Annex 2-1. Final evaluation results on 3GPP NR

# 1 Introduction

This document includes final evaluation results on submissions in Doc.IMT-2020/13, 14, 15, 16 (i.e. “3GPP technology”) from ChEG. Evaluation results for NR are included.

# 2 NR Evaluation results from ChEG

This section includes evaluation results of 5th percentile user spectral efficiency, Average spectral efficiency, User experienced data rate, Area traffic capacity, Mobility, Reliability and Connection density performance. All performances are evaluated through simulations conducted by several members of ChEG. The detailed results can be founding in chapter 3. The simulation assumption follows assumptions provided by proponent; and can be found in chapter 3.

## 2.1 Evaluation of eMBB technical performance

### 2.1.1 5th percentile user spectral efficiency

As defined in Report ITU-R M.2410, the 5th percentile user spectral efficiency is the 5% point of the CDF of the normalized user throughput. The normalized user throughput is defined as 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, divided by the channel bandwidth and is measured in bit/s/Hz.

As required by Report ITU-R M.2412, 5th percentile user spectral efficiency shall be assessed jointly with average spectral efficiency using the same simulation. Therefore, the evaluation results of the 5th percentile user spectral efficiency are provided together with average spectral efficiency in Section 2.2.

### 2.1.2 Average spectral efficiency

As defined in Report ITU-R M.2410, average spectral efficiencyis the aggregate throughput of all users (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) divided by the channel bandwidth of a specific band divided by the number of TRxPs and is measured in bit/s/Hz/TRxP.

As required by Report ITU-R M.2412, average spectral efficiency and 5th percentile user spectral efficiency are assessed jointly using the same simulation.

Average spectral efficiency and 5th percentile user spectral efficiency are evaluated for NR. Both NR FDD and TDD are evaluated. A wide range of antenna configurations and transmission schemes are considered. Detailed evaluation assumptions and results can be found in chapter 3.

The antenna configuration is indicated as (*M*, *N*, *P*, *M*g,*N*g; *M*p, *N*p), where *M* and *N* are the number of vertical, horizontal antenna elements within a panel, *P* is number of polarizations, *M*g is the number of panels in a column, *N*g is the number of panels in row; and *M*p and *N*p are the number of vertical, horizontal TXRUs within a panel and polarization.

#### 2.1.2.1 Indoor Hotspot – eMBB

Evaluation configuration A (carrier frequency = 4 GHz) and evaluation configuration B (carrier frequency = 30 GHz) with either 12TRxP or 36TRxP cases are applied for the evaluations of Indoor Hotspot– eMBB test environment for NR.

##### 2.1.2.1.1 Evaluation configuration A (CF = 4 GHz)

The evaluation results of DL spectral efficiency for NR FDD and NR TDD for evaluation configuration A with 12TRxP are provided in Table 2.2.1.1.1-1.

It is noted that for NR, the component carrier bandwidth can be larger than the simulation bandwidth as defined in Report ITU-R M.2412. For those larger bandwidth cases, the guard band ratio can be further decreased; and the OFDM symbol occupation by PDCCH is expected to be reduced, even to less than one OFDM symbol due to the capability of PDCCH resource sharing with PDSCH.

Such capabilities are evaluated in Indoor Hotspot - eMBB test environment as well as in Dense Urban – eMBB test environment and Rural – eMBB test environment, for DL spectral efficiency. The values of the assumed bandwidths are shown together with the evaluation results.

Table 2.2.1.1.1-1 DL spectral efficiency for NR in Indoor Hotspot – eMBB
(Evaluation configuration A, CF=4 GHz, for 12TRxP)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | BW=20MHz | BW=40MHz | Number of samples | BW=10MHz | BW=20MHz | BW=40MHz |
| 32x4 MU-MIMO Type II Codebook; gNB Config. = (4,4,2,1,1;4,4) | 15 | Average [bit/s/Hz/TRxP] | 9 | 4 | 11.43 | 12.89 | 13.76 | 5 | 11.24 | 12.71 | 13.58 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.37 | 0.42 | 0.45 | 0.39 | 0.44 | 0.47 |

**(b) NR TDD**

| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| --- | --- | --- | --- | --- | --- |
| Number of samples | BW=20MHz | BW=40MHz | BW=100MHz | Number of samples | BW=20MHz | BW=40MHz | BW=100MHz |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config (4,4,2,1,1;4,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | 2 | 11.98 | 14.03 | 15.41 | 3 | 11.98 | 14.00 | 15.37 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.45 | 0.52 | 0.58 | 0.43 | 0.50 | 0.55 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (4,4,2,1,1;4,4) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | 1 | 12.77 | 14.65 | / | 1 | 12.77 | 14.64 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.39 | 0.45 | / | 0.4 | 0.46 | / |
| 32x4 MU-MIMO, Type II Codebook; 4T SRS; gNB Config = (4,4,2,1,1;4,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 13.27 | 15.18 | / | 1 | 13.55 | 15.5 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.49 | 0.56 | / | 0.5 | 0.58 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (4,4,2,1,1;4,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 2 | 11.61 | 13.68 | 15.08 | 2 | 11.96 | 14.09 | 15.53 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.41 | 0.48 | 0.53 | 0.45 | 0.53 | 0.59 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Configu = (4,4,2,1,1;4,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 2 | 12.11 | 13.84 | / | 3 | 12.18 | 13.97 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.39 | 0.45 | / | 0.42 | 0.48 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config= (4,4,2,1,1;4,4) | 30 | DDDDD DDSUU | Average [bit/s/Hz/TRxP] | 9 | 2 | 12.54 | 14.74 | 16.23 | 1 | 11.71 | 13.96 | 15.47 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.41 | 0.48 | 0.53 | 0.41 | 0.49 | 0.54 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config= (4,4,2,1,1;4,4) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 9 | 1 | 11.37 | 13.64 | 15.17 | 1 | 11.59 | 13.91 | 15.47 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.41 | 0.49 | 0.55 | 0.40 | 0.48 | 0.54 |

The evaluation results of DL spectral efficiency for NR FDD and NR TDD for evaluation configuration A with 36TRxP are provided in Table 2.2.1.1.1-2.

It is observed that both NR FDD and NR TDD fulfill the DL spectral efficiency requirement for all the above configurations in evaluation configuration A.

Table 2.2.1.1.1-2 DL spectral efficiency for NR in Indoor Hotspot – eMBB
(Evaluation configuration A, CF=4 GHz, for 36TRxP)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | BW=20MHz | BW=40MHz | Number of samples | BW=10MHz | BW=20MHz | BW=40MHz |
| 32x4 MU-MIMO Type II Codebook;gNB@ Config = (8,16,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 9 | 3 | 12.39 | 13.99 | 14.95 | 3 | 13.04 | 14.72 | 15.73 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.34 | 0.38 | 0.41 | 0.34 | 0.39 | 0.41 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | BW=40MHz | BW=100MHz | Number of samples | BW=20MHz | BW=40MHz | BW=100MHz |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config =(8,16,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | 2 | 12.72 | 14.88 | 16.35 | 2 | 12.87 | 15.06 | 16.55 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.41 | 0.48 | 0.53 | 0.39 | 0.46 | 0.50 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,16,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | 1 | 14.56 | 16.71 | / | 1 | 14.67 | 16.84 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.39 | 0.44 | / | 0.39 | 0.45 | / |
| 32x4 MU-MIMO, Type II codebook; Reciprocity based; 4T SRS; gNB@ (M,N,P,Mg,Ng; Mp,Np) = (8,16,2,1,1;2,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 2 | 12.16 | 13.88 | / | 2 | 12.37 | 14.12 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.35 | 0.40 | / | 0.33 | 0.38 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,16,2,1,1;2,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 13.00 | 15.18 | 16.66 | 1 | 13.17 | 15.38 | 16.88 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.32 | 0.37 | 0.40 | 0.34 | 0.39 | 0.43 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU  | Average [bit/s/Hz/TRxP] | 9 | 1 | 9.48 | 11.05 | 12.12 | 1 | 9.46 | 11.03 | 12.11 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.32 | 0.38 | 0.41 | 0.33 | 0.39 | 0.43 |

The evaluation results of UL spectral efficiency for NR FDD and TDD for evaluation configuration A with 12TRxP are provided in Table 2.2.1.1.1-3.

Table 2.2.1.1.1-3 UL spectral efficiency for NR in Indoor Hotspot – eMBB
(Evaluation configuration A, CF=4 GHz, for 12TRxP)

(a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | Number of samples | BW=10MHz |
| 2x32 SU-MIMO, OFDMA;gNB Config = (4,4,2,1,1;4,4) | 15 | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 8.83 | 1 | 8.87 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.55 | 0.55 |
| 4x32 MU-MIMO, OFDMA;gNB Config = (4,4,2,1,1;4,4) | 15 | Average [bit/s/Hz/TRxP] | 6.75 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.21 | / | / |
| 4x32 SU-MIMO, OFDMA; gNB Config = (4,4,2,1,1;4,4) | 15 | Average [bit/s/Hz/TRxP] | 6.75 | 2 | 9.33 | 3 | 8.91 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.6 | 0.55 |

**(b) NR TDD**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | Number of samples | BW=20MHz |
| 2x32 SU-MIMO, Codebook based;gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 6.95 | 2 | 7.70 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.39 | 0.44 |
| 2x32 SU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.17 | 1 | 7.26 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.40 | 0.41 |
| 4x32 SU-MIMO, Codebook based;gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.58 | 1 | 7.62 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.43 | 0.43 |
| 4x32 SU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.87 | 1 | 7.95 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.44 | 0.45 |
| 4x32 MU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.21 | / | / |
| 4x32 SU-MIMO, Non-Codebook based; gNB Config = (4,4,2,1,1;4,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 9.57 | 1 | 9.26 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.60 | 0.56 |
| 4x32 SU-MIMO, Non-Codebook based; gNB Config = (4,4,2,1,1;4,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 9.25 | 1 | 8.99 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.58 | 0.52 |
| 4x32 SU-MIMO, Codebook based; gNB Configs = (4,4,2,1,1;4,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 8.99 | 1 | 8.65 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.63 | 0.54 |
| 4x32 SU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 8.58 | 1 | 8.12 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.57 | 0.48 |
| 2x32 SU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 8.26 | 1 | 9.35 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.53 | 0.53 |
| 2x32 SU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.85 | 1 | 7.85 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.58 | 0.58 |
| 2x32 SU-MIMO, Codebook based; gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.02 | 1 | 7.01 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.52 | 0.52 |
| 4x32 MU-MIMO, Codebook based;gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 6.75 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.21 | / | / |

##### 2.1.2.1.2 Evaluation configuration B (CF = 30 GHz)

The evaluation results of DL spectral efficiency for NR for evaluation configuration B with 12TRxP are provided in Table 2.2.1.1.2-1.

