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| **Radiocommunication Study Groups** |  |
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| **14 February 2020** |
| **English only** |
|  | **TECHNOLOGY ASPECTS** |
| Industrial Technology Research Institute, Inc. (ITRI)[[1]](#footnote-1) | |
| Final evaluation Report from Trans-Pacific Evaluation Group  on the IMT-2020 proposal in Documents IMT-2020/3(Rev.4) (“3GPP” under STEP 3 of the IMT-2020 PROCESS) | |
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This document describes the final evaluation results and activities identified for IMT-2020 candidate technology submissions in Documents IMT-2020/3(Rev.4) from Trans-Pacific Evaluation Group (TPCEG)[[2]](#footnote-2).

TPCEG was formed by ITRI Inc., and a registered Independent Evaluation Group (IEG) committing in participating in the process of IMT-2020 evaluation. The proponents of TPCEG coming from trans-pacific area, including Taiwan Association of Information and Communication Standards (TAICS)[[3]](#footnote-3) and other research units.

TPCEG has initiated the evaluation work after the ITU-R event, [Workshop on IMT-2020 terrestrial radio interfaces](https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Pages/ws-20171004.aspx), in October 2017. During the period from October 2017 (the 28th meeting of Working Party 5D) to December 2019 (the 33rd meeting of Working Party 5D), the collaboration between TPCEG proponents has been designated for evaluating the IMT-2020 candidate technology submissions. At the TPCEG meeting in December 2019, evaluation and study results are for the (S)RITs submitted by 3GPP have been reviewed by proponents. With the coordination of ITRI Inc., TPCEG concludes the IMT-2020 evaluation work with this final evaluation report.

The attached evaluation report consists of 3 Parts:

– Part I: Administrative Aspects of Trans-Pacific Evaluation Group.

– Part II: Technical Aspects of the work in Trans-Pacific Evaluation Group.

– Part III: Conclusion.

**Attachment:** 1

Attachment

Part I: Administrative Aspects of Trans-Pacific Evaluation Group

## I-A Name of the Independent Evaluation Group

The Independent Evaluation Group is called *Trans-Pacific Evaluation Group (TPCEG)*.

## I-B Introduction and background of Trans-Pacific Evaluation Group

TPCEG is an international, non-profit, technology-neutral study group formed by ITRI as an independent evaluation group with the aim of analyzing and evaluating IMT-2020 (S)RIT proposals.

The mission is to promote growth of wireless broadband through collecting and disseminating information that increases public awareness of industry’s products and services.

The study group targets on:

– Evaluating candidate IMT-2020 technologies against ITU-R criteria

– Coordinating and sharing information and results with proponents and other evaluation groups

– Examining and verifying simulation results

– Preparing evaluation report for candidate (S)RITs.

In Phase 1 from 2017 to 2018, TPCEG invited the proponents form Trans-Pacific region to join evaluation work on IMT-2020 evaluation. With the contributions form TAICS proponents and the coordination from ITRI, an initial evaluation report and an interim report are submitted to ITU-R at WP5D meetings in 18th September 2018 and 10th December 2019.

In Phase 2 from 2019 to 2020, TPCEG keeps updating research results with more evaluation data and conclude the evaluation work with this final report. This final evaluation report is provided for ITU-R at WP5D#34 meeting in February 2020.

## I-C Method of Work

TPCEG is a study group with contribution-driven working model. All TPCEG official announcement are sent to the proponents through email reflector. Contributions can be submitted through mail, mutual visit, and teleconference, and the evaluation results will be discussed with the coordination of ITRI Inc. All evaluation reports will be provided to ITU-R WP5D after being reviewed and confirmed by TPCEG proponents in official meetings.

Since October 2017, TPCEG sent liaisons to interested parties for calling study results of IMT-2020 evaluation. With the submissions from proponents, TPCEG issued a call for question, comments, calibration and results, and held a meeting on 2nd December 2019. During the meeting, TPCEG proponents reviewed all the submitted evaluation results and drafted an interim evaluation report.

TPCEG representatives also work with other ITU-R Independent Evaluation Groups, and have collaboration meetings since 2017. TPCEG starts to call for participation in ITU-R workshop on IMT-2020 terrestrial radio interfaces, which is held in 4th October, Munich, Germany, and shares its activities and plan with other evaluation groups. TPCEG also invites organizations and academic units in Trans-Pacific region to join our works after the workshop. During the year of 2018, TPCEG have received liaisons from Taiwan Association of Information and Communication Standards (TAICS) with studies and evaluation results for 3GPP (S)RIT proposals. In October 2018, TPCEG also have collaboration with WWRF by sharing evaluation status in WWRF#41 meeting. In 2019, TPCEG exchanges the evaluation activities and plans with 5G-IA, 5GMF, TTA, and WWRF in the 6th Annual 5G Huddle in conjunction with WWRF #42 meeting in Tokyo.

In December 2019, TPCEG receives liaison with evaluation study from TAICS. With the additional evaluation results, TPCEG submits an interim evaluation report to ITU-R WP 5D #33.

TPCEG continues collaborating with other independent evaluation groups and provide this final evaluation report by updating the research and evaluation results in ITU-R WP 5D #34 meeting.

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## I-F Other pertinent administrative information.

The official website of Trans-Pacific Evaluation Group is <http://tpceg.org/>.

The overview of Trans-Pacific Evaluation Group is provided in the presentation of [Workshop on IMT-2020 terrestrial radio interfaces](https://www.itu.int/dms_pub/itu-r/oth/0a/06/R0A060000970001PDFE.pdf).

The information about the 5G simulator can be found at: <https://www.commresearch.com.tw/>, and more details can be found in:



## I-G Structure of this Report

This Report is structured according to the proposed structure[[4]](#footnote-4) and consists of 3 Parts:

– Part I: Administrative Aspects of Trans-Pacific Evaluation Group

– Part II: Technical Aspects of the work in Trans-Pacific Evaluation Group

– Part III: Conclusion

Part II: Technical aspects of the work of the Independent Evaluation Group:

## II-A What candidate technologies or portions of the candidate technologies this IEG is or might anticipate evaluating?

In this report, final results are presented for the 3GPP submissions for IMT-2020, including the LTE and NR component RIT. The evaluation works of analytic, inspection, and simulation are anticipated.

It should be noted that other submissions endorsing 3GPP component RITs, e.g. the submissions of Korea, China, and some parts of TSDSI and ETSI/DECT, have been concluded as technically identical to 3GPP submission. With the observations, this evaluation is also valid for the LTE and NR component RITs in those submission.

Table II-A.1

Summary of evaluation methodologies

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristic for evaluation | High-level assessment method | Evaluation methodology in this Evaluation Report | Related section of Reports ITU-R M.2410-0 and ITU-R M.2411-0 |
| Peak data rate | Analytical | Part II, II-E.1 | Report ITU-R M.2410-0, § 4.1 |
| Peak spectral efficiency | Analytical | Part II, II-E.2 | Report ITU-R M.2410-0, § 4.2 |
| User experienced data rate | Analytical for single band and single layer;  Simulation for multi-layer | Part II, II-E.3 | Report ITU-R M.2410-0, § 4.3 |
| 5th percentile user spectral efficiency | Simulation | Part II, II-E.4 | Report ITU-R M.2410-0, § 4.4 |
| Average spectral efficiency | Simulation | Part II, II-E.5 | Report ITU-R M.2410-0, § 4.5 |
| Area traffic capacity | Analytical | Part II, II-E.6 | Report ITU-R M.2410-0, § 4.6 |
| User plane latency | Analytical | Part II, II-E.7 | Report ITU-R M.2410-0, § 4.7.1 |
| Control plane latency | Analytical | Part II, II-E.8 | Report ITU-R M.2410-0, § 4.7.2 |
| Connection density | Simulation | Part II, II-E.9 | Report ITU-R M.2410-0, § 4.8 |
| Energy efficiency | Inspection | Part II, II-E.10 | Report ITU-R M.2410-0, § 4.9 |
| Reliability | Simulation | Part II, II-E.11 | Report ITU-R M.2410-0, § 4.10 |
| Mobility | Simulation | Part II, II-E.12 | Report ITU-R M.2410-0, § 4.11 |
| Mobility interruption time | Analytical | Part II, II-E.13 | Report ITU-R M.2410-0, § 4.12 |
| Bandwidth | Inspection | Part II, II-E.14 | Report ITU-R M.2410-0, § 4.13 |
| Support of wide range of services | Inspection | Part II, II-E.15 | Report ITU-R M.2411-0, § 3.1 |
| Supported spectrum band(s)/range(s) | Inspection | Part II, II-E.16 | Report ITU-R M.2411-0, § 3.2 |

## II-B Confirmation of utilization of the ITU-R evaluation guidelines in Report ITU‑R M.2412

TPCEG confirms that the evaluation guidelines provided in Report ITU-R M.2412-0 have been utilized.

## II-C Documentation of any additional evaluation methodologies that are or might be developed by the Independent Evaluation Group to complement the evaluation guidelines

The following additional evaluation methodologies have been applied by this Evaluation Group:

– Updating of already available link-level and system-level simulators according to the submitted RITs and SRITs as well as to ITU-R requirements.

– These link-level and system-level simulators have been calibrated with respect to externally available results.

## II-D Verification as per Report ITU-R M.2411 of the compliance templates and the self-evaluation for each candidate technology as indicated in A)

This final evaluation report is summarizing the available evaluation results by end February 2020. These results confirm most of the self-evaluation of the proponent 3GPP. After the evaluation and study, some issues are observed with comments for specific technical performance metrics. The overall assessments are provided in Part II, II-F.

## II-E Assessment as per Reports ITU-R M.2410, ITU-R M.2411 and ITU-R M.2412 for each candidate technology as indicated in A)

This section contains the evaluation results received from TPCEG proponents, which are reviewed and harmonized in TPCEG meetings and used to summarize the evaluation results for quantitative assessment on 3GPP proposals on LTE RIT and NR RIT. All evaluation results were generated by following the IMT‑2020 evaluation methodology. Table II-E.1 shows the different sources of the evaluation results correspond to contributors from the different affiliations.

Table II-E.1

Sources of the evaluation results

|  |  |
| --- | --- |
| Source 1 | ITRI |
| Source 2 | MEDIATEK |
| Source 3 | NCCU |
| Source 4 | NCKU |
| Source 5 | NTUST |

Note that ITRI, NCCU, NCKU, and NTUST adopt “WiSE” system level simulator[[5]](#footnote-5) to conduct the results while MTK use in-house simulator for the evaluation. The more detail information of WiSE simulator is overviewed in Annex A-4, and all the methodologies, assumption, and configurations are summarized in Annex A-1, A-2 and A-3.

In the following sub-sections, details on

– Detailed analysis/assessment and evaluation by the IEGs of the compliance templates submitted by the proponents per the Report ITU-R M.2411 section 5.2.4;

– Provide any additional comments in the templates along with supporting documentation for such comments;

– Analysis of the proponent’s self-evaluation by the IEG;

are provided.

### II-E.1 Peak data rate

#### II-E.1.1 NR peak data rate

Based on the calculation of peak spectral efficiency in **Section II-E.2**, the analysis of peak data rate for NR and LTE cases are shown in this section. In order to meet the peak data rate requirement of IMT-2020, different bandwidth and SCS combinations require different minimum number of CC.

##### II-E.1.1.1 Downlink

The DL peak data rate for NR is shown in Table II-E.1.5

Table II-E.1.5

Peak data rate for NR DL cases

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 to meet the requirement (MHz) | Req. (Gbit/s) |
| FDD | FR1 | 15 | 50 | 2.4016 | 38.4256 | 417 | 20 |
| 30 | 100 | 4.8600 | 77.76 | 412 |
| 60 | 100 | 4.7646 | 76.2336 | 420 |
| TDD  (DDDSU) | FR1 | 15 | 50 | 1.8249 | 29.1984 | 548 |
| 30 | 100 | 3.6936 | 59.0976 | 542 |
| 60 | 100 | 3.6182 | 57.8912 | 553 |
| FR2 | 60 | 200 | 5.453 | 87.248 | 734 |
| 120 | 400 | 10.923 | 174.768 | 733 |

##### II-E.1.1.2 Uplink

The UL peak data rate for NR is shown in Table II-E.1.6.

Table II-E.1.6

Peak data rate for NR UL cases

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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) | Req. (Gbit/s) |
| FDD | FR1 | 15 | 50 | 1.2379 | 19.8064 | 404 | 10 |
| 30 | 100 | 2.5032 | 40.0512 | 400 |
| 60 | 100 | 2.4750 | 39.6 | 405 |
| TDD (DDDSU)\* | FR1 | 15 | 50 | 0.2671 | 4.2736 | 1872 |
| 30 | 100 | 0.54 | 8.64 | 1852 |
| 60 | 100 | 0.534 | 8.544 | 1873 |
| FR2 | 60 | 200 | 1.0059 | 16.095 | 1988 |
| 120 | 400 | 2.0118 | 32.189 | 1988 |

Note: For TDD case, the performance can meet ITU-R requirement with sufficient bandwidth support or adopting full uplink frame structure.

