**  | **Channel condition** |
| **Number of samples** | **Reliability** |
| 2x2 SU-MIMO  | 30  | 99.999% | NLOS | 1 | >99.9994% |

Reliability evaluation for configuration B in Uplink

|  |  |  |
| --- | --- | --- |
| **Scheme and antenna configuration** | **Sub-carrier spacing [kHz]** | **ITU****Requirement**  |
| **Channel condition** | **Number of samples** | **Reliability** |
| 2x8 SIMO, OFDMA | 30  | 99.999% | NLOS | 1 | >99.99999% |

# Analytical KPIs

## User experienced data rate

User experienced data rate is the 5% point of the cumulative distribution function (CDF) of the user throughput. User throughput (during active time) is defined as the number of correctly received bits, i.e. the number of bits contained in the service data units (SDUs) delivered to Layer 3, over a certain period of time.

The user experienced data rate, Ruser is given by:

 Ruser = W(Effective Bandwidth) × SEuser (5th Percentile)

The SE is obtained from simulation results. It is assumed that for TDD with 15 kHz SCS, a component carrier with 50 MHz is used. It is assumed that for FDD with 15kHz, a component carrier with 40 MHz is used. For higher bandwidths, the overhead decreases increasing the effective spectral efficiency by a scaling factor for the downlink. Multiple component carriers are aggregated to achieve the DL target user experienced data rate.

User experienced data rate in Dense Urban – eMBB for TDD configuration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scheme | Assumed BandwidthW | 5-percentile SESEuser | User Experienced Data RateRuser = W × SEuser | ITU Requirement |
| Downlink, TDD (DSUUD) | 800 MHz |  0.8851  | 396.48 Mbps | 100 Mbps |
| Uplink, TDD(DSUUD) | 800 MHz | 0.65 | 228.8 Mbps | 50 Mbps |

Footnote:0.885 = 0.75 x 1.18, where 0.75 bps/Hz is the 5% SE for the downlink and 1.18 is the overhead scaling factor. We have considered 16 component carriers (CC) of 50 MHz each.

User experienced data rate Dense Urban – eMBB for FDD configuration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scheme | Assumed BandwidthW | 5-percentile SESEuser | User Experienced Data RateRuser = W × SEuser | ITU Requirement |
| Downlink, FDD | 400 MHz | 1.081 | 432.89 Mbps | 100 Mbps |
| Uplink, FDD | 400 MHz | 0.74 | 296 Mbps | 50 Mbps |

Footnote: 1.08 = 0.89x1.216, where 0.89 bps/Hz is the 5% SE for the downlink and 1.216 is the overhead scaling factor. We have considered 10 CC of 40 MHz each.

## Area traffic capacity

As defined in Report ITU-R M.2410, area traffic capacity is the total traffic throughput served per geographic area (in Mbit/s/m2). The throughput is the number of correctly received bits, i.e. the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time.

The area traffic capacity of the RIT is evaluated using analytical way based on the downlink average spectral efficiency evaluation for Indoor Hotspot – eMBB test environment. Let W denote the channel bandwidth and $ρ$ the TRxP density (TRxP/m2). The area traffic capacity Carea is related to average spectral efficiency SEavg through equation Carea = ρ × W × SEavg.

Area Traffic Capacity – In-H for the TDD configuration for 12 TRXP

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scheme | Assumed Bandwidth W | Avg. SE SEavg | TRxP density (TRxP/m2)ρ  | Area traffic capacityCarea = ρ × W × SEavg Mbit/s/m2 | ITU RequirementMbit/s/m2 |
| Downlink, TDD | 800 MHz  |  11.211  | 0.002 = 12/(120x50) | 10.04  | 10  |

Footnote: 11.21=9.5 x 1.18, where 9.5 bps/Hz is the Avg SE for the downlink and 1.18 is the overhead scaling factor. We have considered 16 component carriers (CC) of 50 MHz each.

Area Traffic Capacity – In-H for the FDD configuration for 12 TRXP

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scheme | Assumed Bandwidth W | Avg. SE SEavg | TRxP density (TRxP/m2)ρ | Area traffic capcityCarea = ρ × W × SEavg Mbit/s/m2 | ITU RequirementMbit/s/m2 |
| Downlink, FDD | 480 MHz  |  11.91  | 0.002 | 11.43 | 10  |

Footnote: 11.91 = 9.8 x 1.216, where 9.8 bps/Hz is the Avg SE for the downlink and 1.216 is the overhead scaling factor. We have considered 12 component carriers (CC) of 40 MHz each.

It is assumed that for TDD with 15 kHz SCS, a component carrier with 50 MHz is used. It is assumed that for FDD with 15kHz, a component carrier with 40 MHz is used. Multiple component carriers are aggregated to achieve the DL target user experienced data rate.