It is noted that for NR, the component carrier bandwidth can be larger than the simulation bandwidth as defined in Report ITU-R M.2412. For those larger bandwidth cases, the guard band ratio can be further decreased; and the OFDM symbol occupation by PDCCH is expected to be reduced, even to less than one OFDM symbol due to the capability of PDCCH resource sharing with PDSCH.

Such capabilities are evaluated for DL spectral efficiency. The values of the assumed bandwidths are shown together with the evaluation results.

Table 2.2.1.1.2-1 DL spectral efficiency for NR in Indoor Hotspot – eMBB
(Evaluation configuration B, CF=30 GHz, for 12TRxP)

(b) NR TDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Number of samples | BW=80MHz / 100 MHz | BW=200MHz | BW=400MHz |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (4,4,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,2) | 60 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | 2 | 12. 28 | 14.08 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.31 | 0.36 | / |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (4,4,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,2) | 120 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.3 | / | / | / |
| 32x4 MU-MIMO, Type II Codebook based (2 panel@UE)gNB Config = (8,8,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,1) | 120 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.3 | / | / | / |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 2 | 13.71 | 15.87 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.57 | 0.66 | / |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 14.93 | 16.95 | 17.65 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.61 | 0.69 | 0.72 |
| 64x8 MU-MIMO, Reciprocity based ; 4T SRS (2 panel@UE)gNB Config = (8,16,2,1,1;2,16);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 16.75 | 19.22 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 1.00 | 1.14 | / |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (8,16,2,1,1;2,16);UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 16.84 | 19.12 | 19.91 |
| 5th-tile [bit/s/Hz] | 0.3 | 1.00 | 1.13 | 1.18 |
| 64x16 MU-MIMO, Reciprocity based ; 4T SRS (2 panel@UE)gNB Config = (4,32,2,1,1;1,32);UE Config = (1,4,2,1,2; 1,4) | 60 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.3 | / | / | / |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS (1 panel@UE)gNB Config = (16,8,2,1,1;2,2);UE Config = (4,4,2,1,1; 1,2) | 120 | DDDU | Average [bit/s/Hz/TRxP] | 9 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.3 | / | / | / |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (8,16,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,2) | 120 | DDDSU | Average [bit/s/Hz/TRxP] | 9 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.3 | / | / | / |

The evaluation results of DL spectral efficiency for NR for evaluation configuration B with 36TRxP are provided in Table 2.2.1.1.2-2.

It is observed that NR fulfills the DL spectral efficiency requirement for all the above configurations in evaluation configuration B.

Table 2.2.1.1.2-2 DL spectral efficiency for NR in Indoor Hotspot – eMBB
(Evaluation configuration B, CF=30 GHz, for 36TRxP)

 (a) NR TDD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Number of samples | BW=80MHz / 100MHz | BW=200MHz | BW=400MHz |
| 32x4 MU-MIMO Type II Codebook based(2 panel@UE)gNB Config = (8,8,2,1,1;4,4) UE Config = (2,4,2,1,2; 1,1) | 120 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.3 | / | / | / |
| 32x8 MU-MIMO, Reciprocity based; 4Tx SRS(2 panel@UE)gNB Config = (4,16,2,1,1;1,16) UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 12.72 | 14.60 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.38 | 0.43 | / |
| 32x8 MU-MIMO, Reciprocity based; 4Tx SRS(2 panels@UE)gNB Config = (4,16,2,1,1;1,16) UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 12.11 | 13.75 | 14.32 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.31 | 0.35 | 0.36 |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (8,16,2,1,1;2,16) UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 14.85 | 17.05 | / |
| 5th-tile [bit/s/Hz] | 0.3 | 0.48 | 0.56 | / |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE)gNB Config = (8,16,2,1,1;2,16);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD | Average [bit/s/Hz/TRxP] | 9 | 1 | 14.22 | 16.14 | 16.81 |
| 5th-tile [bit/s/Hz] | 0.3 | 0.49 | 0.56 | 0.58 |

The evaluation results of UL spectral efficiency for NR for evaluation configuration B with 12TRxP are provided in Table 2.2.1.1.2-3.

Table 2.2.1.1.2-3 UL spectral efficiency for NR in Indoor Hotspot – eMBB
(Evaluation configuration B, CF=30 GHz, for 12TRxP)

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Number of samples | BW=80MHz |
| 8x32 SU-MIMO, Codebook based, OFDMA (2 panel@UE);gNB Config = (4,4,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,2) | 60 | DDDSU | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.04 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.40 |
| 8x32 SU-MIMO,Non-codebook based, OFDMA (2 panel@UE);gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.44 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.37 |
| 8x32, SU-MIMO, Codebook based, OFDMA (2 panel@UE) gNB Config = (8,8,2,1,1;4,4)UE Config = (2,4,2,1,1; 1,2) | 60 | DSUDD | Average [bit/s/Hz/TRxP] | 6.75 | 1 | 7.44 |
| 5th-tile [bit/s/Hz] | 0.21 | 0.32 |

#### 2.1.2.2 Dense Urban – eMBB

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

##### 2.1.2.2.1 Evaluation configuration A (CF = 4 GHz)

The evaluation results of DL spectral efficiency for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.2.1.2.1-1.

Similar to Indoor Hotspot – eMBB test environment, the capability of NR in larger bandwidth are evaluated for DL spectral efficiency. The values of the larger bandwidths are shown together with the evaluation results.

It is observed that both NR FDD and TDD fulfill the DL spectral efficiency requirement for these configurations in evaluation configuration A.

Table 2.2.1.2.1-1 DL spectral efficiency for NR in Dense Urban – eMBB
(Evaluation configuration A, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | BW=20MHz | BW=40MHz | Number of samples | BW=10MHz | BW=20MHz | BW=40MHz |
| 32x4 MU-MIMO Type II Codebook; gNB Config = (8,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 7.8 | 6 | 11.65 | 13.21 | 14.14 | 6 | 11.82 | 13.43 | 14.38 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.39 | 0.45 | 0.48 | 0.38 | 0.44 | 0.47 |
| 32x4 MU-MIMO Type II Codebook; gNB Config = (16,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 12.65 | 14.3 | 15.28 | 1 | 12.31 | 13.91 | 14.87 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.44 | 0.50 | 0.54 | 0.44 | 0.49 | 0.53 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | BW=40MHz | BW=100MHz | Number of samples | BW=20MHz | BW=40MHz | BW=100MHz |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 7.8 | 4 | 13.03 | 15.26 | 16.77 | 3 | 12.94 | 15.20 | 16.74 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.47 | 0.55 | 0.61 | 0.44 | 0.52 | 0.57 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 12.95 | 14.78 | / | 1 | 12.74 | 14.54 | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.39 | 0.44 | / | 0.4 | 0.46 | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 16.10 | 18.84 | 20.70 | 2 | 16.23 | 19.14 | 21.11 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.49 | 0.58 | 0.64 | 0.52 | 0.62 | 0.68 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 15.71 | 18.02 | / | 1 | 15.46 | 17.73 | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.48 | 0.56 | / | 0.49 | 0.56 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (16,8,2,1,1;2,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 13.11 | 15.00 | / | 1 | 12.81 | 14.66 | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.42 | 0.48 | / | 0.41 | 0.46 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 14.25 | 16.21 | / | 1 | 14.95 | 17.02 | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.47 | 0.54 | / | 0.42 | 0.47 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (16,8,2,1,1;2,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 12.88 | 15.04 | 16.50 | 1 | 12.50 | 14.59 | 16.02 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.43 | 0.50 | 0.55 | 0.40 | 0.47 | 0.52 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 15.72 | 18.01 | / | 1 | 15.73 | 18.03 | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.59 | 0.68 | / | 0.57 | 0.65 | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Configs = (16,8,2,1,1;4,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 16.23 | 18.60 | / | 1 | 16.28 | 18.66 | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.60 | 0.68 | / | 0.61 | 0.7 | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 2 | 16.00 | 18.86 | 20.8 | 2 | 15.89 | 18.73 | 20.66 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.58 | 0.69 | 0.76 | 0.57 | 0.67 | 0.74 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS ; gNB Config = (16,8,2,1,1;4,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 15.9 | 18.59 | 20.42 | 1 | 15.87 | 18.55 | 20.38 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.61 | 0.71 | 0.78 | 0.62 | 0.73 | 0.80 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDDD DDSUU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 16.07 | 18.95 | 20.89 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.225 | 0.42 | 0.50 | 0.55 | / | / | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;4,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 14.99 | 17.51 | 19.23 | 1 | 15.08 | 17.62 | 19.34 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.62 | 0.72 | 0.79 | 0.54 | 0.63 | 0.69 |
| 16x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;1,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 9.59 | 11.19 | 12.29 | 1 | 9.51 | 11.11 | 12.19 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.38 | 0.44 | 0.49 | 0.39 | 0.45 | 0.50 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDDDDDSUU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 13.05 | 15.55 | 17.23 | 1 | 13.35 | 15.91 | 17.63 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.54 | 0.64 | 0.71 | 0.46 | 0.55 | 0.61 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 7.8 | 1 | 16.73 | 20.08 | 22.33 | 1 | 16.59 | 19.91 | 22.14 |
| 5th-tile [bit/s/Hz] | 0.225 | 0.61 | 0.73 | 0.81 | 0.57 | 0.68 | 0.76 |

The evaluation results of UL spectral efficiency for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.2.1.2.1-2.