#### II-E.1.2 LTE peak data rate

##### II-E.1.2.1 Downlink

The DL peak data rate for LTE is shown in Table II-E.1.7.

Table II-E.1.7

Peak data rate for LTE DL cases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Duplexing | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 32 CCs (Gbit/s) | Req. (Gbit/s) |
| FDD | 20 | 0.8876 | 28.4 | 20 |
| TDD (DDDSU) | 20 | 0.674 | 21.568 |

##### II-E.1.2.2 Uplink

The UL peak data rate for LTE is shown in Table II-E.1.8.

Table II-E.1.8

Peak data rate for LTE UL cases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Duplexing | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 32 CCs (Gbit/s) | Req. (Gbit/s) |
| FDD | 20 | 0.4246 | 13.5872 | 10 |
| TDD  (DDDSU)\* | 20 | 0.084 | 2.688 |

Note: For TDD case, the performance can meet ITU-R requirement with sufficient bandwidth support or adopting full uplink frame structure.

#### II-E.1.3 Assessment of peak data rate

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement of downlink cases for both FDD and TDD. Besides, uplink cases for both FDD and TDD can also be fulfilled with sufficient bandwidth support or adopting full uplink frame structure.

– 3GPP LTE RIT can fulfill the requirement of downlink cases for both FDD and TDD. Besides, uplink cases for both FDD and TDD can also be fulfilled with sufficient bandwidth support or adopting full uplink frame structure.

### II-E.2 Peak spectral efficiency

#### II-E.2.1 NR peak spectral efficiency

##### II-E.2.1.1 Downlink

The peak spectral efficiency for NR in FR1 and FR2 for FDD and TDD are shown in Table II-E.2.1 and II-E-2.2 respectively. For TDD, the DL/UL configurations of DDDSU are evaluated. From the tables, the spectral efficiency of larger bandwidth is larger than that of small bandwidth since the guard band ratio is more efficient with larger bandwidth. Similar reason can be explained for the more spectral efficiency of smaller SCS. Also, it can be seen that NR fulfils the peak spectral efficiency requirements of 30 bits/s/Hz for DL for both FR1 and FR2 and all supported SCS and BW combinations.

Table II-E.2.1

Peak spectral efficiency for NR FDD DL cases

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz | Req. |
| FR1 | 15 | 40.5744 | 44.3474 | 45.7331 | 46.4259 | 46.8416 | 47.1188 | 47.9143 | 48.0323 | - | - | - | - | 30 |
| 30 | 32.3837 | 39.0766 | 42.6853 | 43.5985 | 44.9333 | 45.2291 | 46.4970 | 46.8985 | 47.7650 | 48.1744 | 48.4107 | 48.5997 | 30 |
| 60 | - | 32.3837 | 38.2234 | 39.2188 | 41.3556 | 42.7801 | 43.6696 | 44.9902 | 45.8753 | 46.9817 | 47.3505 | 47.6455 | 30 |

Table II-E.2.2

Peak spectral efficiency for NR TDD DL cases (DDDSU; =0.7643)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz | Req. |
| FR1 | 15 | 39.9635 | 43.8713 | 45.3399 | 46.0741 | 46.5147 | 46.8084 | 47.6225 | 47.7534 | - | - | - | - | 30 |
| 30 | 31.8528 | 38.5625 | 42.2246 | 43.1709 | 44.5423 | 44.8667 | 46.1663 | 46.5884 | 47.4658 | 47.8921 | 48.1335 | 48.3267 | 30 |
| 60 | - | 31.8528 | 37.7515 | 38.7469 | 40.9073 | 42.3475 | 43.2630 | 44.6160 | 45.5242 | 46.6594 | 47.0378 | 47.3405 | 30 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 50 MHz | 100 MHz | 200 MHz | 400 MHz | Req. |
| FR2 | 60 | 34.1146 | 35.1542 | 35.6740 | - | 30 |
| 120 | 31.8233 | 34.3358 | 35.2648 | 35.7293 | 30 |

##### II-E.2.1.2 Uplink

The UL peak spectral efficiency for NR in FR1 and FR2 for FDD and TDD are shown in Table II-E.2.3 and II-E.2.4 respectively. From the tables, it can be seen that NR fulfils the peak spectral efficiency requirements of 15 bits/s/Hz for UL for both FR1 and FR2 and all supported SCS and BW combinations.

Table II-E.2.3

Peak spectral efficiency for NR FDD UL cases

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz | Req. |
| FR1 | 15 | 22.8587 | 23.8114 | 24.1290 | 24.2878 | 24.383 | 24.4465 | 24.7552 | 24.757 | - | - | - | - | 15 |
| 30 | 20.0360 | 21.941 | 23.1881 | 23.3528 | 23.818 | 23.8232 | 24.2878 | 24.383 | 24.7523 | 24.869 | 24.9600 | 25.0322 | 15 |
| 60 | - | 20.036 | 21.9178 | 21.9415 | 22.689 | 23.1881 | 23.3528 | 23.818 | 24.1290 | 24.517 | 24.6464 | 24.7499 | 15 |

Table II-E.2.4

Peak spectral efficiency for NR TDD UL cases (DDDSU; =0.2357)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 80 MHz | 90 MHz | 100 MHz | Req. |
| FR1 | 15 | 20.8723 | 21.7744 | 22.0751 | 22.2254 | 22.3156 | 22.3758 | 22.6609 | 22.6640 | - | - | - | - | 15 |
| 30 | 18.2283 | 20.0324 | 21.1937 | 21.3544 | 21.7868 | 21.7951 | 22.2254 | 22.3156 | 22.6557 | 22.7659 | 22.8493 | 22.9160 | 15 |
| 60 | - | 18.2283 | 19.9910 | 20.0324 | 20.7292 | 21.1937 | 21.3544 | 21.7868 | 22.0751 | 22.4354 | 22.5555 | 22.6516 | 15 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 50 MHz | 100 MHz | 200 MHz | 400 MHz | Req. |
| FR2 | 60 | 21.3016 | 21.3264 | 21.3389 | - | 15 |
| 120 | 20.6048 | 21.3016 | 21.3264 | 21.3389 | 15 |

#### II-E.2.2 LTE peak spectral efficiency

##### II-E.2.2.1 Downlink

The DL peak spectral efficiency for LTE are provided in Table E-2.5. For LTE TDD, the DL/UL configuration DDDSU is evaluated.

Table II-E.2.5

Peak spectral efficiency for LTE FDD and TDD DL cases

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Duplexing | 15 kHz SCS | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Req. (bit/s/Hz) |
| FDD | FR1 | 256QAM | 43.6960 | 44.1531 | 44.3055 | 44.3817 | 30 |
| TDD (DDDSU) | FR1 | 256QAM | 43.2920 | 43.8475 | 44.0327 | 44.1253 |

##### II-E.2.2.2 Uplink

The UL peak spectral efficiency for LTE are provided in Table 3-9. For LTE TDD, the DL/UL configuration DDDSU is evaluated.

Table II-E.2.6

Peak spectral efficiency for LTE FDD and TDD UL cases

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Duplexing | 15 kHz SCS | | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Req. (bit/s/Hz) |
| FDD | FR1 | 256QAM | 21.1772 | 21.2129 | 21.2248 | 21.2308 | 15 |
| TDD (DDDSU) | FR1 | 256QAM | 17.8426 | 17.9051 | 17.9259 | 17.9364 |

#### II-E.2.3 Assessment of peak spectral efficiency

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement of downlink and uplink for both FDD and TDD cases.

–– 3GPP LTE RIT can fulfill the requirement of downlink and uplink for both FDD and TDD cases.

### II-E.3 User experienced data rate

#### II-E.3.1 Evaluation for NR and LTE RITs

Based on the simulation results of 5th percentile user spectral efficiency in Section II-E.4, the evaluation results of User Experienced Data Rate for LTE and NR in Dense Urban-eMBB test environments are analysed and shown in Table II-E.3.1 to Table II-E.3.4. Note that the values in brackets denote the required bandwidth for achieving the data rate.

Note that more detailed information can be found in Annex A-3.

Table II-E.3.1

Evaluation Result of Dense Urban – eMBB (Configuration A, Downlink)

| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| gNB: 16T = (8,8,2,1,1;1,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 101.35839 (210M) |  |
| gNB: 16T = (8,8,2,1,1;1,8) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 101.557 (200M) |  |
| gNB: 32T = (8,16,2,1,1;1,16) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 104.50132 (220M) |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 101.55904 (440M) |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 103.25952 (210M) |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | FDD | 101.51196 (440M) |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 103.32495 (270M) |  | 101.0672 (260M) |  | 103.691 (200M) | 101.6 (200M) |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | TDD, DDDSU | 100.6927252 (440M) |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-codebook based | 15kHz SCS | TDD, DDDSU |  | 101.0720002 (320M) |  |  | 100.7775 (290M) |  |  |

Table II-E.3.2

Evaluation Result of Dense Urban – eMBB (Configuration A, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 16R = (8,8,2,1,1;1,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 52.30995 (110M) |  |
| gNB: 16R = (8,8,2,1,1;1,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 52.53193 (110M) |  |
| gNB: 32R = (8,16,2,1,1;1,16) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 54.79496 (110M) |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 52.56262 (110M) |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz SCS | FDD | 52.53525 (150M) |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 50.21679 (130M) |  | 50.67132 (140M) |  | 53.73434 (110M) |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz SCS | TDD, DDDSU | 50.6963877 (600M) |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 50.7655049 (530M) |  |  | 50.6044500 (550M) |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO Type I Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  |  |  | 50.112699 (690M) |

Table II-E.3.3

Evaluation Result of Dense Urban – eMBB (Configuration B, Downlink)

| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| gNB: 32T = (8,8,2,1,1;4,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHz SCS | FDD |  |  |  |  | 101.52205 (350M) |  |
| gNB: 8T = (4,8,2,2,2;1,1) UE: 2R=(2,4,2,1,2;1,1) | SU-MIMO  Type I Codebook | 60kHz SCS | FDD |  |  |  |  | 102.16152 (360M) |  |
| gNB: 8T = (4,8,2,2,2; 1,1) UE: 4R = (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHz SCS | TDD DDDSU |  | 100.0176343 (5120M) |  | 100.091209282 (3140M) |  | 100.0219952 (3680M) |

Table II-E.3.4

Evaluation Result of Dense Urban – eMBB (Configuration B, Uplink)

| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| gNB: 32R = (8,8,2,1,1;4,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHz SCS, | FDD |  |  |  |  | 50.53374 (180M) |  |
| gNB: 8R = (4,8,2,2,2;1,1) UE: 2T=(2,4,2,1,2;1,1) | SU-MIMO  Type I Codebook | 60kHz SCS, | FDD |  |  |  |  | 50.69447 (190M) |  |
| gNB: 8R = (4,8,2,2,2; 1,1) UE: 4T = (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHz SCS | TDD DDDSU |  | 50.00826876 (13270M) |  | 50.034859266 (12970M) |  | 50.0233118 (8140M) |

#### II-E.3.2 Assessment of user experienced data rate

With the investigation and research in this section, TPCEG concluded as followed:

• 3GPP NR RIT can fulfill the requirement for all the cases of Dense Urban test environment when sufficient bandwidth is adopted.

• 3GPP NR RIT can fulfill the requirement for the cases with configuration A of Dense Urban test environment when sufficient bandwidth is adopted.

Table II-E.3.5

Assessment of User Experienced Data Rate

| Test Environment | Configuration | | | LTE | | NR | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Dense  Urban | A (4GHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| B (30GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |

### II-E.4 5th percentile user spectral efficiency

#### II-E.4.1 Evaluation for NR and LTE RITs

Based on the configuration and assumption in Annex A-2, the technical performance of 5th User Spectral Efficiency for LTE and NR in Indoor Hotspot-eMBB, Dense Urban-eMBB, and Rural-eMBB test environment are evaluated and shown in Table II-E.4.1 to Table II-E.4.16. In order to investigate and verify the technical performance of LTE and NR RIT, different combinations of 3GPP features, i.e. MIMO schemes, are evaluated.

Note that more detailed information can be found in Annex A-3.