## Peak spectral efficiency

Peak spectral efficiency is the maximum data rate under ideal conditions divided by channel bandwidth (in bit/s/Hz), where the maximum data rate is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e. excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands and guard times).

The generic formula for peak spectral efficiency for FDD and TDD for a specific component carrier (say *j-th CC (component carrier)*) is given by

 $SE\_{p\_{j}}=\frac{v\_{Layers}^{\left(j\right)}Q\_{m}^{\left(j\right)}f^{\left(j\right)}R\_{max}\frac{N\_{PRB}^{BW\left(j\right),μ}12}{T\_{s}^{μ}}\left(1-OH^{\left(j\right)}\right)}{BW^{\left(j\right)}}$ (1.1)

Wherein,

* Rmax = 948/1024
* For the j-th CC,
	+  is the maximum number of layers
	+  is the maximum modulation order
	+ is the scaling factor
		- * The scaling factor can at least take the values 1 and 0.75.
			* is signalled per band and per band per band combination as per UE capability signaling
	+  is the numerology (as defined in T3.9038.211)
	+  is the average OFDM symbol duration in a subframe for numerology , i.e. . Note that normal cyclic prefix is assumed.
	+  is the maximum RB allocation in bandwidth  with numerology , as given in T3.9038.104 section 5.3.2, where  is the UE supported maximum bandwidth in the given band or band combination.
	+ is the overhead calculated as the average ratio of the number of REs occupied by L1/L2 control, Synchronization Signal, PBCH, reference signals and guard period (for TDD), etc. with respect to the total number of REs in effective bandwidth time product as given by α(j).BW(j).(14\*Tsu)

− α(j) is the normalized scalar considering the downlink/uplink ratio; for FDD α(j)=1 for DL and UL; and for TDD and other duplexing α(j) for DL and UL is calculated based on the DL/UL configuration.

− For guard period (GP), 50% of GP symbols are considered as downlink overhead, and 50% of GP symbols are considered as uplink overhead.

### DL Peak Spectral Efficiency

For evaluating downlink Peak Spectral Efficiency, we consider an FDD case with 50MHz bandwidth, and 15kHz subcarrier spacing, in FR1 region. In an ideal case, we can have a maximum of 8layers, using 256QAM.

For the reference signal overheads, we assume the following :

|  |  |  |
| --- | --- | --- |
|  | Applied duplexing | FR1 |
| OH | FDD | * PDCCH: CORESET of 24 PRBs (4 CCE) in every slot
	+ - 12 RE/PRB/slot
* TRS burst of 2 slots with periodicity of 20ms and occupies 52 PRBs
	+ - 12 RE/PRB/20 ms
* DMRS: Type 2, 16 RE/PRB/slot for 8 layers
* CSI-RS: 8 CSI-RS ports with periodicity of 20ms
	+ - 8 RE/PRB/20 ms
* 1 SS/PBCH blocks (SSB) per 20ms; one SSB occupies 960REs = 4 OFDM symbols × 20 PRB × 12 REs/PRB

NOTE1: if the channel bandwidth is less than the bandwidth of SSB, then SSB is not transmitted and the overhead of SS/PBCH block is zero.NOTE2: If the channel bandwidth is less than TRS bandwidth, the TRS bandwidth is assumed to be equal to the channel bandwidth. |

Using these values, we get the downlink peak spectral efficiency to be 54.35\*(1-0.1) = 48.9 bits/sec/Hz which is higher than the ITU requirement of 30 bits/sec/Hz

### UL Peak Spectral Efficiency

For evaluating uplink Peak Spectral Efficiency, we consider an FDD case with 50MHz bandwidth, and 15kHz subcarrier spacing, in FR1 region. In an ideal case, we can have a maximum of 4 layers, using 256QAM.

For the reference signal overheads, we assume the following :

|  |  |  |
| --- | --- | --- |
|  | Applied duplexing |  FR1 |
| OH1  | FDD, TDD (DDDSU) | * PUCCH: short PUCCH with 1 PRB and 1 symbol in every UL slot; 12 RE/slot
* DMRS: Type I, one complete symbol; 12 RE/PRB/slot
* SRS: 1 symbol with periodicity of 10ms for FDD; 1 symbol with periodicity of 20ms for TDD
 |

Using these values, we get the uplink peak spectral efficiency to be 27.18\*(1-0.08) = 25.0 bits/sec/Hz which is higher than the ITU requirement of 15 bits/sec/Hz

## Peak data rate

As defined in Report ITU-R M.2410, peak data rate is the maximum achievable data rate under ideal conditions (in bit/s), which is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e. excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands and guard times).