It is observed that both NR FDD and TDD fulfill the UL spectral efficiency requirement for these configurations in evaluation configuration A.

Table 2.2.1.2.1-2 UL spectral efficiency for NR in Dense Urban – eMBB
(Evaluation configuration A, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | Number of samples | BW=10MHz |
| 2x16 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.77 | 1 | 6.67 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.25 | 0.22 |
| 2x32 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 8.12 | 2 | 8.08 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.39 | 0.35 |
| 4x32 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 8.83 | 1 | 8.8 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.45 | 0.37 |
| 4x16 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.09 | 1 | 6.40 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.33 | 0.35 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | Number of samples | BW=20MHz |
| 2x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.14 | 1 | 6.11 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.28 | 0.25 |
| 2x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.57 | 1 | 6.48 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.28 | 0.25 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 7.03 | 2 | 7.21 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.36 | 0.41 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 7.49 | 1 | 7.47 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.36 | 0.29 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.73 | 2 | 7.64 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.33 | 0.35 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 7.02 | 1 | 7.18 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.32 | 0.29 |
| 4x16 SU-MIMO, Non-codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.56 | 1 | 6.90 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.27 | 0.32 |
| 4x16 SU-MIMO, Non-codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.28 | 1 | 6.34 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.26 | 0.35 |
| 4x16 SU-MIMO, codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 6.05 | 1 | 6.43 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.25 | 0.28 |
| 4x16 SU-MIMO, codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 5.69 | 1 | 6.02 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.23 | 0.29 |
| 2x32 SU-MIMO, Codebook based, OFDMA, gNB Config = (12,8,2,1,1;4,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 5.4 | / | / | 1 | 8.16 |
| 5th-tile [bit/s/Hz] | 0.15 | / | 0.55 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 8.28 | 1 | 8.24 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.60 | 0.58 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 7.86 | 1 | 7.87 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.52 | 0.52 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDDDDDSUU | Average [bit/s/Hz/TRxP] | 5.4 | 1 | 7.03 | 1 | 7.04 |
| 5th-tile [bit/s/Hz] | 0.15 | 0.47 | 0.47 |

#### 2.1.2.3 Rural – eMBB

Evaluation configuration A (carrier frequency = 700 MHz), evaluation configuration B (carrier frequency = 4 GHz), and evaluation configuration C (LMLC) are applied for the evaluations of Rural – eMBB test environment for NR.

##### 2.1.2.3.1 Evaluation configuration A (CF = 700 MHz)

The evaluation results of DL spectral efficiency for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.2.1.3.1-1.

Similar to Indoor Hotspot – eMBB test environment, the capability of NR in larger bandwidth are evaluated for DL spectral efficiency. The values of the assumed bandwidths are shown together with the evaluation results.

It is observed that both NR FDD and TDD fulfill the DL spectral efficiency requirement for these configurations in evaluation configuration A.

Table 2.2.1.3.1-1 DL spectral efficiency for NR in Rural – eMBB
(Evaluation configuration A, CF=700 MHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | BW=20MHz | BW=40MHz | Number of samples | BW=10MHz | BW=20MHz | BW=40MHz |
| 8x2 MU-MIMO Type II Codebook; gNB Config = (8,4,2,1,1;1,4) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 6 | 6.1 | 6.84 | 7.29 | 5 | 6.21 | 6.98 | 7.44 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.17 | 0.19 | 0.20 | 0.18 | 0.2 | 0.22 |
| 16x2 MU-MIMO Type II Codebook; gNB Config = (8,4,2,1,1;2,4) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 7.48 | 8.39 | 8.94 | 2 | 8.83 | 9.96 | 12.64 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.15 | 0.17 | 0.18 | 0.20 | 0.22 | 0.24 |
| 16x2 MU-MIMO Type II Codebook; gNB Config = (4,8,2,1,1;1,8) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 9.58 | 10.81 | 11.55 | 1 | 10.02 | 11.23 | 11.96 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.25 | 0.28 | 0.30 | 0.27 | 0.30 | 0.32 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | BW=40MHz | BW=100MHz | Number of samples | BW=20MHz | BW=40MHz | BW=100MHz |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;1,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 4 | 6.77 | 7.80 | 8.50 | 3 | 6.43 | 7.44 | 8.12 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.16 | 0.19 | 0.21 | 0.18 | 0.21 | 0.22 |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;1,4) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 7.66 | 8.63 | / | 1 | 7.57 | 8.53 | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.16 | 0.18 | / | 0.16 | 0.18 | / |
| 16x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;2,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 9.21 | 10.64 | 11.61 | 1 | 9.22 | 10.65 | 11.62 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.21 | 0.25 | 0.27 | 0.22 | 0.25 | 0.28 |
| 16x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;2,4) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.9 | 10.08 | / |  | 8.95 | 10.14 | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.18 | 0.2 | / | 0.18 | 0.21 | / |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;1,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 2 | 8.99 | 10.33 | / | 2 | 9.61 | 11.06 | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.27 | 0.31 | / | 0.27 | 0.31 | / |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;1,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 2 | 6.71 | 7.84 | 8.60 | 2 | 6.91 | 8.07 | 8.86 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.19 | 0.22 | 0.24 | 0.19 | 0.22 | 0.25 |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;1,4) | 30 | DDDDDDDSUU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 5.07 | 5.99 | 6.60 | 1 | 5.12 | 6.04 | 6.67 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.14 | 0.16 | 0.18 | 0.15 | 0.17 | 0.19 |
| 8x2 MU-MIMO, Reciprocity based; 2T SRS; gNB Config = (8,4,2,1,1;1,4) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 5.04 | 5.98 | 6.62 | 1 | 5.04 | 5.98 | 6.62 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.14 | 0.16 | 0.18 | 0.14 | 0.16 | 0.18 |

The evaluation results of UL spectral efficiency for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.2.1.3.1-2.

It is observed that both NR FDD and TDD fulfill the UL spectral efficiency requirement for these configurations in evaluation configuration A.

Table 2.2.1.3.1-2 UL spectral efficiency for NR in Rural – eMBB
(Evaluation configuration A, CF=700 MHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | Number of samples | BW=10MHz |
| 1x8 SU-MIMO, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 15 | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.28 | 2 | 0.43 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.14 | 0.03 |
| 2x8 SU-MIMO, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 15 | Average [bit/s/Hz/TRxP] | 1.6 | 2 | 5.99 | 3 | 6.3 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.19 | 0.19 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | Number of samples | BW=20MHz |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 2 | 3.75 | 1 | 4.76 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.14 | 0.10 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 5.08 | 1 | 5.05 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.1 | 0.09 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.44 | 1 | 4.45 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.18 | 0.16 |
| 2x8 SU-MIMO, Non-codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 5.08 | 1 | 4.22 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.16 | 0.17 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.71 | 1 | 4.74 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.20 | 0.16 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.51 | 1 | 4.56 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.18 | 0.15 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 5.34 | 1 | 5.38 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.11 | 0.13 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4) | 30 | DDDDDDDSUU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.78 | 1 | 4.81 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.13 | 0.12 |

##### 2.1.2.3.2 Evaluation configuration B (CF = 4 GHz)

The evaluation results of DL spectral efficiency for NR FDD and NR TDD for evaluation configuration B are provided in Table 2.2.1.3.2-1.

Similar to Indoor Hotspot – eMBB test environment, the capability of NR in larger bandwidth are evaluated for DL spectral efficiency. The values of the assumed bandwidths are shown together with the evaluation results.

It is observed that both NR FDD and TDD fulfill the DL spectral efficiency requirement for these configurations in evaluation configuration B.