Table II-E.4.1

Evaluation Result of Indoor Hotspot – eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 0.444783 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:2R=(1,1,2,1,1;1,1) | MU-MIMO,  Type II Codebook | 15kHz | FDD |  |  | 0.33 |  |  |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | MU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 0.456399 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | FDD | 0.215441 |  |  |  |  |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 0.314694 |  | 0.339 |  | 0.459902 | 0.311 |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 0.52168 |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | MU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 0.560736 |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | FDD | 0.276194 |  |  |  |  |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 0.383291 |  | 0.3515 |  | 0.507171 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | TDD, DDDSU | 0.199425 |  |  |  |  |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 15kHz | TDD, DDDSU |  | 0.442529 |  |  | 0.311 |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 30kHz | TDD, DDDSU |  |  |  |  | 0.332 |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 15kHz | TDD, DDDSU |  | 0.480373 |  |  | 0.421 |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | TDD, DDDSU | 0.349816 |  |  |  |  |  |  |

Table II-E.4.2

Evaluation Result of Indoor Hotspot – eMBB (Configuration A, Uplink)

| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 TRP | gNB: 32R = (4,4,2,1,1;2,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  | 0.57 |  |  |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 0.445728 |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | FDD | 0.21028 |  |  |  |  |  |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 0.280793 |  | 0.22 |  | 0.454421 | 0.196 |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 0.293354 |  | 0.287 |  | 0.480998 |  |
| 36 TRP | gNB: 32R= (8,16,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 0.482104 |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | FDD | 0.253358 |  |  |  |  |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | TDD, DDDSU |  | 0.329337 |  |  | 0.214 |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | TDD, DDDSU | 0.205454 |  |  |  |  |  |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | TDD, DDDSU |  | 0.28254 |  |  | 0.286 |  |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | TDD, DDDSU | 0.197204 |  |  |  |  |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 30kHz | TDD, DDDSU |  |  |  |  | 0.249 |  |  |

Table II-E.4.3

Evaluation Result of Indoor Hotspot – eMBB (Configuration B, Downlink)

| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.361197 |  |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 4R=(4,4,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.342728 |  |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 8R=(2,4,2,1,2;1,2) | MU-MIMO  Type II Codebook | 60kHZ SCS | FDD |  | 0.408 |  |  |  |
| 12 TRP | gNB: 8T = (16,8,2,1,1;2,2) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.336454 |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.334454 |  |
| 12 TRP | gNB: 8T= (4,8,2,1,1;2,2) UE: 4R=(2,4,2,1,2; 1,1) | SU-MIMO Non-Codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 0.599 |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU | 0.614484 |  | 0.48177 |  |  |
| 12 TRP | gNB: 32T= (8,8,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  | 0.780537 |  |  |
| 36 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU | 0.536184 |  |  |  |  |

Table II-E.4.4

Evaluation Result of Indoor Hotspot – eMBB (Configuration B, Uplink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST- NR |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.278333 |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 4T=(4,4,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.262144 |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 8T=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  | 0.405 |  |  |  |
| 12 TRP | gNB: 8R = (16,8,2,1,1;2,2) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.290464 |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.276339 |  |
| 12 TRP | gNB: 8T= (4,8,2,1,1;2,2) UE: 4R=(2,4,2,1,2; 1,1) | SU-MIMO Non-Codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 0.196 |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 0.364456 |  | 0.299285 |  |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 0.361414 |  | 0.336 |
| 36 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,3) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 0.31743 |  | 0.329224 |  |  |

Table II-E.4.5

Evaluation Result of Indoor Hotspot – eMBB (Configuration C, Downlink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI- NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32T = (8,16,2,1,1;4,4) UE: 4R=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.424814 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | MU-MIMO  Type II Codebook | 60kHZ SCS | FDD |  | 0.471 |  |  |  |
| 12 TRP | gNB: 8T = (8,16,2,1,1;2,2) UE: 2R=(2,4,2,1,1;1,1) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.39972 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 0.844094 |  | 0.599692 |  |  |
| 12 TRP | gNB: 32T= (8,16,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 0.790012 |  |  |
| 12 TRP | gNB: 8T = (4,16,2,1,1;4,4) UE: 4R = (2,4,2,1,2; 1,1) | SU-MIMO Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 0.605 |
| 36 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 0.824964 |  |  |  |  |

Table II-E.4.6

Evaluation Result of Indoor Hotspot – eMBB (Configuration C, Uplink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32R = (8,16,2,1,1;4,4) UE: 4T=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.364089 |  |
| 12 TRP | gNB: 8R = (8,16,2,1,1;2,2) UE: 2T=(2,4,2,1,1;1,1) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 0.372489 |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 0.334526 |  |  |  |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 8T= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 0.397442 |  |  |
| 12 TRP | gNB: 32R= (8,16,2,1,1;4,4) UE: 8T= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 0.47 |  | 0.357 |
| 12 TRP | gNB: 8R = (4,16,2,1,1;4,4) UE: 4T = (2,4,2,1,2; 1,1) | SU-MIMO Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 0.129 |
| 36 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,3) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 0.414448 |  |  |  |  |

Table II-E.4.7

Evaluation Result of Dense Urban – eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 16T = (8,8,2,1,1;1,8) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.482659 |  |
| gNB: 32T = (8,16,2,1,1;1,16) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.507785 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.475006 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.230816 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | FDD | 0.230709 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.491712 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 0.382685 |  | 0.38872 |  | 0.518455 | 0.508 |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R= (1,2,2,1,1; 1,2) | MU-MIMO,  Type II Codebook | 15kHz SCS | FDD |  |  | 0.4 |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | TDD, DDDSU | 0.302268 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-codebook based | 15kHz SCS | TDD, DDDSU |  | 0.417184 |  |  | 0.459 |  |  |

Table II-E.4.8

Evaluation Result of Dense Urban – eMBB (Configuration A, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB : 16R = (8,8,2,1,1;1,8); UE : 2T = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  | 0.49 |  |  | 0.475545 |  |
| gNB: 16R = (8,8,2,1,1;1,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.477563 |  |
| gNB: 32R = (8,16,2,1,1;1,16) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.498136 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.477842 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz SCS | FDD | 0.350235 |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 0.386283 |  | 0.361938 |  | 0.488494 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz SCS | TDD, DDDSU | 0.347855 |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 0.394335 |  |  | 0.37879 |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO Type I Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  |  |  | 0.299 |

Table II-E.4.9

Evaluation Result of Dense Urban – eMBB (Configuration B, Downlink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| gNB: 8T = (4,8,2,2,2; 1,1) UE: 4R = (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHz SCS | TDD DDDSU |  | 0.025802 |  | 0.042103 |  | 0.0359 |

Table II-E.4.10

Evaluation Result of Dense Urban – eMBB (Configuration B, Uplink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| gNB: 8R = (4,8,2,2,2; 1,1) UE: 4T = (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHz SCS | TDD DDDSU |  | 0.0155147 |  | 0.015882 |  | 0.0253 |

Table II-E.4.11

Evaluation Result of Rural– eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | MU-MIMO, Type II Codebook | 15kHz SCS | FDD |  |  | 0.128 |  |  |  |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | MU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.492289 |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | SU-MIMO  Class A Codebook | 15kHz,SCS | FDD | 0.275462 |  |  |  |  |  |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  | 0.170257 |  | 0.495195 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.489989 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.50473 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  | 0.387017 |  |  |  | 0.494 |  |
| gNB: 8T = (16,8,2,1,1;2,2) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.538422 |  |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.524 |  |
| gNB : 16T = (8,4,2,1,1;2,4); UE : 4R = (1,2,2,1,1; 1,2) | SU-MIMO Non-Codebook based | 15kHz SCS | TDD, DDDSU |  | 0.423533 |  |  |  |  |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | SU-MIMO  Non-Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  | 0.165427 |  | 0.4798 |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | SU-MIMO Class A Codebook | 15kHz,SCS | TDD, DDDSU | 0.323954 |  |  |  |  |  |  |

Table II-E.4.12

Evaluation Result of Rural– eMBB (Configuration A, Uplink)

| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| gNB : 8R = (8,4,2,1,1;1,4); UE : 1T = (1,1,1,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  | 0.224 |  |  |  |  |
| gNB : 16R = (8,4,2,1,1;2,4); UE : 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 2Tx Codebook | 15kHz,SCS | FDD | 0.290422 |  |  |  |  |  |  |
| gNB : 8R = (8,4,2,1,1;1,4); UE : 2T = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  | 0.070936 |  | 0.482104 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.465 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.532272 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  | 0.305826 |  |  |  | 0.553 |  |
| gNB: 8R = (16,8,2,1,1;2,2) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.470741 |  |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.482 |  |
| gNB : 16R = (8,4,2,1,1;2,4); UE : 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 0.30115 |  |  |  |  |  |
| gNB : 8R = (8,4,2,1,1;1,4); UE : 2T = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  | 0.071838 |  | 0.070992 |
| gNB : 16R = (8,4,2,1,1;2,4); UE : 4T = (1,2,2,1,1; 1,2) | SU-MIMO LTE 2Tx Codebook | 15kHz,SCS | TDD, DDDSU | 0.305628 |  |  |  |  |  |  |

Table II-E.4.13

Evaluation Result of Rural– eMBB (Configuration B, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB: 32T = (8,16,2,1,1;1,16) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 0.427771 |  | 0.428237 |  | 0.520385 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.532272 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | FDD | 0.292282 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | TDD, DDDSU | 0.3256528 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-Codebook | 15kHz SCS | TDD, DDDSU |  | 0.416091 |  |  | 0.445838 |  | 0.417 |

Table II-E.4.14

Evaluation Result of Rural– eMBB (Configuration B, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB: 32R = (8,16,2,1,1;1,16) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.532948 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.525459 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 0.170809 |  | 0.0977864 |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO LTE 4Tx Codebook | 15kHz SCS | FDD | 0.176055 |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 0.14168 |  |  | 0.113204 |  | 0.153 |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO LTE 4Tx Codebook | 15kHz SCS | TDD, DDDSU | 0.15916 |  |  |  |  |  |  |

Table II-E.4.15

Evaluation Result of Rural– eMBB (Configuration C, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO,  Type II codebook | 15 kHz SCS | FDD |  |  | 0.12 |  |  |  |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.552609 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.462947 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | MU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.49344 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.504123 |  |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.530253 |  |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.47127 |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 0.503518 |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz,SCS | FDD | 0.275619 |  |  |  |  |  |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  | 0.368717 |  | 0.402 |  | 0.502312 |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-Codebook | 15kHz SCS | TDD, DDDSU |  | 0.420298 |  |  | 0.407 |  | 0.261 |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz,SCS | TDD, DDDSU | 0.330157 |  |  |  |  |  |  |

Table II-E.4.16

Evaluation Result of Rural– eMBB (Configuration C, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.461928 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.455903 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.460913 |  |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  | 0.096 |  |  | 0.460407 |  |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 0.4534638 |  |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 0.245949 |  | 0.217 |  | 0.452949 |  |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz,SCS | FDD | 0.231291 |  |  |  |  |  |  |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 0.239443 |  |  | 0.239443 |  | 0.117 |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz,SCS | TDD, DDDSU | 0.252252 |  |  |  |  |  |  |

#### II-E.4.2 Assessment of 5th percentile user spectral efficiency

With the investigation and research in this section, TPCEG concluded as followed:

• 3GPP NR RIT can fulfill the requirement with the configuration cases in all Indoor Hotspot, all Rural, and partial of Dense Urban test environments. For the case of configuration B in Dense Urban test environment, there are performance issues found.

• 3GPP LTE RIT can fulfill the requirement with the configuration cases in all Rural and partial of Dense Urban test environments. For configuration A case in Indoor Hotpot test environment, LTE RIT can still fulfill the requirement with aggressive configurations.

Table II-E.4.17

Assessment of User Experienced Data Rate

| Test Environment | Configuration | | | LTE | | NR | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Indoor Hotspot | A (4GHz) | Downlink | ○ | | ◎ | |
| Uplink | ○ | | ◎ | |
| B (30GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| C (70GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| Dense  Urban | A (4GHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| B (30GHz) | Downlink | － | | ※(1) | |
| Uplink | － | | ※(1) | |
| Rural | A (4GHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| B (30GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| C (700MHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |
| Note 1: Base on the self-Evaluation from 3GPP, NR RIT can still fulfil the requirement if the penetration loss condition changed from “20% high loss, 80% low loss” to “100% low loss.” | | | | | | | |

### II-E.5 Average spectral efficiency

#### II-E.5.1 Evaluation for NR and LTE RITs

Based on the configuration and assumption in Annex A-2, the technical performance of Average Spectral Efficiency for LTE and NR in Indoor Hotspot-eMBB, Dense Urban-eMBB, and Rural-eMBB test environment are shown in Table II-E.5.1 to Table II-E.5.16. In order to investigate and verify the technical performance of LTE and NR RIT, different combinations of 3GPP features, i.e. MIMO schemes, are evaluated.

Note that more detailed information can be found in Annex A-3.