### DL Peak Data rate

**Table 4.2.4.1.1 DL peak data rate**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Duplexing** | **SCS [kHz]** | **Per CC BW (MHz)** | **Peak data rate per CC (Gbit/s)** | **Aggregated peak data rate over 16 CCs (Gbit/s)** | **Required DL bandwidth (MHz) 1** | **Req. (Gbit/s)** |
| FDD | FR1 | 15 | 50 | 2.45 | 39.2 | 420 | 20 |
| NOTE 1: The value only indicates the required bandwidth to meet the DL peak data rate. It is not necessarily supported as the Transmission bandwidth. |

### UL Peak Data rate

UL peak data rate is evaluated based on the evaluation results of peak spectral efficiency provided in Section 1. Table 2.2.1 provides the evaluation results for the specific component carrier (CC) bandwidth. It is observed that the RIT fulfils the UL peak data rate requirement.

**Table 2.2.1 UL peak data rate**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Duplexing** | **SCS [kHz]** | **Per CC BW (MHz)** | **Peak data rate per CC (Gbit/s)** | **Aggregated peak data rate over 16 CCs (Gbit/s)** | **Required UL bandwidth to meet the requirement (MHz)1** | **Req. (Gbit/s)** |
| FDD | FR1 | 15 | 50 | 1.25 | 20 | 400 | 10 |
| NOTE 1: The value only indicates the required bandwidth to meet the DL peak data rate. It is not necessarily supported as the Transmission bandwidth. |

# Inspection KPIs

### Bandwidth and scalability

As defined in Report ITU-R M.2410, bandwidth is the maximum aggregated system bandwidth. The bandwidth may be supported by single or multiple radio frequency (RF) carriers. Scalable bandwidth is the ability of the candidate RIT/SRIT to operate with different bandwidths.

According to Section 5.3.2 of T3 90.38.104, the maximum bandwidth related to specific sub-carrier spacing (SCS) and frequency range (FR) for a component carrier is provided in Table 6.1. Besides, according to Section 6.4 of T3.90.38.331, carrier aggregation of up to sixteen component carriers is supported. Accordingly, the capability of maximum aggregated system bandwidth is presented in Table 6.1. It is observed that the maximum aggregated bandwidth for FR 1 is 800 MHz to 1600 MHz; while for FR 2, the maximum aggregated bandwidth is 3200 MHz to 6400 MHz. Therefore, the bandwidth requirement of at least 100 MHz is met by the RIT under all frequency ranges for all sub-carrier spacing values.

RIT capability on bandwidth

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **SCS [kHz]**  | **Maximum bandwidth for one component carrier (MHz)** | **Maximum number of component carriers for carrier aggregation** | **Maximum aggregated bandwidth (MHz)** |
| FR1 | 15 | 50 |  16 | 800 |
| 30 | 100 | 16 | 1600 |
| 60 | 100 | 16 | 1600 |
| FR2  | 60 | 200 | 16 | 3200 |
| 120 | 400 | 16 | 6400 |

According to Section 5.3.2 of T3.9038.104, different bandwidths are supported for a component carrier at given SCS as listed in Table 6.2. Accordingly, the bandwidth scalability capability of the RIT is summarized in Table 6.3. It is observed that up to 13 different bandwidths are supported for FR 1, and up to 4 different bandwidths are supported for FR 2. Therefore bandwidth scalability capability is fulfilled by the RIT.

Transmission bandwidth configuration NRB

(a) For FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SCS (kHz)** | **5MHz** | **10MHz** | **15MHz** | **20 MHz** | **25 MHz** | **30 MHz** | **40 MHz** | **50MHz** | **60 MHz** | **70****MHz** | **80 MHz** | **90 MHz** | **100 MHz** |
| **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** | **NRB** |
| 15 | 25 | 52 | 79 | 106 | 133 | 160 | 216 | 270 | N/A | N.A | N/A | N/A | N/A |
| 30 | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 189 | 217 | 245 | 273 |
| 60 | N/A | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 93 | 107 | 121 | 135 |

 (b) For FR2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCS [kHz]** | **50 MHz** | **100 MHz** | **200 MHz** | **400 MHz** |
| **NRB** | **NRB** | **NRB** | **NRB** |
| 60 | 66 | 132 | 264 | N.A |
| 120 | 32 | 66 | 132 | 264 |
|  |  |  |  |  |

Bandwidth scalability capability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **SCS [kHz]**  | **Minimum component carrier bandwidth (MHz)** | **Maximum component carrier bandwidth (MHz)** | **Maximum Number of supported bandwidth for a component carrier** |
| FR1 | 15 | 5 | 50 | 8 |
| 30 | 5 | 100 | 13 |
| 60 | 10 | 100 | 12 |
| FR2 | 60 | 50 | 200 | 3 |
| 120 | 50 | 400 | 4 |
|  |  |  |  |  |