Table 2.2.1.3.2-1 DL spectral efficiency for NR in Rural – eMBB
(Evaluation configuration B, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | BW=20MHz | BW=40MHz | Number of samples | BW=10MHz | BW=20MHz | BW=40MHz |
| 32x4 MU-MIMO Type II Codebook; gNB Config = (8,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 5 | 12.97 | 14.65 | 15.56 | 5 | 13.91 | 15.73 | 16.82 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.44 | 0.49 | 0.53 | 0.46 | 0.52 | 0.56 |
| 32x4 MU-MIMO Type II Codebook; gNB Config = (8,16,2,1,1;1,16) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 16.64 | 18.81 | 21.1 | 1 | 16.63 | 18.79 | 20.09 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.51 | 0.58 | 0.61 | 0.52 | 0.58 | 0.62 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | BW=40MHz | BW=100MHz | Number of samples | BW=20MHz | BW=40MHz | BW=100MHz |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 4 | 14.36 | 16.75 | 18.37 | 3 | 14.06 | 16.46 | 18.08 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.45 | 0.52 | 0.58 | 0.44 | 0.51 | 0.57 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 15.31 | 17.47 | / | 1 | 15.18 | 17.33 | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.37 | 0.42 | / | 0.37 | 0.43 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 2 | 15.04 | 17.46 | / | 1 | 15.17 | 17.84 | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.58 | 0.68 | / | 0.49 | 0.58 | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 14.29 | 16.68 | 18.31 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.47 | 0.55 | 0.60 | / | / | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDDD DDSUU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 16.89 | 19.59 | 21.44 | / | / | / | / |
| 5th-tile [bit/s/Hz] | 0.12 | 0.43 | 0.50 | 0.55 | / | / | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 2 | 15.40 | 18.14 | 20.00 | 2 | 15.23 | 17.94 | 19.78 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.58 | 0.69 | 0.76 | 0.54 | 0.64 | 0.71 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | / | / | / | / | 1 | 14.52 | 16.90 | 18.53 |
| 5th-tile [bit/s/Hz] | 0.12 | / | / | / | 0.49 | 0.57 | 0.63 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS gNB Config = (8,8,2,1,1;2,8) | 30 | DDDDDDDSUU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 13.21 | 15.74 | 17.44 | 1 | 13.19 | 15.71 | 17.41 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.43 | 0.51 | 0.57 | 0.48 | 0.57 | 0.63 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 14.54 | 17.45 | 19.40 | 1 | 14.76 | 17.72 | 19.70 |
| 5th-tile [bit/s/Hz] | 0.12 | 0.46 | 0.55 | 0.61 | 0.48 | 0.58 | 0.64 |

The evaluation results of UL spectral efficiency for NR FDD and NR TDD for evaluation configuration B are provided in Table 2.2.1.3.2-2.

It is observed that both NR FDD and TDD fulfill the UL spectral efficiency requirement for these configurations in evaluation configuration B.

Table 2.2.1.3.2-2 UL spectral efficiency for NR in Rural – eMBB
(Evaluation configuration B, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=10MHz | Number of samples | BW=10MHz |
| 1x32 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.38 | 2 | 4.52 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.17 | 0.16 |
| 4x32 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 7.69 | / | / |
| 5th-tile [bit/s/Hz] | 0.045 | 0.26 | / |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement | Channel model A | Channel model B |
| Number of samples | BW=20MHz | Number of samples | BW=20MHz |
| 1x32 SU-MIMO, Codebook based, OFDMA; gNB Config (8,8,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 3.18 | 1 | 3.12 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.11 | 0.09 |
| 1x32 SU-MIMO, Codebook based, OFDMA; gNB Config (8,8,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 3.54 | 1 | 3.46 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.12 | 0.10 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config (8,8,2,1,1;2,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 5.73 | 1 | 5.76 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.18 | 0.13 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config (8,8,2,1,1;2,8) | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 6.30 | 1 | 6.04 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.19 | 0.15 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config (12,8,2,1,1;4,8) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 7.83 | 1 | 7.66 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.31 | 0.32 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config (12,8,2,1,1;4,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | / | / | 1 | 6.82 |
| 5th-tile [bit/s/Hz] | 0.045 | / | 0.29 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config (12,8,2,1,1;4,8) | 30 | DDDSUDDSUU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 7.44 | 1 | 7.33 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.34 | 0.29 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config (12,8,2,1,1;4,8) | 30 | DDDDDDDSUU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 6.66 | 1 | 6.56 |
| 5th-tile [bit/s/Hz] | 0.045 | 0.30 | 0.26 |
| 4x16 SU-MIMO, Codebook based, OFDMA; gNB Config (8,8,2,1,1;1,8) | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 2.7 | / | / |
| 5th-tile [bit/s/Hz] | 0.045 | 0.17 | / |

##### 2.1.2.3.3 Evaluation configuration C (LMLC)

LMLC (Low mobility large cell) is characterized by the large inter-site distance (ISD=6000m) and the low mobility users in Rural – eMBB test environment.

The evaluation results of DL spectral efficiency for NR FDD and NR TDD for evaluation configuration C are provided in Table 2.2.1.3.3-1.

Similar to Indoor Hotspot – eMBB test environment, the capability of NR in larger bandwidth are evaluated for DL spectral efficiency. The values of the assumed bandwidths are shown together with the evaluation results.

It is observed that both NR FDD and TDD fulfill the DL spectral efficiency requirement for these configurations in evaluation configuration C.

Table 2.2.1.3.3-1 DL spectral efficiency for NR in Rural – eMBB
(Evaluation configuration C, LMLC)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement1 | Channel model A | Channel model B |
| Number of samples | BW=10MHz | BW=20MHz | BW=40MHz | Number of samples | BW=10MHz | BW=20MHz | BW=40MHz |
| 8x4 MU-MIMO Type II Codebook; gNB Config = (8,4,2,1,1;1,4) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 5 | 7.57 | 8.49 | 9.05 | 4 | 7.46 | 8.22 | 8.76 |
| 5th-tile [bit/s/Hz] |  | 0.23 | 0.26 | 0.27 | 0.22 | 0.25 | 0.26 |
| 16x4 MU-MIMO Type II Codebook; gNB Config = (8,4,2,1,1;2,4) | 15 | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.13 | 9.13 | 9.73 | 1 | 8.14 | 9.13 | 9.73 |
| 5th-tile [bit/s/Hz] |  | 0.20 | 0.23 | 0.24 | 0.20 | 0.23 | 0.24 |
| Note 1: According to Report ITU-R M.2410, the 5th percentile user spectral efficiency requriement is not applicable to LMLC. The value shown here is for information only. |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement1 | Channel model A | Channel model B |
| Number of samples | BW=20MHz | BW=40MHz | BW=100MHz | Number of samples | BW=20MHz | BW=40MHz | BW=100MHz |
| 8x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,4,2,1,1;1,4); | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 4 | 7.35 | 8.50 | 9.28 | 3 | 8.14 | 9.45 | 10.35 |
| 5th-tile [bit/s/Hz] |  | 0.22 | 0.26 | 0.28 | 0.28 | 0.33 | 0.36 |
| 8x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,4,2,1,1;1,4); | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.01 | 9.02 | / | 1 | 8.02 | 9.04 | / |
| 5th-tile [bit/s/Hz] |  | 0.2 | 0.22 | / | 0.2 | 0.22 | / |
| 16x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,4,2,1,1;2,4); | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.61 | 9.98 | 10.91 | 1 | 8.59 | 9.95 | 10.89 |
| 5th-tile [bit/s/Hz] |  | 0.2 | 0.23 | 0.25 | 0.19 | 0.22 | 0.25 |
| 16x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,4,2,1,1;2,4); | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.83 | 9.98 | / | 1 | 8.82 | 9.96 | / |
| 5th-tile [bit/s/Hz] |  | 0.22 | 0.25 | / | 0.21 | 0.24 | / |
| 8x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,4,2,1,1;1,4); | 15 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.64 | 10.16 | / | 1 | 8.76 | 10.3 | / |
| 5th-tile [bit/s/Hz] |  | 0.28 | 0.33 | / | 0.23 | 0.27 | / |
| 8x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,4,2,1,1;1,4) | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 3.3 | 1 | 8.34 | 9.91 | 10.97 | 1 | 8.38 | 9.96 | 11.02 |
| 5th-tile [bit/s/Hz] |  | 0.28 | 0.33 | 0.37 | 0.31 | 0.37 | 0.41 |
| Note 1: According to Report ITU-R M.2410, the 5th percentile user spectral efficiency requriement is not applicable to LMLC. The value shown here is for information only. |

The evaluation results of UL spectral efficiency for NR FDD and NR TDD for evaluation configuration C are provided in Table 2.2.1.3.3-2.

It is observed that both NR FDD and TDD fulfill the UL spectral efficiency requirement for these configurations in evaluation configuration C.

Table 2.2.1.3.3-2 UL spectral efficiency for NR in Rural – eMBB
(Evaluation configuration C, LMLC)

(a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement1 | Channel model A | Channel model B |
| Number of samples | BW=10MHz | Number of samples | BW=10MHz |
| 2x8 SU-MIMO, OFDMA;gNB Config = (8,4,2,1,1;1,4); | 15 | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.14 | 2 | 4.1 |
| 5th-tile [bit/s/Hz] |  | 0.08 | 0.07 |
| 4x8 SU-MIMO, OFDMA;gNB Config = (8,4,2,1,1;1,4); | 15 | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.81 | 1 | 4. 8 |
| 5th-tile [bit/s/Hz] |  | 0.1 | 0.09 |
| Note 1: According to Report ITU-R M.2410, the 5th percentile user spectral efficiency requriement is not applicable to LMLC. The value shown here is for information only. |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement1 | Channel model A | Channel model B |
| Number of samples | BW=20MHz | Number of samples | BW=20MHz |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4); | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 3.33 | 1 | 3.31 |
| 5th-tile [bit/s/Hz] |  | 0.06 | 0.05 |
| 2x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4); | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 3.56 | 1 | 3.57 |
| 5th-tile [bit/s/Hz] |  | 0.05 | / |
| 4x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4); | 30 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 3.84 | 2 | 3.53 |
| 5th-tile [bit/s/Hz] |  | 0.07 | 0.07 |
| 4x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4); | 15 | DDDSU | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.07 | 1 | 4.08 |
| 5th-tile [bit/s/Hz] |  | 0.06 | 0.05 |
| 4x8 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,4,2,1,1;1,4); | 30 | DSUUD | Average [bit/s/Hz/TRxP] | 1.6 | 1 | 4.41 | 1 | 3.56 |
| 5th-tile [bit/s/Hz] |  | / | / |
| Note 1: According to Report ITU-R M.2410, the 5th percentile user spectral efficiency requriement is not applicable to LMLC. The value shown here is for information only. |

## 2.1.3 User experienced data rate

As defined in Report ITU-R M.2410, 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.