Table II-E.5.1

Evaluation Result of Indoor Hotspot – eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 7.57782 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:2R=(1,1,2,1,1;1,1) | MU-MIMO,  Type II Codebook | 15kHz | FDD |  |  | 11.12 |  |  |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | MU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 10.8501 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | FDD | 7.04908 |  |  |  |  |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 9.8615 |  | 10.34 |  | 8.5887 | 9.23 |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 10.0679 |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | MU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 11.1319 |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | FDD | 8.40566 |  |  |  |  |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 11.3785 |  | 11.344 |  | 11.1647 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | TDD, DDDSU | 7.98542 |  |  |  |  |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 15kHz | TDD, DDDSU |  | 11.3474 |  |  | 11.864 |  |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 30kHz | TDD, DDDSU |  |  |  |  | 10.457 |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 15kHz | TDD, DDDSU |  | 12.6608 |  |  | 13.017 |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | TDD, DDDSU | 9.12108 |  |  |  |  |  |  |

Table II-E.5.2

Evaluation Result of Indoor Hotspot – eMBB (Configuration A, Uplink)

| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 TRP | gNB: 32R = (4,4,2,1,1;2,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  | 8.56 |  |  |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 6.04505 |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | FDD | 6.6569 |  |  |  |  |  |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 7.67609 |  | 8.2 |  | 6.85453 | 7.531 |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 9.27352 |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 9.27042 |  | 9.453 |  | 9.992924 |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | FDD | 7.17706 |  |  |  |  |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | TDD, DDDSU |  | 7.44566 |  |  | 7.405 |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | TDD, DDDSU | 6.5068 |  |  |  |  |  |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE:4T=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 30kHz | TDD, DDDSU |  |  |  |  | 8.686 |  |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | TDD, DDDSU |  | 7.82727 |  |  | 8.827 |  |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE:4T =(1,2,2,1,1;1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz | TDD, DDDSU | 6.1286 |  |  |  |  |  |  |

Table II-E.5.3

Evaluation Result of Indoor Hotspot – eMBB (Configuration B, Downlink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK -NR | NCCU - NR | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 8.56857 |  |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 4R=(4,4,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 8.44971 |  |
| 12 TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 8R=(2,4,2,1,2;1,2) | MU-MIMO  Type II Codebook | 60kHZ SCS | FDD |  | 12.69 |  |  |  |
| 12 TRP | gNB: 8T = (16,8,2,1,1;2,2) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 10.2105 |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 8.880706 |  |
| 12 TRP | gNB: 8T= (4,8,2,1,1;2,2) UE: 4R=(2,4,2,1,2; 1,1) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 11.66 |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU | 13.8769 |  | 13.2547 |  |  |
| 12 TRP | gNB: 32T= (8,8,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  | 16.7091 |  |  |
| 36 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU | 12.4368 |  |  |  |  |

Table II-E.5.4

Evaluation Result of Indoor Hotspot – eMBB (Configuration B, Uplink)

| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK -NR | NCCU - NR | NCKU - NR | NTUST- NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 7.60872 |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 4T=(4,4,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 6.93568 |  |
| 12 TRP | gNB: 32R = (4,4,2,1,1;4,4) UE: 8T=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  | 10.17 |  |  |  |
| 12 TRP | gNB: 8R = (16,8,2,1,1;2,2) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 8.70128 |  |
| 36 TRP | gNB: 32R = (8,16,2,1,1;2,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 8.34509 |  |
| 12 TRP | gNB: 8T= (4,8,2,1,1;2,2) UE: 4R=(2,4,2,1,2; 1,1) | SU-MIMO Non-Codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 5.199 |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 10.4195 |  | 9.9576 |  |  |
| 12TRP | gNB: 32R= (8,8,2,1,1;4,4) UE: 8T= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 9.57989 |  |  |
| 36 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,3) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 9.41587 |  | 9.68419 |  | 8.89 |

Table II-E.5.5

Evaluation Result of Indoor Hotspot – eMBB (Configuration C, Downlink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI- NR | MTK -NR | NCCU - NR | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32T = (8,16,2,1,1;4,4) UE: 4R=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 15.3232 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | MU-MIMO  Type II Codebook | 60kHZ SCS | FDD |  | 12.869 |  |  |  |
| 12 TRP | gNB: 8T = (8,16,2,1,1;2,2) UE: 2R=(2,4,2,1,1;1,1) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 11.7426 |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU | 16.8342 |  | 14.0518 |  |  |
| 12 TRP | gNB: 32T= (8,16,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  | 16.6441 |  |  |
| 12 TRP | gNB: 8T = (4,16,2,1,1;4,4) UE: 4R = (2,4,2,1,2; 1,1) | SU-MIMO Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 11.548 |
| 36 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU | 18.2067 |  |  |  |  |

Table II-E.5.6

Evaluation Result of Indoor Hotspot – eMBB (Configuration C, Uplink)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK -NR | NCCU - NR | NCKU - NR | NTUST - NR |
| 12 TRP | gNB: 32R = (8,16,2,1,1;4,4) UE: 4T=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 12.3614 |  |
| 12 TRP | gNB: 8R = (8,16,2,1,1;2,2) UE: 2T=(2,4,2,1,1;1,1) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  | 11.8636 |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 11.3545 |  |  |  |  |
| 12 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 8T= (2,4,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 10.127 |  |  |
| 12 TRP | gNB: 32R= (8,16,2,1,1;4,4) UE: 8T= (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU |  |  | 11.438 |  | 11.36 |
| 12 TRP | gNB: 8R = (4,16,2,1,1;4,4) UE: 4T = (2,4,2,1,2; 1,1) | SU-MIMO Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  | 4.703 |
| 36 TRP | gNB: 32R= (4,4,2,1,1;4,4) UE: 4T= (2,4,2,1,1; 1,3) | SU-MIMO  Type I Codebook | 60kHZ SCS | TDD, DDDSU | 11.6149 |  |  |  |  |

Table II-E.5.7

Evaluation Result of Dense Urban – eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB: 16T = (8,8,2,1,1;1,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 8.40802 |  |
| gNB: 16T = (8,8,2,1,1;1,8) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 11.326 |  |
| gNB: 32T = (8,16,2,1,1;1,16) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 12.362 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 9.26461 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 13.2295 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | FDD | 8.94097 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 13.6329 |  | 13.9066 |  | 12.6341 | 14.233 |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R= (1,2,2,1,1; 1,2) | MU-MIMO,  Type II Codebook | 15kHz SCS | FDD |  |  | 11.39 |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | TDD, DDDSU | 10.564 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-codebook based | 15kHz SCS | TDD, DDDSU |  | 15.2433 |  |  | 15.767 |  |  |

Table II-E.5.8

Evaluation Result of Dense Urban Rural – eMBB (Configuration A, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB : 16R = (8,8,2,1,1;1,8); UE : 2T = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  | 8.53 |  |  | 6.41486 |  |
| gNB: 16R = (8,8,2,1,1;1,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 7.36996 |  |
| gNB: 32R = (8,16,2,1,1;1,16) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 9.08383 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 7.97483 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz SCS | FDD | 9.53707 |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 11.7209 |  | 11.2581 |  | 9.66735 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz SCS | TDD, DDDSU | 9.76821 |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 10.9789 |  |  | 10.306 |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO Type I Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  |  |  | 8.354 |

Table II-E.5.9

Evaluation Result of Dense Urban – eMBB (Configuration B, Downlink)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK -NR | NCCU - NR | NCKU - NR | NTUST- NR |
| gNB: 32T = (8,8,2,1,1;4,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHz SCS | FDD |  |  |  | 9.19746 |  |
| gNB: 8T = (4,8,2,2,2;1,1) UE: 2R=(2,4,2,1,2;1,1) | SU-MIMO  Type I Codebook | 60kHz SCS | FDD |  |  |  | 8.67726 |  |
| gNB: 8T = (4,8,2,2,2; 1,1) UE: 4R = (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHz SCS | TDD DDDSU | 9.1835 |  | 16.7091 |  | 7.9372 |

Table II-E.5.10

Evaluation Result of Dense Urban – eMBB (Configuration B, Uplink)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | MTK -NR | NCCU - NR | NCKU - NR | NTUST- NR |
| gNB: 32R = (8,8,2,1,1;4,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHz SCS, | FDD |  |  |  | 5.73887 |  |
| gNB: 8R = (4,8,2,2,2;1,1) UE: 2T=(2,4,2,1,2;1,1) | SU-MIMO  Type I Codebook | 60kHz SCS, | FDD |  |  |  | 6.88379 |  |
| gNB: 8R = (4,8,2,2,2; 1,1) UE: 4T = (2,4,2,1,2; 1,2) | SU-MIMO  Type I Codebook | 60kHz SCS | TDD DDDSU | 7.50172 |  | 7.04452 |  | 6.063 |

Table II-E.5.11

Evaluation Result of Rural – eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | MU-MIMO, Type II Codebook | 15kHz SCS | FDD |  |  | 5.64 |  |  |  |  |
| gNB : 16T = (8,4,2,1,1;2,4); UE : 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz,SCS | FDD | 10.4004 |  |  |  |  |  |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | MU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 9.18912 |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  | 9.40108 |  | 8.98573 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 5.19901 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 9.87647 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  | 14.9171 |  |  |  | 9.36 |  |
| gNB: 8T = (16,8,2,1,1;2,2) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 5.02025 |  |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 8.02 |  |
| gNB : 8T = (8,4,2,1,1;1,4); UE : 2R = (1,1,2,1,1; 1,1) | SU-MIMO  Non-Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  | 9.87994 |  | 11.6014 |
| gNB : 16T = (8,4,2,1,1;2,4); UE : 4R = (1,2,2,1,1; 1,2) | SU-MIMO Class A Codebook | 15kHz,SCS | TDD, DDDSU | 11.5833 |  |  |  |  |  |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | TDD, DDDSU |  | 16.2195 |  |  |  |  |  |

Table II-E.5.12

Evaluation Result of Rural – eMBB (Configuration A, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST- NR |
| gNB : 8R = (8,4,2,1,1;1,4); UE : 1T = (1,1,1,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  | 4.5 |  |  |  |  |
| gNB : 16R = (8,4,2,1,1;2,4); UE : 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 2Tx Codebook | 15kHz,SCS | FDD | 9.3021 |  |  |  |  |  |  |
| gNB : 8R = (8,4,2,1,1;1,4); UE : 2T = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  | 9.04172 |  | 8.62443 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 5.67638 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 10.1495 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  | 11.8373 |  |  |  | 10.4 |  |
| gNB: 8R = (16,8,2,1,1;2,2) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 5.5952 |  |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 8.82 |  |
| gNB : 16R = (8,4,2,1,1;2,4); UE : 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 11.8337 |  |  |  |  |  |
| gNB : 8R = (8,4,2,1,1;1,4); UE : 2T = (1,1,2,1,1; 1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  |  |  |  | 8.38696 |  |  |
| gNB : 16R = (8,4,2,1,1;2,4); UE : 4T = (1,2,2,1,1; 1,2) | SU-MIMO LTE 2Tx Codebook | 15kHz,SCS | TDD, DDDSU | 9.80635 |  |  |  |  |  | 7.215 |

Table II-E.5.13

Evaluation Result of Rural – eMBB (Configuration B, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 32T = (8,16,2,1,1;1,16) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 14.6912 |  | 14.987 |  | 13.7512 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 14.2035 |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | FDD | 10.0495 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz SCS | TDD, DDDSU | 10.838 |  |  |  |  |  |  |
| gNB: 32T = (8,8,2,1,1;2,8) UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-Codebook | 15kHz SCS | TDD, DDDSU |  | 15.5592 |  |  | 15.8969 |  | 15.495 |

Table II-E.5.14

Evaluation Result of Rural – eMBB (Configuration B, Uplink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 32R = (8,16,2,1,1;1,16) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 11.2257 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 11.7435 |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 13.2096 |  | 10.4989 |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO LTE 4Tx Codebook | 15kHz SCS | FDD | 10.2188 |  |  |  |  |  |  |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 12.6963 |  |  | 9.91389 |  | 9.721 |
| gNB: 32R = (8,8,2,1,1;2,8) UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO LTE 4Tx Codebook | 15kHz SCS | TDD, DDDSU | 10.4111 |  |  |  |  |  |  |

Table II-E.5.15

Evaluation Result of Rural – eMBB (Configuration C, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO,  Type II codebook | 15 kHz SCS | FDD |  |  | 8.11 |  |  |  |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 5.28185 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 9.73906 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | MU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 14.3168 |  |
| gNB: 16T = (8,4,2,1,1;2,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 14.1458 |  |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 1R=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 5.26592 |  |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 9.24839 |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | MU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  |  |  |  |  | 13.5597 |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz,SCS | FDD | 10.0217 |  |  |  |  |  |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz,SCS | FDD |  | 14.6566 |  | 15.1419 |  | 13.0369 |  |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Non-Codebook | 15kHz SCS | TDD, DDDSU |  | 15.5941 |  |  | 15.9376 |  | 11.493 |
| gNB: 8T = (8,4,2,1,1;1,4); UE: 4R = (1,2,2,1,1; 1,2) | SU-MIMO  Class A Codebook | 15kHz,SCS | TDD, DDDSU | 10.9934 |  |  |  |  |  |  |

Table II-E.5.16

Evaluation Result of Rural – eMBB (Configuration C, Uplink)

| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR | MTK -NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 4.46738 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 6.38119 |  |
| gNB: 16R = (8,4,2,1,1;2,4) UE: 4T=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 7.5349 |  |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 1T=(1,1,1,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  | 4.06 |  |  | 3.88578 |  |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 2T=(1,1,2,1,1;1,1) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  |  |  |  |  | 4.89954 |  |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | FDD |  | 6.4714 |  | 6.45 |  | 5.89071 |  |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz,SCS | FDD | 5.4062 |  |  |  |  |  |  |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  Type I Codebook | 15kHz SCS | TDD, DDDSU |  | 6.10067 |  |  | 6.10067 |  | 5.52 |
| gNB: 8R = (8,4,2,1,1;1,4); UE: 4T = (1,2,2,1,1; 1,2) | SU-MIMO  LTE 4Tx Codebook | 15kHz,SCS | TDD, DDDSU | 5.6875 |  |  |  |  |  |  |

#### II-E.5.2 Assessment of average spectral efficiency

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement with the configuration cases in all Indoor Hotspot, all Dense Urban, and all Rural test environments.