User experienced data rate for NR are evaluated under Dense Urban – eMBB test environment.

#### 2.1.3.1 Dense Urban – eMBB

For Dense Urban – eMBB test environment, single-band single-layer case using evaluation configuration A (carrier frequency = 4 GHz), and multi-band case using evaluation configuration C as defined in Report ITU-R M.2412 are considered in evaluation. Detailed evaluation assumptions for configuration A are based on spectral efficiency evaluation, and can be found in chapter 3; detailed evaluation assumptions and results for configuration C can be found in chapter 3.

##### 2.1.3.1.1 Evaluation configuration A (CF = 4 GHz)

For evaluation configuration A (single-band case), user experienced data rate for NR is evaluated based on 5th percentile user spectral efficiency, using the analytical way as provided in Report ITU-R M.2412.

The evaluation results of DL user experienced data rate for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.3.1.1-1.

It is assumed that for FDD and TDD with 15 kHz SCS, a component carrier with 40 MHz is used; and for TDD with 30 kHz SCS, a component carrier with 100 MHz is used. Multiple component carriers are aggregated to achieve the DL target user experienced data rate. The assumed DL/UL aggregated system bandwidth (for FDD) or overall aggregated system bandwidth (for TDD) is given in Table 2.3.1.1-1.

It is observed that both NR FDD and TDD fulfill the DL user experienced data rate requirement in evaluation configuration A.

Table 2.3.1.1-1 DL user experienced data rate for NR in Dense Urban – eMBB
(Evaluation configuration A, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | ITURequirement [Mbps] | Channel model A | Channel model B |
| Number of samples | Assumed DL system bandwidth [MHz] | User exp. data rate [Mbps] | Number of samples | Assumed DL system bandwidth [MHz] | User exp. data rate [Mbps] |
| 32x4 MU-MIMO Type II Codebook; gNB Config = (8,8,2,1,1;2,8) | 15 | 100 | 6 | 240 | 114.38 | 6 | 240 | 112.32 |
| 32x4 MU-MIMO Type II Codebook; gNB Config = (16,8,2,1,1;2,8) | 15 | 100 | 1 | 200 | 107.02 | 1 | 200 | 105.81 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | Frame structure | ITURequirement [Mbps] | Channel model A | Channel model B |
| Number of samples | Assumed system bandwidth [MHz] | User exp. data rate [Mbps] | Number of samples | Assumed system bandwidth [MHz] | User exp. data rate [Mbps] |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU,S slot =10DL:2GP:2UL | 100 | 3 | 300 | 138.60 | 3 | 300 | 129.45 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU,S slot =11DL:1GP:2UL | 100 | 1 | 300 | 137.16 | / | / | / |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSU,S slot =10DL:2GP:2UL | 100 | 1 | 360 | 107.33 | 1 | 320 | 111.28 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSU,S slot =10DL:2GP:2UL | 100 | 1 | 300 | 144.34 | 2 | 200 | 102.80 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 15 | DDDSU,S slot =10DL:2GP:2UL | 100 | 1 | 240 | 100.87 | 1 | 240 | 102.57 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (16,8,2,1,1;2,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 400 | 107.44 | 1 | 400 | 104.60 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 360 | 108.72 | 2 | 400 | 106.75 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (16,8,2,1,1;2,8) | 30 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 400 | 123.50 | 1 | 400 | 116.27 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 280 | 107.37 | 1 | 280 | 103.20 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (16,8,2,1,1;4,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 280 | 107.91 | 1 | 280 | 110.81 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 300 | 126.31 | 1 | 300 | 126.74 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DSUUDS slot =6DL:2GP:6UL | 100 | 1 | 300 | 114.97 | 1 | 300 | 109.22 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (16,8,2,1,1;4,8) | 30 | DSUUDS slot =11DL:1GP:2UL | 100 | 1 | 300 | 132.83 | 1 | 300 | 135.22 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDDD DDSUUS slot =6DL:4GP:4UL | 100 | 1 | 300 | 124.58 | / | / | / |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (4,8,2,1,1;4,8) | 30 | DDDSUS slot =10DL:2GP:2UL | 100 | 1 | 200 | 119.46 | 1 | 200 | 104.18 |
| 16x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSUS slot =10DL:2GP:2UL | 100 | 1 | 300 | 110.93 | 1 | 300 | 113.01 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDDDDDSUUS slot =6DL:4GP:6UL | 100 | 1 | 200 | 107.91 | 1 | 300 | 138.32 |
| 64x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSUDDSUUS slot =10DL:2GP:2UL | 100 | 1 | 200 | 106.39 | 1 | 300 | 149.29 |

The evaluation results of UL user experienced data rate for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.3.1.1-2.

It is assumed that for FDD with 15 kHz SCS, a component carrier with 40 MHz is used; for TDD with 15 kHz SCS, a component carrier with 50 MHz is used; and for TDD with 30 kHz SCS, a component carrier with 100 MHz is used. Multiple component carriers are aggregated to achieve the UL target user experienced data rate. The assumed aggregated system bandwidth is given in Table 2.3.1.1-2.

It is observed that both NR FDD and TDD fulfill the UL user experienced data rate requirement in evaluation configuration A.

Table 2.3.1.1-2 UL user experienced data rate for NR in Dense Urban – eMBB
(Evaluation configuration A, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | ITURequirement [Mbps] | Channel model A | Channel model B |
| Number of samples | Assumed UL system bandwidth [MHz] | User exp. data rate [Mbps] | Number of samples | Assumed UL system bandwidth [MHz] | User exp. data rate [Mbps] |
| 2x16 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | 50 | 1 | 200 | 50.92 | 1 | 240 | 52.48 |
| 2x32 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | 50 | 1 | 160 | 62.09 | 2 | 160 | 55.87 |
| 4x32 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | 50 | 1 | 120 | 54.20 | 1 | 160 | 59.95 |
| 4x16 SU-MIMO, OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | 50 | 1 | 160 | 52.80 | 1 | 160 | 55.84 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | Frame structure | ITURequirement [Mbps] | Channel model A | Channel model B |
| Number of samples | Assumed system bandwidth [MHz] | User exp. data rate [Mbps] | Number of samples | Assumed system bandwidth [MHz] | User exp. data rate [Mbps] |
| 2x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSUS slot =10DL:2GP:2UL | 50 | 1 | 800 | 53.68 | 1 | 900 | 54.55 |
| 2x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSUS slot =10DL:2GP:2UL | 50 | 1 | 800 | 53.94 | 1 | 900 | 53.83 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSUS slot =10DL:2GP:2UL | 50 | 1 | 600 | 51.80 | 2 | 600 | 59.48 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 15 | DDDSUS slot =10DL:2GP:2UL | 50 | 1 | 600 | 52.24 | 1 | 700 | 50.11 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8)  | 30 | DDDSUS slot =10DL:2GP:2UL | 50 | 1 | 700 | 56.21 | 1 | 700 | 52.61 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSUS slot =10DL:2GP:2UL | 50 | 2 | 700 | 55.80 | 1 | 800 | 55.98 |
| 4x32 MU-MIMO, Codebook based, OFDMA; gNB Config = (8,16,2,1,1;1,16) | 15 | DSUUDS slot =6DL:2GP:6UL | 50 | 1 | 300 | 73.15 | / | / | / |
| 4x16 SU-MIMO, Non-codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 50 | 1 | 500 | 58.82 | 1 | 400 | 55.07 |
| 4x16 SU-MIMO, Non-codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 30 | DSUUDS slot =11DL:1GP:2UL | 50 | 1 | 500 | 57.08 | 1 | 400 | 61.35 |
| 4x16 SU-MIMO, codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 50 | 1 | 500 | 54.90 | 1 | 500 | 60.35 |
| 4x16 SU-MIMO, codebook based,OFDMA; gNB Config = (8,8,2,1,1;1,8) | 30 | DSUUDS slot =11DL:1GP:2UL | 50 | 1 | 500 | 50.11 | 1 | 400 | 50.89 |
| 2x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,4) | 30 | DSUUDS slot =6DL:2GP:6UL | 50 | / | / | / | 1 | 200 | 55.44 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DSUUDS slot =6DL:2GP:6UL | 50 | 1 | 200 | 59.63 | 1 | 200 | 57.54 |
| 4x128, MU-MIMO, Codebook based, OFDMA; gNB Config = (8,16,2,1,1;4,16) | 30 | DDSUS slot =10DL:2GP:2UL | 50 | / | / | / | 1 | 1000 | 52.92 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDSUDDSUUS slot =10DL:2GP:2UL | 50 | 1 | 300 | 53.56 | 1 | 300 | 53.77 |
| 2x64 SU-MIMO, Codebook based, OFDMA; gNB Config = (12,8,2,1,1;4,8) | 30 | DDDDDDDSUUS slot =6DL:4GP:4UL | 50 | 1 | 500 | 56.53 | 1 | 500 | 56.77 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | DSUUDS slot =11DL:1GP:2UL | 50 | / | / | / | 1 | 300 | 50.06 |
| 4x32 SU-MIMO, Codebook based, OFDMA; gNB Config = (8,8,2,1,1;2,8) | 15 | DDDSUS slot =10DL:2GP:2UL | 50 | / | / | / | 1 | 800 | 54.59 |

## 2.1.4 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.

NR evaluation for area traffic capacity is conducted for Indoor Hotspot – eMBB test environment. A wide range of antenna configurations and transmission schemes are considered. Detailed evaluation assumptions are according to spectral efficiency evaluation, which can be found in chapter 3.

#### 2.1.4.1 Indoor Hotspot – eMBB

The area traffic capacity of NR is evaluated using analytical way based on the downlink average spectral efficiency evaluation for NR in Indoor Hotspot – eMBB test environment. The analytical way is defined in Report ITU-R M.2412.

##### 2.1.4.1.1 Evaluation configuration A (CF = 4 GHz)

The evaluation results of area traffic capacity for NR FDD and NR TDD for evaluation configuration A with 12TRxP are provided in Table 2.4.1.1-1.

It is assumed that for FDD and TDD with 15 kHz SCS, a component carrier with 40 MHz is used; and for TDD with 30 kHz SCS, a component carrier with 100 MHz is used. Multiple component carriers are aggregated to achieve the target area traffic capacity. The assumed aggregated DL system bandwidth (for FDD) and overall system bandwidth (for TDD) are given in Table 2.4.1.1-1.

Table 2.4.1.1-1 Area traffic capacity for NR in Indoor Hotspot – eMBB
(Evaluation configuration A, CF=4 GHz, for 12TRxP)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | ITURequirement [Mbps/m2] | Channel model A | Channel model B |
| Number of samples | Assumed DL systembandwidth [MHz] | Area traffic capacity [Mbps/m2] | Number of samples | Assumed DL system bandwidth [MHz] | Area traffic capacity [Mbps/m2] |
| 32x4 MU-MIMO Type II CodebookgNB Config = (4,4,2,1,1;4,4) | 15 | 10 | 10 | 400 | 10.96 | 6 | 400 | 10.92 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | Frame structure | ITURequirement [Mbps/m2] | Channel model A | Channel model B |
| Number of samples | Assumed system bandwidth [MHz] | Area traffic capacity [Mbps/m2] | Number of samples | Assumed system bandwidth [MHz] | Area traffic capacity [Mbps/m2] |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS;gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSU;S slot = (10DL:2GP:2UL) | 10 | 1 | 400 | 11.67 | 3 | 500 | 11.64 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRSgNB Config = (4,4,2,1,1;4,4) | 15 | DDDSU;S slot = (10DL:2GP:2UL) | 10 | 1 | 480 | 10.65 | 1 | 480 | 10.64 |
| 32x4 MU-MIMO, Type II Codebook based, gNB Config = (4,4,2,1,1;4,4) | 15 | DSUUD;S slot = (11DL:1GP :2UL) | 10 | 1 | 600 | 10.28 | 1 | 600 | 10.50 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS, gNB Config = (4,4,2,1,1;4,4) | 30 | DSUUD;S slot = (11DL:1GP :2UL) | 10 | 1 | 600 | 10.71 | 1 | 600 | 10.91 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS, gNB Config = (4,4,2,1,1;4,4) | 30 | DSUUD;S slot = (6DL:2GP :6UL) | 10 | 1 | 700 | 10.04 | 1 | 700 | 10.46 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS, gNB Config = (4,4,2,1,1;4,4) | 15 | DSUUD;S slot = (11DL:1GP :2UL) | 10 | 2 | 680 | 10.62 | 2 | 640 | 10.38 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS, gNB Config = (4,4,2,1,1;4,4) | 15 | DSUUD;S slot = (6DL:2GP :6UL) | 10 | / | / | / | 1 | 760 | 10.00 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS, gNB Config = (4,4,2,1,1;4,4) | 30 | DDDDD DDSUU;S slot = (6DL:4GP:4UL) | 10 | 2 | 500 | 12.29 | 1 | 500 | 11.71 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS, gNB Config = (4,4,2,1,1;4,4) | 30 | DDDSU DDSUU;S slot = (6DL:4GP:4UL) | 10 | 1 | 600 | 11.96 | 1 | 500 | 10.17 |

The evaluation results of area traffic capacity for NR FDD and NR TDD for evaluation configuration A with 36TRxP are provided in Table 2.4.1.1-2.

It is assumed that for FDD and TDD with 15 kHz SCS, a component carrier with 40 MHz is used; and for TDD with 30 kHz SCS, a component carrier with 100 MHz is used. Multiple component carriers are aggregated to achieve the DL target user experienced data rate. The assumed aggregated system bandwidth is given in Table 2.4.1.1-2.

It is observed that both NR FDD and TDD fulfill the area traffic capacity requirement for all the above configurations in evaluation configuration A.

Table 2.4.1.1-2 Area traffic capacity for NR in Indoor Hotspot – eMBB
(Evaluation configuration A, CF=4 GHz, for 36TRxP)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | ITURequirement [Mbps/m2] | Channel model A | Channel model B |
| Number of samples | Assumed DL systembandwidth [MHz] | Area traffic capacity [Mbps/m2] | Number of samples | Assumed DL system bandwidth [MHz] | Area traffic capacity [Mbps/m2] |
| 32x4 MU-MIMO Type II CodebookgNB Conifg = (8,16,2,1,1;2,8) | 15 | 10 | 3 | 120 | 10.76 | 3 | 120 | 11.32 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | Frame structure | ITURequirement [Mbps/m2] | Channel model A | Channel model B |
| Number of samples | Assumed system bandwidth [MHz] | Area traffic capacity [Mbps/m2] | Number of samples | Assumed system bandwidth [MHz] | Area traffic capacity [Mbps/m2] |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS gNB Config = (8,16,2,1,1;2,8) | 30 | DDDSU;S Slot = (10DL:2GP,2UL) | 10 | 2 | 200 | 14.85 | 2 | 200 | 15.04 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS gNB Config = (8,16,2,1,1;2,8) | 15 | DDDSU;S Slot = (10DL:2GP:2UL) | 10 | 1 | 160 | 12.15 | 1 | 160 | 12.24 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,16,2,1,1;2,8) | 15 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 2 | 240 | 11.28 | 2 | 240 | 11.47 |
| 32x4 MU-MIMO, Reciprocity based; gNB Config = (8,16,2,1,1;2,8) | 30 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 200 | 11.28 | 1 | 200 | 11.43 |
| 32x4 MU-MIMO, Reciprocity based; 4T SRS; gNB Config = (8,8,2,1,1;2,8) | 30 | DDDSU;S Slot = (10DL:2GP:2UL) | 10 | 1 | 200 | 11.02 | 1 | 200 | 11.00 |

##### 2.1.4.1.2 Evaluation configuration B (CF = 30 GHz)

The evaluation results of area traffic capacity for NR for evaluation configuration B with 12TRxP are provided in Table 2.4.1.2-1.

It is assumed that for TDD with 60 kHz SCS, a component carrier with 200 MHz is used; and for TDD with 120 kHz SCS, a component carrier with 400 MHz is used. Multiple component carriers are aggregated to achieve the target area traffic capacity. The assumed aggregated system bandwidth is given in Table 2.4.1.2-1.

Table 2.4.1.2-1 Area traffic capacity for NR in Indoor Hotspot – eMBB
(Evaluation configuration B, CF=30 GHz, for 12TRxP)

(a) NR TDD

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | Frame structure | ITURequirement [Mbps/m2] | Number of samples | Assumed system bandwidth [MHz] | Area traffic capacity [Mbps/m2] |
| 32x8 MU-MIMO, 4T SRS (2 panel@UE), gNB Config = (4,4,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,2) | 60 | DDDSU;S Slot = (10DL:2GP:2UL) | 10 | 1 | 600 | 13.05 |
| 32x8 MU-MIMO, 4T SRS (2 panel@UE), gNB Config = (4,4,2,1,1;4,4);UE Config = (2,4,2,1,2; 1,2) | 60 | DDDSU;S Slot = (11DL:1GP:2UL) | 10 | 1 | 600 | 13.59 |
| 32x8 MU-MIMO, 4T SRS (2 panel@UE), gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 600 | 11.57 |
| 32x8 MU-MIMO, 4T SRS (2 panel@UE), gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD;S Slot = (6DL:2GP:6UL) | 10 | 1 | 800 | 11.72 |
| 32x8 MU-MIMO, 4T SRS (2 panel@UE), gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 800 | 15.93 |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE), gNB Config = (8,16,2,1,1;2,16);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 600 | 13.02 |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE), gNB Config = (8,16,2,1,1;2,16);UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 800 | 17.98 |

The evaluation results of area traffic capacity for NR for evaluation configuration B with 36TRxP are provided in Table 2.4.1.2-2.

It is assumed that for TDD with 60 kHz SCS, a component carrier with 200 MHz is used; and for TDD with 120 kHz SCS, a component carrier with 400 MHz is used. Multiple component carriers are aggregated to achieve the target area traffic capacity. The assumed aggregated system bandwidth is given in Table 2.4.1.2-2.

It is observed that both NR fulfills the area traffic capacity requirement for all the above configurations in evaluation configuration B.

Table 2.4.1.2-2 Area traffic capacity for NR in Indoor Hotspot – eMBB
(Evaluation configuration B, CF=30 GHz, for 36TRxP)

(a) NR TDD

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing | Frame structure | ITURequirement [Mbps/m2] | Number of samples | Assumed system bandwidth [MHz] | Area traffic capacity [Mbps/m2] |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE), gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 60 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 400 | 19.77 |
| 32x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE), gNB Config = (8,8,2,1,1;2,8);UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 400 | 19.39 |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE), gNB Config = (8,16,2,1,1;2,16);UEConfig = (2,4,2,1,2; 1,2) | 60 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 200 | 11.54 |
| 64x8 MU-MIMO, Reciprocity based; 4T SRS (2 panel@UE), gNB Config = (8,16,2,1,1;2,16);UE Config = (2,4,2,1,2; 1,2) | 120 | DSUUD;S Slot = (11DL:1GP:2UL) | 10 | 1 | 400 | 22.76 |

## 2.1.5 Mobility

As defined in Report ITU-R M.2410, 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.

A wide range of antenna configurations and transmission schemes are considered for NR. Detailed evaluation assumptions and results can be found in chapter 3.