– 3GPP LTE RIT can fulfill the requirement with the configuration cases in partial Dense Urban, and all Rural test environments. For configuration A case in Indoor Hotpot test environment, LTE RIT can still fulfill the requirement with aggressive configurations.

Table II-E.5.17

Assessment of User Experienced Data Rate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Environment | Configuration | | | LTE | | NR | |
| Indoor Hotspot | A (4GHz) | Downlink | ○ | | ◎ | |
| Uplink | ○ | | ◎ | |
| B (30GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| C (70GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| Dense Urban | A (4GHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| B (30GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| Rural | A (4GHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| B (30GHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| C (700MHz) | Downlink | ◎ | | ◎ | |
| Uplink | ◎ | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |

### II-E.6 Area traffic capacity

#### II-E.6.1 Evaluation for NR and LTE RITs

Based on the simulation results of average spectral efficiency in Section II-E.5, the technical performance of Area Traffic Capacity for LTE and NR in Indoor Hotspot-eMBB test environments are analysed and shown in Table II-E.6.1 to Table II-E.6.3. Note that the values in brackets denote the required bandwidth to achieve the capacity.

Note that more detailed information can be found in Annex A-3.

Table II-E.6.1

Evaluation Result of Indoor Hotspot– eMBB (Configuration A, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | | NCKU - NR | NTUST - NR |
| 12TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 10.0027224 (660M) |  |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | MU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 10.199094 (470M) |  |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | FDD | 10.009693 (710M) |  |  |  |  |  |  |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 10.05873 (510M) |  | 10.1332 (490M) |  | 10.134666 (590M) | 10.153 (550M) |
| 36TRP | gNB: 32T = (8,16,2,1,1;2,8) UE: 2R=(1,1,2,1,1;1,1) | SU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 10.269258 (170M) |  |
| 36TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | MU-MIMO, Type I codebook | 15kHz | FDD |  |  |  |  |  | 10.01871 (150M) |  |
| 36TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | FDD | 10.086792 (200M) |  |  |  |  |  |  |
| 36TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO, Type I codebook | 15kHz | FDD |  | 10.24065 (150M) |  | 10.2096 (150M) |  | 10.04823 (150M) |  |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | TDD, DDDSU | 10.035964 (830M) |  |  |  |  |  |  |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 15kHz | TDD, DDDSU |  | 10.137517 (590M) |  |  | 10.0601(560M) |  |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 15kHz | TDD, DDDSU |  | 10.352331 (180M) |  |  | 10.0522 (170M) |  |  |
| 36TRP | gNB: 32T = (8,16,2,1,1;2,8) UE:4R =(1,2,2,1,1;1,2) | SU-MIMO  ClassA Codebook | 15kHz | TDD, DDDSU | 10.358354 (250M) |  |  |  |  |  |  |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE:4R=(1,2,2,1,1;1,2) | SU-MIMO, Non-codebook based | 30kHz | TDD, DDDSU |  |  |  |  | 10.1337(640M) |  |  |

Table II-E.6.2

Evaluation Result of Indoor Hotspot– eMBB (Configuration B, Downlink)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| 12TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  |  | 10.1109126 (590M) |  |
| 12TRP | gNB: 32T = (4,4,2,1,1;4,4) UE: 4R=(4,4,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  |  | 10.139652 (600M) |  |
| 12TRP | gNB: 8T = (16,8,2,1,1;2,2) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  |  | 10.00629 (490M) |  |
| 36 TRP | gNB: 32T = (8,16,2,1,1;2,8) UE: 4R=(1,2,2,1,1;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  |  | 10.12400484 (190M) |  |
| 12 TRP | gNB: 8T= (4,8,2,1,1;2,2) UE: 4R=(2,4,2,1,2; 1,1) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  |  | 10.06367604 (570M) |
| 12TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  | 10.08595295 (480M) |  | 10.03513 (500M) |  |  |
| 12TRP | gNB: 32T= (8,8,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  | 10.120367(400M) |  |  |
| 36TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  | 10.16917338 (180M) |  |  |  |  |

Table II-E.6.3

Evaluation Result of Indoor Hotspot– eMBB (Configuration C, Downlink)

| Antenna  Configuration | TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -LTE | ITRI -NR | MTK-NR | NCCU - NR | NCKU - NR | NTUST - NR |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 TRP | gNB: 32T = (8,16,2,1,1;4,4) UE: 4R=(2,4,2,1,2;1,2) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  |  | 10.113312 (330M) |  |
| 12 TRP | gNB: 8T = (8,16,2,1,1;2,2) UE: 2R=(2,4,2,1,1;1,1) | SU-MIMO  Type I Codebook | 60kHZ SCS | FDD |  |  |  |  | 10.098636 (430M) |  |
| 12 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  | 10.19613826 (400M) |  | 10.0003007 (470M) |  |  |
| 12 TRP | gNB: 32T= (8,16,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  | 10.0809984(400M) |  |  |
| 12 TRP | gNB: 8T = (4,16,2,1,1;4,4) UE: 4R = (2,4,2,1,2; 1,1) | SU-MIMO Non-codebook based | 60kHZ SCS | TDD, DDDSU |  |  |  |  |  | 10.141869328 (580M) |
| 36 TRP | gNB: 32T= (4,4,2,1,1;4,4) UE: 8R= (2,4,2,1,2; 1,2) | SU-MIMO  Non-codebook based | 60kHZ SCS | TDD, DDDSU |  | 10.7517482 (130M) |  |  |  |  |

#### II-E.6.2 Assessment of area traffic capacity

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement for all the downlink cases of Indoor Hotspot test environment when sufficient bandwidth is adopted.

– 3GPP LTE RIT can fulfill the requirement for the downlink case with configuration A of Indoor Hotspot test environment when sufficient bandwidth is adopted.

Table II-E.6.4

Assessment of User Experienced Data Rate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Environment | Configuration | | | LTE | | NR | |
| Indoor Hotspot | A (4GHz) | Downlink | ◎ | | ◎ | |
| B (30GHz) | Downlink | － | | ◎ | |
| C (70GHz) | Downlink | － | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |

### II-E.7 User plane latency

#### II-E.7.1 Definition and Requirement

As defined in Report ITU-R M.2410, user plane latency is the contribution of the radio network to the time from when the source sends a packet to when the destination receives it (in ms).

This requirement is defined for the purpose of evaluation in the eMBB and URLLC usage scenarios.

The minimum requirements for user plane latency are:

– 4 ms for eMBB

– 1 ms for URLLC

assuming unloaded conditions (i.e. a single user) for small IP packets (e.g. 0 byte payload + IP header), for both downlink and uplink.

#### II-E.7.2 Analysis for NR

The evaluation of NR user plane latency is based on the procedure illustrated Figure 5.7.1.1.1-1 in TR 37.910 v2.0.0.

Based on the DL user plane procedure and assumptions given in Table 5.7.1.1.1-1, a variety of configurations and UE capabilities are evaluated for NR. For NR FDD and TDD, DL user plane latency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.7.1.1

DL user plane latency for NR FDD (ms)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DL user plane latency – NR FDD | | | UE capability 1 | | | | | UE capability 2 | | | |
| SCS | | | | | SCS | | | |
| 15 kHz | 30 kHz | 60 kHz | 120 kHz | 15 kHz | | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 1.37 | 0.76 | 0.54 | 0.34 | 1.00 | | 0.55 | 0.36 |
| p=0.1 | 1.58 | 0.87 | 0.64 | 0.40 | 1.12 | | 0.65 | 0.41 |
| M=7 (7OS non-slot) | p=0 | 1.49 | 0.82 | 0.57 | 0.36 | 1.12 | | 0.61 | 0.39 |
| p=0.1 | 1.70 | 0.93 | 0.67 | 0.42 | 1.25 | | 0.71 | 0.44 |
| M=14 (14OS slot) | p=0 | 2.13 | 1.14 | 0.72 | 0.44 | 1.80 | | 0.94 | 0.56 |
| p=0.1 | 2.43 | 1.29 | 0.82 | 0.51 | 2.00 | | 1.04 | 0.63 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 0.98 | 0.56 | 0.44 | 0.29 | 0.49 | | 0.29 | 0.23 |
| p=0.1 | 1.16 | 0.67 | 0.52 | 0.35 | 0.60 | | 0.35 | 0.28 |
| M=4 (4OS non-slot) | p=0 | 1.11 | 0.63 | 0.47 | 0.31 | 0.66 | | 0.37 | 0.27 |
| p=0.1 | 1.30 | 0.74 | 0.56 | 0.36 | 0.78 | | 0.45 | 0.32 |
| M=7 (7OS non-slot) | p=0 | 1.30 | 0.72 | 0.52 | 0.33 | 0.93 | | 0.51 | 0.34 |
| p=0.1 | 1.49 | 0.83 | 0.61 | 0.39 | 1.08 | | 0.59 | 0.40 |

Table II-E.7.1.2

DL user plane latency for NR TDD (ms) (Frame structure: DDDSU)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DL user plane latency – NR TDD (DDDSU) | | | UE capability 1 | | | UE capability 2 | | |
| SCS | | | SCS | | |
| 15 kHz | 30 kHz | 60 kHz | 15 kHz | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 1.57 | 0.86 | 0.58 | 1.18 | 0.65 | 0.40 |
| p=0.1 | 1.95 | 1.05 | 0.70 | 1.56 | 0.84 | 0.50 |
| M=7 (7OS non-slot) | p=0 | 1.69 | 0.92 | 0.61 | 1.30 | 0.71 | 0.43 |
| p=0.1 | 2.07 | 1.11 | 0.73 | 1.67 | 0.90 | 0.53 |
| M=14 (14OS slot) | p=0 | 2.38 | 1.26 | 0.78 | 1.99 | 1.06 | 0.60 |
| p=0.1 | 2,78 | 1.46 | 0.93 | 2.37 | 1.25 | 0.70 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 1.16 | 0.65 | 0.48 | 0.66 | 0.39 | 0.27 |
| p=0.1 | 1.52 | 0.83 | 0.59 | 1.02 | 0.57 | 0.36 |
| M=4 (4OS non-slot) | p=0 | 1.28 | 0.71 | 0.51 | 0.82 | 0.47 | 0.31 |
| p=0.1 | 1.64 | 0.90 | 0.63 | 1.17 | 0.65 | 0.40 |
| M=7 (7OS non-slot) | p=0 | 1.49 | 0.82 | 0.56 | 1.10 | 0.61 | 0.38 |
| p=0.1 | 1.86 | 1.01 | 0.69 | 1.47 | 0.80 | 0.47 |

Table II-E.7.1.3

DL user plane latency for NR TDD (ms) (Frame structure: DSUUD)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DL user plane latency – NR TDD (DSUUD) | | | UE capability 1 | | | | | UE capability 2 | | |
| SCS | | | | | SCS | | |
| 15 kHz | 30 kHz | 60 kHz | 120 kHz | 15 kHz | | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 1.93 | 1.04 | 0.68 | 0.41 | 1.56 | | 0.82 | 0.48 |
| p=0.1 | 2.37 | 1.26 | 0.78 | 0.48 | 1.99 | | 1.04 | 0.59 |
| M=7 (7OS non-slot) | p=0 | 2.05 | 1.1 | 0.71 | 0.43 | 1.69 | | 0.88 | 0.53 |
| p=0.1 | 2.49 | 1.32 | 0.83 | 0.5 | 2.13 | | 1.1 | 0.64 |
| M=14 (14OS slot) | p=0 | 2.74 | 1.44 | 0.88 | 0.51 | 2.39 | | 1.23 | 0.7 |
| p=0.1 | 3.19 | 1.66 | 1 | 0.58 | 2.83 | | 1.45 | 0.81 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 1.47 | 0.81 | 0.56 | 0.35 | 1.01 | | 0.54 | 0.36 |
| p=0.1 | 1.9 | 1.02 | 0.67 | 0.41 | 1.43 | | 0.75 | 0.47 |
| M=4 (4OS non-slot) | p=0 | 1.59 | 0.87 | 0.59 | 0.37 | 1.16 | | 0.62 | 0.4 |
| p=0.1 | 2.01 | 1.08 | 0.7 | 0.43 | 1.58 | | 0.83 | 0.5 |
| M=7 (7OS non-slot) | p=0 | 1.83 | 0.99 | 0.65 | 0.4 | 1.47 | | 0.77 | 0.48 |
| p=0.1 | 2.26 | 1.2 | 0.76 | 0.46 | 1.9 | | 0.99 | 0.58 |

Table II-E.7.1.4

DL user plane latency for NR TDD (ms) (Frame structure: DUDU)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DL user plane latency – NR TDD (DU) | | | UE capability 1 | | | | | UE capability 2 | | |
| SCS | | | | | SCS | | |
| 15 kHz | 30 kHz | 60 kHz | 120 kHz | 15 kHz | | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 1.83 | 1.00 | 0.64 | 0.40 | 1.47 | | 0.77 | 0.48 |
| p=0.1 | 2.04 | 1.11 | 0.73 | 0.48 | 1.66 | | 0.87 | 0.52 |
| M=7 (7OS non-slot) | p=0 | 1.94 | 1.04 | 0.65 | 0.41 | 1.59 | | 0.83 | 0.50 |
| p=0.1 | 2.16 | 1.16 | 0.75 | 0.49 | 1.79 | | 0.93 | 0.55 |
| M=14 (14OS slot) | p=0 | 2.61 | 1.38 | 0.83 | 0.50 | 2.29 | | 1.18 | 0.68 |
| p=0.1 | 2.96 | 1.55 | 0.96 | 0.58 | 2.49 | | 1.29 | 0.78 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 1.27 | 0.71 | 0.51 | 0.33 | 0.76 | | 0.42 | 0.30 |
| p=0.1 | 1.46 | 0.81 | 0.61 | 0.39 | 0.99 | | 0.53 | 0.36 |
| M=4 (4OS non-slot) | p=0 | 1.46 | 0.80 | 0.56 | 0.35 | 0.98 | | 0.54 | 0.36 |
| p=0.1 | 1.65 | 0.91 | 0.66 | 0.41 | 1.22 | | 0.65 | 0.41 |
| M=7 (7OS non-slot) | p=0 | 1.71 | 0.93 | 0.63 | 0.38 | 1.32 | | 0.71 | 0.44 |
| p=0.1 | 1.91 | 1.03 | 0.73 | 0.46 | 1.55 | | 0.81 | 0.50 |

Based on the UL user plane procedure and assumptions given in Table 5.7.1.1.2-1, a variety of configurations and UE capabilities are evaluated for NR. For NR FDD and TDD, UL user plane latency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.7.1.5

UL user plane latency for NR FDD with grant free transmission (ms)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL user plane latency (Grant free) – NR FDD | | | UE capability 1 | | | | UE capability 2 | | | | |
| SCS | | | | SCS | | | | |
| 15 kHz | 30 kHz | 60 kHz | 120 kHz | 15 kHz | 30 kHz | | 60 kHz | |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 1.57 | 0.86 | 0.59 | 0.37 | 1.20 | | 0.65 | | 0.41 |
| p=0.1 | 1.78 | 1.01 | 0.69 | 0.43 | 1.39 | | 0.75 | | 0.47 |
| M=7 (7OS non-slot) | p=0 | 1.68 | 0.91 | 0.61 | 0.38 | 1.30 | | 0.70 | | 0.43 |
| p=0.1 | 1.89 | 1.06 | 0.71 | 0.44 | 1.50 | | 0.80 | | 0.49 |
| M=14 (14OS slot) | p=0 | 2.15 | 1.15 | 0.73 | 0.44 | 1.80 | | 0.94 | | 0.56 |
| p=0.1 | 2.45 | 1.30 | 0.84 | 0.51 | 2.00 | | 1.06 | | 0.63 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 0.96 | 0.55 | 0.44 | 0.28 | 0.52 | | 0.30 | | 0.24 |
| p=0.1 | 1.14 | 0.65 | 0.52 | 0.34 | 0.62 | | 0.36 | | 0.28 |
| M=4 (4OS non-slot) | p=0 | 1.31 | 0.72 | 0.52 | 0.33 | 0.79 | | 0.43 | | 0.30 |
| p=0.1 | 1.50 | 0.84 | 0.61 | 0.39 | 0.96 | | 0.55 | | 0.37 |
| M=7 (7OS non-slot) | p=0 | 1.40 | 0.77 | 0.55 | 0.34 | 1.02 | | 0.55 | | 0.36 |
| p=0.1 | 1.60 | 0.89 | 0.63 | 0.40 | 1.19 | | 0.64 | | 0.42 |
| M=14 (14OS slot) | p=0 | 2.14 | 1.14 | 0.74 | 0.44 | 1.81 | | 0.93 | | 0.56 |
| p=0.1 | 2.44 | 1.30 | 0.84 | 0.51 | 2.01 | | 1.03 | | 0.63 |

Table II-E.7.1.6

UL user plane latency for NR TDD with grant free transmission (ms) (Frame structure: DDDSU)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL user plane latency – NR TDD (DDDSU) | | | UE capability 1 | | | UE capability 2 | | |
| SCS | | | SCS | | |
| 15 kHz | 30 kHz | 60 kHz | 15 kHz | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 3.57 | 1.86 | 1.08 | 3.18 | 1.65 | 0.90 |
| p=0.1 | - | 2.11 | 1.21 | 3.68 | 1.90 | 1.03 |
| M=7 (7OS non-slot) | p=0 | 3.68 | 1.91 | 1.11 | 3.29 | 1.71 | 0.93 |
| p=0.1 | - | 2.16 | 1.23 | 3.79 | 1.96 | 1.05 |
| M=14 (14OS slot) | p=0 | - | 2.16 | 1.23 | 3.79 | 1.96 | 1.05 |
| p=0.1 | - | 2.41 | 1.36 | - | 2.21 | 1.18 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 2.58 | 1.36 | 0.83 | 2.08 | 1.10 | 0.63 |
| p=0.1 | 3.07 | 1.60 | 0.95 | 2.57 | 1.35 | 0.75 |
| M=4 (4OS non-slot) | p=0 | 3.12 | 1.63 | 0.97 | 2.66 | 1.39 | 0.77 |
| p=0.1 | 3.62 | 1.88 | 1.09 | 3.15 | 1.64 | 0.90 |
| M=7 (7OS non-slot) | p=0 | 3.23 | 1.69 | 0.99 | 2.84 | 1.48 | 0.82 |
| p=0.1 | 3.72 | 1.93 | 1.12 | 3.33 | 1.73 | 0.94 |

Table II-E.7.1.7

UL user plane latency for NR TDD with grant free transmission (ms) (Frame structure: DSUUD)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL user plane latency – NR TDD (DSUUD) | | | UE capability 1 | | | | | UE capability 2 | | | |
| SCS | | | | | SCS | | | |
| 15 kHz | 30 kHz | 60 kHz | 120 kHz | 15 kHz | | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 2.74 | 1.39 | 0.85 | 0.5 | 2.38 | | 1.22 | 0.70 |
| p=0.1 | 3.22 | 1.64 | 0.97 | 0.56 | 2.77 | | 1.46 | 0.82 |
| M=7 (7OS non-slot) | p=0 | 2.84 | 1.49 | 0.91 | 0.53 | 2.49 | | 1.28 | 0.73 |
| p=0.1 | 3.34 | 1.74 | 1.03 | 0.59 | 2.97 | | 1.52 | 0.85 |
| M=14 (14OS slot) | p=0 | 3.34 | 1.74 | 1.03 | 0.59 | 2.99 | | 1.53 | 0.85 |
| p=0.1 | 3.84 | 1.99 | 1.15 | 0.67 | 3.47 | | 1.77 | 0.98 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 1.86 | 1 | 0.66 | 0.4 | 1.39 | | 0.73 | 0.46 |
| p=0.1 | 2.31 | 1.23 | 0.78 | 0.46 | 1.85 | | 0.96 | 0.57 |
| M=4 (4OS non-slot) | p=0 | 2.34 | 1.24 | 0.78 | 0.46 | 1.91 | | 0.99 | 0.58 |
| p=0.1 | 2.81 | 1.47 | 0.9 | 0.52 | 2.38 | | 1.22 | 0.7 |
| M=7 (7OS non-slot) | p=0 | 2.44 | 1.29 | 0.81 | 0.47 | 2.09 | | 1.08 | 0.63 |
| p=0.1 | 2.91 | 1.53 | 0.92 | 0.54 | 2.56 | | 1.31 | 0.75 |
| M=14 (14OS slot) | p=0 | 3.34 | 1.74 | 1.03 | 0.59 | 2.99 | | 1.53 | 0.85 |
| p=0.1 | 3.82 | 1.98 | 1.15 | 0.67 | 3.47 | | 1.77 | 0.97 |

Table II-E.7.1.8

UL user plane latency for NR TDD with grant free transmission (ms) (Frame structure: DUDU)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL user plane latency – NR TDD (DU) | | | UE capability 1 | | | | | UE capability 2 | | | |
| SCS | | | | | SCS | | | |
| 15 kHz | 30 kHz | 60 kHz | 120 kHz | 15 kHz | | 30 kHz | 60 kHz |
| **Resource mapping Type A** | M=4 (4OS non-slot) | p=0 | 2.04 | 1.09 | 0.71 | 0.42 | 1.68 | | 0.87 | 0.53 |
| p=0.1 | 2.24 | 1.28 | 0.80 | 0.49 | 1.87 | | 0.97 | 0.57 |
| M=7 (7OS non-slot) | p=0 | 2.14 | 1.14 | 0.73 | 0.42 | 1.79 | | 0.93 | 0.55 |
| p=0.1 | 2.36 | 1.34 | 0.83 | 0.50 | 1.99 | | 1.03 | 0.60 |
| M=14 (14OS slot) | p=0 | 2.64 | 1.39 | 0.86 | 0.50 | 2.29 | | 1.18 | 0.68 |
| p=0.1 | 3.04 | 1.60 | 1.01 | 0.58 | 2.49 | | 1.28 | 0.78 |
| **Resource mapping Type B** | M=2 (2OS non-slot) | p=0 | 1.29 | 0.71 | 0.52 | 0.33 | 0.80 | | 0.44 | 0.31 |
| p=0.1 | 1.47 | 0.82 | 0.62 | 0.39 | 1.00 | | 0.54 | 0.36 |
| M=4 (4OS non-slot) | p=0 | 1.66 | 0.90 | 0.61 | 0.38 | 1.12 | | 0.59 | 0.39 |
| p=0.1 | 1.86 | 1.04 | 0.72 | 0.44 | 1.42 | | 0.75 | 0.47 |
| M=7 (7OS non-slot) | p=0 | 1.77 | 0.96 | 0.64 | 0.39 | 1.39 | | 0.73 | 0.46 |
| p=0.1 | 1.97 | 1.09 | 0.75 | 0.45 | 1.60 | | 0.83 | 0.51 |
| M=14 (14OS slot) | p=0 | 2.64 | 1.39 | 0.86 | 0.50 | 2.29 | | 1.18 | 0.68 |
| p=0.1 | 3.04 | 1.59 | 1.01 | 0.58 | 2.49 | | 1.28 | 0.78 |

#### II-E.7.2 Analysis for LTE

The evaluation of LTE user plane latency is based on the procedure illustrated Figure 5.7.1.2.1-1 in TR 37.910 v2.0.0.

Based on the DL user plane procedure and assumptions given in Table 5.7.1.2.1-1, a variety of configurations and UE capabilities are evaluated for LTE. For LTE FDD and TDD, DL user plane latency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.7.2.1

DL user plane latency for LTE FDD

|  |  |  |
| --- | --- | --- |
| TTI duration | Error probability | DL UP latency (ms) |
| 2OS | p=0 | 0.63 |
| p=0.1 | 0.73 |
| 3OS | p=0 | 0.94 |
| p=0.1 | 1.10 |
| Mixed 2OS/3OS | p=0 | 0.75 |
| p=0.1 | 0.88 |
| 7OS | p=0 | 2.20 |
| p=0.1 | 2.58 |

Table II-E.7.2.2

user plane latency for LTE TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| TTI duration | Criterion | Error probability | DL UP latency (ms) | |
| DSUDD (Cfg.1) | DSUUD (Cfg.2) |
| 7OS | Average case | p=0 | 2.55 | 2.69 |
| p=0.1 | 3.10 | 3.14 |
| Best case | p=0 | 2.00 | 2.00 |
| p=0.1 | 2.40 | 2.40 |

Based on the UL user plane procedure and assumptions given in Table 5.7.1.2.2-1, a variety of configurations and UE capabilities are evaluated for LTE. For LTE FDD and TDD, UL user plane latency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.7.2.3

UL user plane latency for LTE FDD

|  |  |  |
| --- | --- | --- |
| TTI duration | Error probability | UL UP latency (ms) |
| 2OS | p=0 | 0.63 |
| p=0.1 | 0.73 |
| 3OS | p=0 | 0.94 |
| p=0.1 | 1.10 |
| Mixed 2OS/3OS | p=0 | 0.75 |
| p=0.1 | 0.88 |
| 7OS | p=0 | 2.20 |
| p=0.1 | 2.58 |

Table II-E.7.2.4

UL user plane latency for LTE TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| TTI duration | Criterion | Error probability | UL UP latency (ms) | |
| DSUDD (Cfg.1) | DSUUD (Cfg.2) |
| 7OS | Average case | p=0 | - | 3.26 |
| p=0.1 | - | 3.73 |
| Best case | p=0 | 2.00 | 2.00 |
| p=0.1 | 2.45 | 2.40 |

#### II-E.7.4 Assessment of user plan latency

With the analysis in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

– 3GPP LTE RIT can fulfill the requirement.