#### 2.1.5.1 Indoor Hotspot – eMBB

Evaluation configuration A (carrier frequency = 4 GHz) and evaluation configuration B (carrier frequency = 30 GHz) with either 12TRxP or 36TRxP cases are applied for the evaluations of Indoor Hotspot– eMBB test environment for NR. Both NR FDD and TDD are evaluated.

##### 2.1.5.1.1 Evaluation configuration A (CF = 4 GHz)

The evaluation results of mobility for NR FDD and NR TDD for evaluation configuration A with 12TRxP are provided in Table 2.5.1.1-1.

Table 2.5.1.1-1 NR mobility in Indoor Hotspot – eMBB
(Evaluation configuration A, CF=4 GHz, for 12TRxP)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x8 SIMO | 15 | 1.5 | LOS | 2 | 2.09 | LOS | 3 | 2.13 |
| NLOS | 2 | 1.79 | NLOS | 3 | 1.83 |
| 2x8 SU-MIMO | 30 | LOS | / | / | LOS | / | / |
| NLOS | 1 | 3.85 | NLOS | / | / |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x8 SIMO | 30 | DDDSU | 1.5 | LOS | 1 | 1.94 | LOS | 1 | 1.95 |
| NLOS | 1 | 1.59 | NLOS | 1 | 1.60 |
| 1x8 SIMO | 15 | DSUUD | LOS | 1 | 2.07 | LOS | 1 | 2.08 |
| NLOS | 1 | 1.78 | NLOS | 1 | 1.79 |
| 2x8 SU-MIMO | 30 | DDDDDDDSUU | NLOS | 1 | 3.85 | NLOS | / | / |
| LOS | / | / | LOS | / | / |

#### 2.1.5.2 Dense Urban – eMBB

Evaluation configuration A (carrier frequency = 4 GHz) and evaluation configuration B (carrier frequency = 30 GHz) are applied for the evaluations of Dense Urban – eMBB test environment for NR.

##### 2.1.5.2.1 Evaluation configuration A (CF = 4 GHz)

The evaluation results of mobility for NR FDD and NR TDD for evaluation configuration A are provided in Table 2.5.2.1-1.

It is observed that NR fulfills the mobility requirement in evaluation configuration A.

Table 2.5.2.1-1 NR mobility in Dense Urban – eMBB
(Evaluation configuration A, CF=4 GHz)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x8 SIMO | 15 | 1.12 | LOS | 2 | 2.31 | LOS | 3 | 2.31 |
| NLOS | 2 | 2.00 | NLOS | 3 | 1.97 |
| 2x8 SU-MIMO | 30 | NLOS | 2 | 4.72 | NLOS | 1 | 3.55 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x8 SIMO | 30 | DDDSU | 1.12 | LOS | 1 | 2.17 | LOS | 1 | 2.06 |
| NLOS | 1 | 1.82 | NLOS | 1 | 1.79 |
| 1x8 SIMO | 15 | DSUUD | LOS | 1 | 2.33 | LOS | 1 | 2.29 |
| NLOS | 1 | 2.03 | NLOS | 1 | 2.00 |
| 2x8 SU-MIMO | 30 | DDDDDDDSUU | NLOS | 1 | 4.58 | NLOS | / | / |

#### 2.1.5.3 Rural – eMBB

Evaluation configuration A (carrier frequency = 700 MHz) and evaluation configuration B (carrier frequency = 4 GHz) are applied for the evaluations of Rural – eMBB test environment for NR. Both NR FDD and TDD are evaluated. The mobility class of 120km/h and 500km/h are considered.

##### 2.1.5.3.1 Evaluation configuration A (CF = 700 MHz)

The evaluation results of mobility for NR FDD and NR TDD for evaluation configuration A for mobility class of 120km/h are provided in Table 2.5.3.1-1.

Table 2.5.3.1-1 NR mobility in Rural – eMBB
(Evaluation configuration A, CF=700 MHz, Mobility class of 120km/h)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO(Scheduler 1) | 15 | 0.8 | LOS | 1 | 2.90 | LOS | 2 | 3.18 |
| NLOS | 1 | 2.32 | NLOS | 2 | 2.53 |
| 2x2 SU-MIMO | 15 | NLOS | 2 | 1.79 | NLOS | 1 | 1.54 |
| 1x8 SIMO | 15 | LOS | 1 | 2.89 | LOS | 1 | 2.91 |
| NLOS | 1 | 2.86 | NLOS | 1 | 2.90 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO | 15 | DDDSU | 0.8 | LOS | 1 | 2.63 | LOS | 1 | 2.63 |
| NLOS | 1 | 2.10 | NLOS | 1 | 2.09 |
| 2x2 SU-MIMO | 15 | DDDSU | NLOS | 1 | 2.01 | NLOS | / | / |
| 1x8 SIMO | 15 | DSUUD | LOS | 1 | 2.81 | LOS | 1 | 2.82 |
| NLOS | 1 | 2.77 | NLOS | 1 | 2.81 |

The evaluation results of mobility for NR FDD and NR TDD for evaluation configuration A for mobility class of 500km/h are provided in Table 2.5.3.1-2.

It is observed that NR fulfills the mobility requirement under both 120km/h and 500km/h.

Table 2.5.3.1-2 NR mobility in Rural – eMBB
(Evaluation configuration A, CF=700 MHz, Mobility class of 500km/h)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO | 30 | 0.45 | LOS | 1 | 2.64 | LOS | 1 | 2.64 |
| NLOS | 1 | 2.07 | NLOS | 1 | 2.07 |
| 2x2 SU-MMO | 15 | NLOS | 1 | 1.92 | NLOS | / | / |
| 2x2 SU-MMO | 30 | NLOS | 1 | 1.28 | NLOS | 1 | 1.21 |
| 1x8 SIMO | 30 | LOS | 1 | 2.40 | LOS | 1 | 2.43 |
| NLOS | 1 | 2.39 | NLOS | 1 | 2.40 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO | 30 | DDDSU | 0.45 | LOS | 1 | 2.39 | LOS | 1 | 2.39 |
| NLOS | 1 | 1.88 | NLOS | 1 | 1.87 |
| 2x2 SU-MIMO | 15 | DDDSU | LOS | / | / | LOS | / | / |
| NLOS | 1 | 1.92 | NLOS | / | / |
| 1x8 SIMO | 30 | DSUUD | LOS | 1 | 2.30 | LOS | 1 | 2.33 |
| NLOS | 1 | 2.28 | NLOS | 1 | 2.29 |

##### 2.1.5.3.2 Evaluation configuration B (CF = 4 GHz)

The evaluation results of mobility for NR FDD and NR TDD for evaluation configuration B for mobility class of 120km/h are provided in Table 2.5.3.2-1.

Table 2.5.3.2-1 NR mobility in Rural – eMBB
(Evaluation configuration B, CF=4 GHz, Mobility class of 120km/h)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO(Scheduler 1) | 30 | 0.8 | LOS | 1 | 1.74 | LOS | 2 | 1.99 |
| NLOS | 1 | 1.30 | NLOS | 2 | 1.6 |
| 1x8 SIMO | 30 | LOS | 1 | 1.87 | LOS | 1 | 1.86 |
| NLOS | 1 | 1.74 | NLOS | 1 | 1.73 |
| 2x8 SU-MIMO | 30 | NLOS | 1 | 2.68 | NLOS | 1 | 2.41 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO | 30 | DDDSU | 0.8 | LOS | 1 | 1.57 | LOS | 1 | 1.52 |
| NLOS | 1 | 1.18 | NLOS | 1 | 1.16 |
| 1x8 SIMO | 30 | DSUUD | LOS | 1 | 1.79 | LOS | 1 | 1.78 |
| NLOS | 1 | 1.66 | NLOS | 1 | 1.65 |

The evaluation results of mobility for NR FDD and NR TDD for evaluation configuration B for mobility class of 500km/h are provided in Table 2.5.3.2-2.

It is observed that NR fulfills the mobility requirement under both 120km/h and 500km/h.

Table 2.5.3.22 NR mobility in Rural – eMBB
(Evaluation configuration B, CF=4 GHz, Mobility class of 500km/h)

 (a) NR FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO | 60 | 0.45 | LOS | 1 | 1.33 | LOS | 1 | 1.33 |
| NLOS | 1 | 0.92 | NLOS | 1 | 0.91 |
| 1x8 SIMO | 30 | LOS | 1 | 1.43 | LOS | 1 | 1.38 |
| NLOS | 1 | 1.11 | NLOS | 1 | 1.08 |
| 2x8 SU-MIMO | 30 | NLOS | 1 | 1.56 | NLOS | 1 | 1.48 |

(b) NR TDD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scheme and antenna configuration** | Sub-carrier spacing (kHz) | Frame structure | ITURequirement (bit/s/Hz) | Channel model A | Channel model B |
| Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) | Channel condition | Number of samples | Normalized traffic channel link data rate (bit/s/Hz) |
| 1x4 SIMO | 60 | DDDSU | 0.45 | LOS | 1 | 1.22 | LOS | 1 | 1.22 |
| NLOS | 1 | 0.84 | NLOS | 1 | 0.83 |
| 1x8 SIMO | 30 | DSUUD | LOS | 1 | 1.37 | LOS | 1 | 1.31 |
| NLOS | 1 | 1.06 | NLOS | 1 | 1.03 |

## 2.2 Evaluation of URLLC technical performance

## 2.2.1 Reliability

As defined in Report ITU-R M.2412, 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.

NR Reliability is evaluated under Urban Macro – URLLC test environment. Both downlink and uplink are evaluated. A variety of configurations are considered. Detailed assumptions and results are provided in chapter 3.