### II-E.8 Control plane latency

#### II-E.8.1 Definition and Requirement

As defined in Report ITU-R M.2410, control plane latency refers to the transition time from a most “battery efficient” state (e.g. Idle state) to the start of continuous data transfer (e.g. Active state).

Control plane latency refers to the transition time from a most “battery efficient” state (e.g. Idle state) to the start of continuous data transfer (e.g. Active state).

This requirement is defined for the purpose of evaluation in the eMBB and URLLC usage scenarios.

The minimum requirement for control plane latency is 20 ms. Proponents are encouraged to consider lower control plane latency, e.g. 10 ms.

#### II-E.8.2 Analysis for NR

The evaluation of NR control plane latency is based on the procedure illustrated Figure 5.7.2.1-1 in TR 37.910 v2.0.0.

Based on the control plane procedure and assumptions given in Table 5.7.2.1-1, a variety of configurations and UE capabilities are evaluated for NR. For NR FDD and TDD, control plane latency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.8.2.1

Control plane latency for NR FDD (ms)

(a) PRACH length = 2 OFDM symbols

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Resource mapping type | Non-slot duration | UE capability 1 | | | | UE capability 2 | | |
| 15kHz SCS | 30kHz SCS | 60kHz SCS | 120kHz SCS | 15kHz SCS | 30kHz SCS | 60kHz SCS |
| Type A | *M* =4 | 15.4 | 13.1 | 12.3 | 11.7 | 15.0 | 12.8 | 12.1 |
| (4OS non-slot) |
| *M* =7 | 15.6 | 13.4 | 12.4 | 11.7 | 15.2 | 13.2 | 12.2 |
| (7OS non-slot) |
| Type B | *M*=2 | 13.3 | 12.0 | 11.8 | 11.3 | 13.0 | 11.9 | 11.6 |
| (2OS non-slot) |
| *M* =4 | 13.8 | 12.3 | 12.0 | 11.5 | 13.4 | 12.1 | 11.7 |
| (4OS non-slot) |
| *M* =7 | 14.7 | 12.8 | 12.2 | 11.6 | 14.3 | 12.6 | 12.0 |
| (7OS non-slot) |

(b) PRACH length = 6 OFDM symbols

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Resource mapping type | Non-slot duration | UE capability 1 | | | | UE capability 2 | | | |
| 15kHz SCS | 30kHz SCS | 60kHz SCS | 120kHz SCS | 15kHz SCS | 30kHz SCS | 60kHz SCS |
| Type A | *M* =4 (4OS non-slot) | 15.6 | 13.5 | 12.4 | 11.7 | 15.1 | 13.0 | 12.1 |
| *M* =7 (7OS non-slot) | 15.8 | 13.6 | 12.5 | 11.7 | 15.3 | 13.1 | 12.2 |
| Type B | *M*=2 (2OS non-slot) | 13.7 | 12.3 | 11.9 | 11.4 | 13.4 | 12.0 | 11.7 |
| *M* =4 (4OS non-slot) | 14.2 | 12.5 | 12.0 | 11.5 | 13.9 | 12.3 | 11.8 |
| *M* =7 (7OS non-slot) | 15.3 | 13.0 | 12.3 | 11.6 | 14.8 | 12.8 | 12.1 |

(c) PRACH length=1ms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Resource mapping type | Non-slot duration | UE capability 1 | | UE capability 2 | |
| 15kHz SCS | 30kHz SCS | 15kHz SCS | 30kHz SCS |
| Type A | *M* =4 | 16.3 | 13.6 | 16.3 | 13.6 |
| (4OS non-slot) |
| *M* =7 | 16.5 | 14.3 | 16.5 | 14.3 |
| (7OS non-slot) |
| *M* =14  (14OS slot) | 17.0 | 14.5 | 17.0 | 14.5 |
| Type B | *M*=2 | 14.1 | 12.9 | 13.8 | 12.7 |
| (2OS non-slot) |
| *M* =4  (4OS non-slot) | 14.7 | 13.3 | 14.3 | 12.9 |
| *M* =7  (7OS non-slot) | 15.8 | 13.8 | 15.0 | 13.3 |

Table II-E.8.2.2

Control plane latency for NR TDD (ms)

(a) PRACH length = 2 OFDM symbols

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Resource mapping type | Non-slot duration | UE capability 1 | | UE capability 2 | |
| 15kHz SCS | 30kHz SCS | 15kHz SCS | 30kHz SCS |
| Type A | *M* =4 (4OS non-slot) | 17.9 | 14.0 | 17.9 | 14.0 |
| *M* =7 (7OS non-slot) | 18.1 | 14.4 | 18.1 | 14.2 |
| Type B | *M*=2 (2OS non-slot) | 16.8 | 13.4 | 16.8 | 13.4 |
| *M* =4 (4OS non-slot) | 17.2 | 13.6 | 17.2 | 13.6 |
| *M* =7 (7OS non-slot) | 17.6 | 13.8 | 17.6 | 13.8 |

(b) PRACH length=1ms

|  |  |  |  |
| --- | --- | --- | --- |
| Resource mapping type | Non-slot duration | UE capability 1 | UE capability 2 |
| 15kHz SCS | 15kHz SCS |
| Type A | *M* =4 (4OS non-slot) | 18.3 | 18.3 |
| *M* =7 (7OS non-slot) | 18.5 | 18.5 |
| Type B | *M*=2 (2OS non-slot) | 17.1 | 17.1 |
| *M* =4 (4OS non-slot) | 17.6 | 17.6 |
| *M* =7 (7OS non-slot) | 18.0 | 18.0 |

#### II-E.8.3 Analysis for LTE

The evaluation of LTE control plane latency is based on the procedure illustrated Figure 5.7.2.2-1 in TR 37.910 v2.0.0.

Based on the control plane procedure and assumptions given in Table 5.7.2.2-1, a variety of configurations and UE capabilities are evaluated for NR. Besides FDD, control plane latency for LTE TDD with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.8.3.1

Control plane latency of LTE TDD for DL data transfer

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Step | Average CP Latency for DL data transfer [ms] | | | | | | |
| Config 0 | Config 1 | Config 2 | Config 3 | Config 4 | Config 5 | Config 6 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | 3 | 2 | 2 | 2.7 | 2 | 2 | 2.5 |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | 4.8 | 5.4 | 5.8 | 4.8 | 5.7 | 5.9 | 4.5 |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | 3 | 3 | 3 | 3 | 3 | 3 | 3.3 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | 4 | 3 | 3 | 3 | 3 | 3 | 3.8 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total delay [ms] | 18.8 | 17.4 | 17.8 | 17.5 | 17.7 | 17.9 | 18.1 |
| Notes:  1 The description of each component is the same as in Table 5.7.2.2-1. TDD frame structure configuration 0~6 are defined in TS36.211.  2 For step 1, the procedure for transition from a most “battery efficient” state has yet not begun, hence this step is not relevant for the latency of the procedure which is illustrated by a '0' in the above.  3 For step 3, the eNB processing delay is 2ms as in FDD. Additional delay due to waiting for DL subframe is included. The delay value is the average delay taken over the starting subframes when the procedure is initiated under the corresponding TDD configuration.  4 For step 5, the UE processing delay is 4 ms as in FDD, see LS in R2-1806411. Additional delay due to waiting for UL subframe is included. The delay value is the average delay taken over the starting subframes when the procedure is initiated under the corresponding TDD configuration.  5 For step 7, the eNB processing delay (L2 and RRC) has been reduced to 3 ms as in FDD. Additional delay due to waiting for DL subframe is included. The delay value is the average delay taken over the starting subframes when the procedure is initiated under the corresponding TDD configuration.  6 For step 9 for DL data transfer, only the processing delay in the UE (L2 and RRC) is considered as in FDD. Additional delay due to waiting for DL subframe for receiving DL grant is included. The delay value is the average delay taken over the starting subframes when the procedure is initiated under the corresponding TDD configuration.  7 For step 10, the beginning of this subframe is considered to be "*the start of continuous data transfer*", hence this step is not relevant for the latency of the procedure which is illustrated by a '0' in the above. | | | | | | | |

Table II-E.8.3.2

Control plane latency of LTE TDD for UL data transfer

|  |  |  |
| --- | --- | --- |
| Step | Description | CP Latency for UL data transfer [ms] for the following cases |
| Config 0, Starting Subframe = 2,7  Config 1, Starting Subframe = 2,7  Config 3, Starting Subframe = 1, 2  Config 4, Starting Subframe = 2  Config 6, Starting Subframe = 2,7 |
| 1 | Delay due to RACH scheduling period (1TTI) | 0 |
| 2 | Transmission of RACH Preamble | 1 |
| 3 | Preamble detection and processing in eNB | 2 |
| 4 | Transmission of RA response | 1 |
| 5 | UE Processing Delay (decoding of scheduling grant, timing alignment and C-RNTI assignment + L1 encoding of RRC Connection Resume Request) | 4 |
| 6 | Transmission of RRC Connection Resume Request | 1 |
| 7 | Processing delay in eNB (L2 and RRC) | 3 |
| 8 | Transmission of RRC Connection Resume | 1 |
| 9 | Processing delay in UE of RRC Connection Resume including grant reception | 7 |
| 10 | Transmission of RRC Connection Resume Complete and UP data | 0 |
|  | Total delay [ms] | 20 |
| Notes:  1 TDD frame structure configuration 0~6 are defined in TS36.211. The delay value is for the given starting subframes under the corresponding TDD configuration.  2 For step 1, the procedure for transition from a most “battery efficient” state has yet not begun, hence this step is not relevant for the latency of the procedure which is illustrated by a '0' in the above.  3 For step 3, the eNB processing delay is 2ms as in FDD. Additional delay due to waiting for DL subframe is 0 for the given starting subframes under the corresponding TDD configuration.  4 For step 5, the UE processing delay is 4 ms as in FDD, see LS in R2-1806411. Additional delay due to waiting for UL subframe is 0 for the given starting subframes under the corresponding TDD configuration.  5 For step 7, the eNB processing delay (L2 and RRC) has been reduced to 3 ms as in FDD. Additional delay due to waiting for DL subframe is 0 for the given starting subframes under the corresponding TDD configuration.  6 For step 9 for UL data transfer, the processing delay is considered as in FDD. Additional delay due to waiting for DL subframe for receiving UL grant is 0 for the given starting subframes under the corresponding TDD configuration.  7 For step 10, the beginning of this subframe is considered to be "*the start of continuous data transfer*", hence this step is not relevant for the latency of the procedure which is illustrated by a '0' in the above. | | |

#### II-E.8.4 Assessment of control plan latency

With the analysis in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

– 3GPP LTE RIT can fulfill the requirement.

### II-E.9 Connection density

#### II-E.9.1 Evaluation for NR and LTE RITs

The connection density results for NR and LTE are shown in Tables II-E.9.1 and Table II-E.9.2 for two traffic arrival patterns. From the results in the two tables, it can be seen that NR RIT and LTE RIT fulfil the connection density requirements of 1,000,000 devices/km2 with the configuration of 500m ISD and 1732m ISD.

Note that more detailed information can be found in Annex A-3.

Table II-E.9.1

Evaluation Result of Connection Density (Configuration A, 500m ISD, Uplink)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | Traffic | ITRI-LTE (NB IoT) | ITRI-NR |
| gNB: 2R = (8,1,2,1,1; 1,1) UE: 1T=1T, (1,1,1,1,1; 1,1) | 1x8 SU-MIMO Type I codebook | 15kHz, SCS | FDD | 1 message/2 hours/device | 41,144,272 | 40,154,329 |
| gNB: 2R = (8,1,2,1,1; 1,1) UE: 1T=1T, (1,1,1,1,1; 1,1) | 1x8 SU-MIMO Type I codebook | 15kHz SCS | FDD | 1 message/day/device | 493,731,267 | 481,851,947 |

Table II-E.9.2

Evaluation Result of Connection Density (Configuration B, 1732m ISD, Uplink)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | Traffic | ITRI-LTE (NB-IoT) | ITRI-NR |
| gNB: 2R = (8,1,2,1,1; 1,1) UE: 1T=1T, (1,1,1,1,1; 1,1) | 1x8 SU-MIMO Type I codebook | 15kHz, SCS | FDD | 1 message/2 hours/device | 1,404,697 | 1,746,033 |
| gNB: 2R = (8,1,2,1,1; 1,1) UE: 1T=1T, (1,1,1,1,1; 1,1) | 1x8 SU-MIMO Type I codebook | 15kHz SCS | FDD | 1 message/day/device | 16,856,369.00 | 20,952,390 |

#### II-E.9.2 Assessment of connection density

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement in mMTC test environments.