#### 2.2.1.1 DL reliability

For downlink reliability, both evaluation configuration A (carrier frequency = 4 GHz) and evaluation configuration B (carrier frequency = 700 MHz) are evaluated.

The evaluation results of NR FDD for downlink reliability are provided in Table 2.2.1.1-1. All the evaluation results are derived with less than 100 MHz and 40 MHz bandwidth for evaluation configuration A (CF = 4 GHz) and B (CF = 700 MHz), respectively. It is observed that NR FDD fulfils the reliability requirement for downlink in a wide range of configurations.

Table 2.2.1.1-1 Evaluation results of downlink reliability for NR FDD

1. Evaluation configuration A (CF = 4 GHz)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing [kHz] | ITURequirement  | Channel condition | Channel model A | Channel model B |
| Number of samples | Reliability | Number of samples | Reliability |
| 2x2 SU-MIMO 14os1 slot,Slot aggregation, (1 PDCCH + 2 PDSCH) | 60  | 99.999% | NLOS | 1 | 99.999899% | 1 | 99.99991% |
| NOTE1: os = OFDM symbol |

1. Evaluation configuration B (CF = 700 MHz)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing [kHz] | ITURequirement  | Channel condition | Channel model A | **Channel model B** |
| Number of samples | Reliability | Number of samples | **Reliability** |
| 2x2 SU-MIMO 14os slot, One shot (1 PDCCH+1 PDSCH) | 30  | 99.999% | NLOS | 1 | 99.9998% | 2 | 99.9994% |
| 2x2 SU-MIMO 7os non-slot, one-shot (1 PDCCH+1 PDSCH) | 30  | 99.999% | NLOS | 2 | 99.9994% | 2 | 99.9994% |
| 2x2 SU-MIMO,4os non-slot, Slot aggregation (1 PDCCH + 2 PDSCH) | 30  | 99.999% | NLOS | 1 | 99.9995% | 1 | 99.9996% |

#### 2.2.1.2 UL reliability

For uplink reliability, both evaluation configuration A (carrier frequency = 4 GHz) and evaluation configuration B (carrier frequency = 700 MHz) are evaluated.

The evaluation results of NR FDD for uplink reliability are provided in Table 2.2.1.2-1. All the evaluation results are derived with less than 100 MHz and 40 MHz bandwidth for evaluation configuration A (CF = 4 GHz) and B (CF = 700 MHz), respectively.

Table 2.2.1.21 Evaluation results of uplink reliability for NR FDD

(a) Evaluation configuration A (CF = 4 GHz)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing [kHz] | ITURequirement  | Channel model A | Channel model B |
| Channel condition | Number of samples | Reliability | Channel condition | Number of samples | Reliability |
| 1x16 SIMO, OFDMA , 14os slot, Grant free, One shot (1 PUSCH) | 60  | 99.999% | NLOS | 1 | 99.9999% | NLOS | 1 | 99.99999% |
| 1x8 SIMO, OFDMA, 14os slot,Grant free One shot (1 PUSCH) | 30  | 99.999% | NLOS | / | / | NLOS | 1 | 99.9992% |
| 1x8 SIMO, OFDMA, 14os, Grant free, 2 repetitions (2 PUSCH) | 30 | 99.999% | NLOS | 1 | 99.999984% | NLOS | 1 | 99.99999964% |

(b) Evaluation configuration B (CF = 700 MHz)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing [kHz] | ITURequirement  | Channel model A | Channel model B |
| Channel condition | Number of samples | Reliability | Channel condition | Number of samples | Reliability |
| 1x8 SIMO, OFDMA, 14os slot, Grant freeOne shot (1 PUSCH) | 30  | 99.999% | NLOS | 1 | 99.99999% | NLOS | 1 | 99.9999997% |
| 1x8 SIMO, OFDMA, 14os slot, Grant free, One shot (1 PUSCH, 8RB) | 30  | 99.999% | NLOS | 1 | 99.9993% | NLOS | 1 | 99.9993% |
| 1x8 SIMO, OFDMA, 14os slot, Grant free, One shot (1 PUSCH, 12RB) | 30  | 99.999% | NLOS | 1 | 99.9992% | NLOS | 1 | 99.9992% |
| 1x8 SIMO, OFDMA, 7os non-slot, One shot (1 PUSCH, 12RB) | 30  | 99.999% | NLOS | 1 | 99.9993% | NLOS | 1 | 99.9993% |
| 1x8 SIMO, OFDMA, 14os slot, Grant free, One shot (1 PUSCH) | 30  | 99.999% | NLOS | / | / | NLOS | 1 | 99.99967% |
| 1x8 SIMO, OFDMA, 14os slot, Grant free, 2 repetitions (2 PUSCH) | 30  | 99.999% | NLOS | 1 | 99.9999999% | NLOS | / | / |

The evaluation results of NR TDD for uplink reliability are provided in Table 2.1.1.1-2. All the evaluation results are derived with less than 100 MHz and 40 MHz bandwidth for evaluation configuration A (CF = 4 GHz) and B (CF = 700 MHz), respectively.

It is observed that NR fulfils the reliability requirement for uplink in a wide range of configurations.

Table 2.2.1.2-1 Evaluation results of uplink reliability for NR TDD

(a) Evaluation configuration A (CF = 4 GHz)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing [kHz] | Frame structure | ITURequirement  | Channel model A | Channel model B |
| Channel condition | Number of samples | Reliability | Channel condition | Number of samples | Reliability |
| 2x8 SIMO, OFDMA,4os non-slot, Grant free,2 repetitions (2 PUSCH) | 60 | 0.5ms periodicity DL:UL=1:1 | 99.999% | NLOS | 1 | 99.99999% | NLOS | / | / |

Table 2.2.1.2-2 Evaluation results of uplink reliability for NR TDD

(a) Evaluation configuration B (CF = 700 MHz)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing [kHz] | Frame structure | ITURequirement  | Channel model A | Channel model B |
| Channel condition | Number of samples | Reliability | Channel condition | Number of samples | Reliability |
| 2x8 SUMO, OFDMA, 4os non-slot, Grant free, 2 repetitions (2 PUSCH) | 60 | 0.5ms periodicity DL:UL=1:1 | 99.999% | NLOS | 1 | 99.9999958% | NLOS | / | / |

## 2.3 Evaluation of mMTC technical performance

## 2.3.1 Connection density

As specified in Report ITU-R M.2410, connection density is the system capacity metric defined as the total number of devices fulfilling a specific quality of service (QoS) per unit area (per km2) with 99% grade of service (GoS).

In Report ITU-R M.2412, the required QoS is that a 32-byte packet is successfully received within 10 s.

The connection density can be evaluated using one or both of two alternative methods: The Full-buffer system-level simulation followed by link level simulation, and the Non-full-buffer system level simulation. These are defined in section 7.1.3 of Report ITU-R M.2412. The detailed assumptions for these approaches, including system level configurations and traffic model, are defined in Table 5 – d) in Report ITU-R M.2412.

The connection density of NR is evaluated by using the full buffer system level simulation followed by link level simulation (referred to as “full buffer system level simulation” below).

In a first step this evaluation method employs a full buffer system level simulation to derive the uplink SINR distribution for a candidate technology. In a second step link level simulation are performed to determine the uplink spectral efficiency and data rate as functions of SINR. When combined these three functions supports the calculation of the expected long-term time-frequency resources required for each SINR to support the specified traffic model.

Connection density is in a final step conceptually derived by the system bandwidth, declared for the candidate technology, divided by the average required frequency resource. The requirement is fulfilled if the recorded connection density exceeds the 1.000.000 devices/km2, while the time resource, i.e. the packet delay, at the 99th percentile SINR is less than 10 s.

This evaluation method is targeted to evaluate the connection density in terms of the capability of uplink data transmission. The capacity calculation is based on an assumption of ideal resource allocation among the multiple packets and users (e.g., there is no collision on resource allocation). The packet delay calculation does not consider the delays introduced by the connection access procedure.

Under this evaluation method, NR FDD is evaluated. The Urban Macro – mMTC test environment is used for evaluation. Both evaluation configuration A (ISD=500 m) and evaluation configuration B (ISD=1732 m) are considered.

The evaluation results of NR FDD are shown in Table 2.3.1-1 expressed as the average performance presented by the contributing companies. It is observed that NR fulfills connection density requirement under full buffer system level simulation followed by link level simulation. Detailed simulation assumptions and results can be found in chapter 3.

Table 2.3.1-1 Evaluation results of connection density for NR FDD
(Full buffer system level simulation followed by link level simulation
packet arrival rate: 1 packet / 2 hour / device)

(a) Evaluation configuration A (ISD=500 m)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing | ITURequirement (device/km2) | Channel model A | Channel model B |
| Number of samples | Connection density (device/km2) | Required bandwidth (kHz) | Number of samples | Connection density (device/km2) | Required bandwidth (kHz) |
| 1x2 SIMO OFDMA  | 15 kHz | 1,000,000 | 2 | 37581462 | 180 | 2 | 36901760 | 180 |

(b) Evaluation configuration B (ISD=1 732 m)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scheme and antenna configuration | Sub-carrier spacing | ITURequirement (device/km2) | Channel model A | Channel model B |
| Number of samples | Connection density (device/km2) | Required bandwidth (kHz) | Number of samples | Connection density (device/km2) | Required bandwidth (kHz) |
| 1x2 SIMO OFDMA  | 15 kHz | 1,000,000 | 2 | 1281228 | 180 | 2 | 1444728 | 180 |

# 3 Detailed evaluation results

During evaluation phase, all ChEG members participated in evaluation and 8 members provided NR results, i.e. CAICT, CATT, CMCC, China Telecom, Huawei, OPPO, VIVO and ZTE.

Detailed evaluation results can be found in another attachment.