– 3GPP LTE RIT can fulfill the requirement in mMTC test environments.

Table II-E.9.3

Assessment of Connection Density

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Environment | Configuration | | | LTE | | NR | |
| mMTC | A (700 MHz) | 500m ISD | ◎ | | ◎ | |
| B (700 MHz) | 1732 ISD | ◎ | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |

### II-E.10 Energy efficiency

#### II-E.10.1 Definition and Requirement

As defined in Report ITU-R M.2410, network energy efficiency is the capability of a RIT/SRIT to minimize the radio access network energy consumption in relation to the traffic capacity provided. Device energy efficiency is the capability of the RIT/SRIT to minimize the power consumed by the device modem in relation to the traffic characteristics.

The RIT/SRIT shall have the capability to support a high sleep ratio and long sleep duration. Proponents are encouraged to describe other mechanisms of the RIT/SRIT that improve the support of energy efficient operation for both network and device.

The sleep ratio is the fraction of unoccupied time resources (for the network) or sleeping time (for the device) in a period of time corresponding to the cycle of the control signaling (for the network) or the cycle of discontinuous reception (for the device) when no user data transfer takes place. The sleep duration is the continuous period of time with no transmission (for network and device) and reception (for the device).

Energy efficiency of the network and the device can relate to the support for the following two aspects:

a) Efficient data transmission in a loaded case;

b) Low energy consumption when there is no data.

This requirement is defined for the purpose of evaluation in the eMBB usage scenario.

#### II-E.10.2 Analysis for NR

The evaluation of NR energy efficiency is based on the procedure illustrated Section 5.8 in TR 37.910 v2.0.0.

Based on the transmission process and assumptions given in Figure 5.8.1.1-1 and Figure 5.8.2.1.1-1 in TR 37.910 v2.0.0., the performance for a variety of sleep ratio and sleep duration are evaluated for NR. For network and device sides, energy efficiency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.10.2.1

NR network sleep ratio in slot level

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SSB configuration | | SSB set periodicity *P*SSB | | | | | |
| SCS [kHz] | Number of SS/PBCH block per SSB set, *L* | 5ms | 10ms | 20ms | 40ms | 80ms | 160ms |
| 15kHz | 1 | 80.00% | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% |
| 2 | 80.00% | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% |
| 30kHz | 1 | 95.00% | 97.50% | 98.75% | 99.38% | 99.69% | 99.84% |
| 4 | 80.00% | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% |
| 120kHz | 8 | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% | 99.69% |
| 16 | 80.00% | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% |
| 240kHz | 16 | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% | 99.69% |
| 32 | 80.00% | 90.00% | 95.00% | 97.50% | 98.75% | 99.38% |

Table II-E.10.2.2

NR network sleep ratio in symbol level

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SSB configuration | | SSB set periodicity *P*SSB | | | | | |
| SCS [kHz] | Number of SS/PBCH block per SSB set, *L* | 5ms | 10ms | 20ms | 40ms | 80ms | 160ms |
| 15kHz | 1 | 93.57% | 96.43% | 97.86% | 98.93% | 99.46% | 99.73% |
| 2 | 87.14% | 92.86% | 95.71% | 97.86% | 98.93% | 99.46% |
| 30kHz | 1 | 96.79% | 98.21% | 98.93% | 99.46% | 99.73% | 99.87% |
| 4 | 87.14% | 92.86% | 95.71% | 97.86% | 98.93% | 99.46% |
| 120kHz | 8 | 94.29% | 97.14% | 98.57% | 99.29% | 99.64% | 99.82% |
| 16 | 88.57% | 94.29% | 97.14% | 98.57% | 99.29% | 99.64% |
| 240kHz | 16 | 94.29% | 97.14% | 98.57% | 99.29% | 99.64% | 99.82% |
| 32 | 88.57% | 94.29% | 97.14% | 98.57% | 99.29% | 99.64% |

Table II-E.10.2.3

NR network sleep duration (ms) in slot level

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SSB configuration | | SSB set periodicity *P*SSB | | | | | |
| SCS [kHz] | Number of SS/PBCH block per SSB set, *L* | 5ms | 10ms | 20ms | 40ms | 80ms | 160ms |
| 15kHz | 1 | 4.00 | 9.00 | 19.00 | 39.00 | 79.00 | 159.00 |
| 2 | 4.00 | 9.00 | 19.00 | 39.00 | 79.00 | 159.00 |
| 30kHz | 1 | 4.50 | 9.50 | 19.50 | 39.50 | 79.50 | 159.50 |
| 4 | 4.00 | 9.00 | 19.00 | 39.00 | 79.00 | 159.00 |
| 120kHz | 8 | 4.50 | 9.72 | 18.92 | 39.03 | 78.97 | 158.99 |
| 16 | 4.00 | 9.88 | 18.77 | 39.05 | 78.96 | 158.99 |
| 240kHz | 16 | 4.50 | 9.86 | 18.90 | 39.04 | 78.97 | 158.99 |
| 32 | 4.00 | 9.94 | 18.76 | 39.06 | 78.96 | 158.99 |

Table II-E.10.2.4

NR device sleep ratio in slot level (for idle / inactive mode)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Paging cycle *N*PC\_RF \*10 (ms) | SCS(kHz) | SSB L | SSB reception time(ms) | SSB cycle (ms) | Number of SSB burst set | RRM measurement time per DRX (ms) | Transition time(ms) | Sleep ratio |
| RRC-Idle/Inactive | 320 | 240 | 32 | 1 | -- | 1 | 3.5 | 10 | 95.5% |
| 2560 | 15 | 2 | 1 | -- | 1 | 3 | 10 | 99.5% |
| 2560 | 15 | 2 | 1 | 160 | 2 | 3 | 10 | 93.2% |

Table II-E.10.2.5

NR device sleep ratio in slot level (for connected mode)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | DRX cycle *T*SC\_ms \* *M*SC (ms) | Number of SSB burst set | DRX-onDurationTimer(ms) | RRM measurement time per DRX (ms) | Transition time(ms) | Sleep ratio |
| RRC-Connected | 320 | 1 | 2 | 3.5 | 10 | 95.2% |
| 320 | 1 | 10 | 3 | 10 | 92.8% |
| 2560 | 1 | 100 | 3 | 10 | 95.6% |
| 10240 | 1 | 1600 | 3 | 10 | 84.2% |

#### II-E.10.3 Analysis for LTE

The evaluation of LTE energy efficiency is based on the procedure illustrated Section 5.8 in TR 37.910 v2.0.0.

Based on the transmission process and assumptions given in Figure 5.8.1.2-1 in TR 37.910 v2.0.0., the performance for a variety of sleep ratio and sleep duration are evaluated for LTE. For network and device sides, energy efficiency with various configuration are evaluated, and the following results are investigated and endorsed.

Table II-E.10.3.1

LTE network sleep ratio in subframe level

|  |  |
| --- | --- |
| Cell type | Sleep ratio |
| FeMBMS/Unicast-mixed cell | 80% |
| MBMS-dedicated cell | 93.75% |

Table II-E.10.3.2

LTE network sleep duration (ms) in subframe level

|  |  |
| --- | --- |
| Cell type | Sleep duration (ms) |
| FeMBMS/Unicast-mixed cell | 4.00 |
| MBMS-dedicated cell | 39.00 |

Table II-E.10.3.3

LTE device sleep ratio in subframe level (for idle mode)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Paging cycle *N*PC\_RF \*10 (ms) | Synchronization reception time per cycle (ms) | Synchronization cycle (ms) | Number of synchronization | RRM measurement time per DRX (ms) | Transition time (ms) | DL/UL subframe ratio | Sleep ratio |
| RRC-Idle | 320 | 2 | 10\* | 1 | 6 | 10 | 1 | 93.1% |
| 320 | 2 | 10\* | 2 | 6 | 10 | 1 | 90.0% |
| 2560 | 2 | 10\* | 1 | 6 | 10 | 1 | 99.1% |
| 2560 | 2 | 10\* | 2 | 6 | 10 | 1 | 98.8% |

Table II-E.10.3.3

Table 5.8.2.2.1-2 LTE device sleep ratio in subframe level (for connected mode)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | DRX cycle *T*CYCLE\_SF (ms) | Synchronization reception time (ms) | Synchronization cycle(ms) | Number of synchronization | PDCCH reception time (ms) | RRM measurement time per DRX (ms) | DL/UL subframe ratio | Sleep ratio |
| RRC-Connected | 320 | 2 | -- | 1 | 10 | 6 | 1 | 91.9% |
| 320 | 2 | 10 | 2 | 10 | 6 | 0.5 | 85.6% |
| 2560 | 2 | -- | 1 | 100 | 6 | 1 | 95.5% |
| 2560 | 2 | 10 | 2 | 100 | 6 | 0.5 | 91.2% |
| 10240 | 2 | -- | 1 | 1600 | 6 | 1 | 84.2% |

#### II-E.10.4 Assessment of energy efficiency

With the analysis in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

– 3GPP LTE RIT can fulfill the requirement.

### II-E.11 Reliability

#### II-E.11.1 Evaluation for NR and LTE RITs

The reliability results for NR are shown in Tables II-E.11.1 to Table II-E.11.4 for uplink and downlink cases. From the results in the four tables, it can be seen that NR RIT fulfils the reliability requirements by sustaining higher reliability than 1-10-5.

Note that more detailed information can be found in Annex A-3.

Table II-E.11.1

Evaluation Result of Reliability (Configuration A, Downlink)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR |
| gNB: 8T = (8,4,2,1,1;1,4) UE: 4R=(1,2,2,1,1;1,2) | 8x4 SU-MIMO  Type I Codebook | 15kHz, SCS | FDD |  | 99.99929997% |

Table II-E.11.2

Evaluation Result of Reliability (Configuration A, Uplink)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 1T=(1,1,2,1,1;1,1) | 1x8 SU-MIMO  Type I Codebook | 15kHz, SCS | FDD |  | 99.99999% |

Table II-E.11.3

Evaluation Result of Reliability (Configuration B, Downlink)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR |
| gNB: 2Tx (8,1,2,1,1;1,1) UE: 2Rx (1,1,2,1,1;1,1) | 2x2 SU-MIMO Type I codebook | 15kHz, SCS | FDD |  | 99.99929998% |

Table II-E.11.4

Evaluation Result of Reliability (Configuration B, Uplink)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-LTE | ITRI-NR |
| gNB: 8R = (8,1,2,1,1;1,4) UE: 1T=(1,1,1,1,1;1,1) | 1x8 SU-MIMO  Type I codebook | 15 kHz, SCS | FDD |  | 99.99999984% |

#### II-E.11.2 Assessment of reliability

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement in URLLC test environments.

– Further evaluation results are needed to confirm the performance of 3GPP LTE RIT.

Table II-E.11.5

Assessment of Reliability

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Environment | Configuration | | | LTE | | NR | |
| URLLC | A (4 GHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| B (700 MHz) | Downlink | － | | ◎ | |
| Uplink | － | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |

### II-E.12 Mobility

#### II-E.12.1 Evaluation for NR and LTE RITs

Based on the configuration and assumption in Annex A, the evaluation results of Mobility in Indoor Hotspot-eMBB, Dense Urban-eMBB, and Rural-eMBB test environment are shown in II-E-12.1 to II-E.12.4. From the results in the four tables, it can be seen that NR and LTE RITs fulfil the mobility requirements of different spectral efficiency with the configuration of particular speeds.

Note that more detailed information can be found in Annex A-3.

Table II-E.12.1

Evaluation Result of Mobility (Indoor, Configuration A, 4GHz)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | | ITRI- LTE | |
| NLOS | LOS | NLOS | LOS |
| gNB: 8R = (4,4,2,1,1;,1,4) UE: 1T = (1,1,1,1,1;1,1) | 1 X 8 SU-MIMO Type I codebook | 15 kHz | FDD | 1.6505 | 1.5315 | 1.6787 | 1.66204 |

Table II-E.12.2

Evaluation Result of Mobility (Dense Urban, Configuration A, 4GHz)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | | ITRI- LTE | |
| NLOS | LOS | NLOS | LOS |
| gNB: 8R = (8,4,2,1,1;1,4) UE: 1T = (1,1,1,1,1;1,1) | 1 X 8 SU-MIMO Type I codebook | 15 kHz | FDD | 2.069 | 2.00648 | 2.2032 | 2.13055 |

Table II-E.12.3

Evaluation Result of Mobility (Rural, Configuration A, 700MHz)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | | ITRI- LTE | |
| NLOS | LOS | NLOS | LOS |
| gNB: 4R = (8,2,2,1,1;1,2) UE: 1T = (1,1,1,1,1;1,1) | 1 X 4 SU-MIMO Type I codebook | 15 kHz (120 km/h) | FDD | 3.4685 | 3.4685 | 3.8143 | 3.8143 |
| gNB: 4R = (8,2,2,1,1;1,2) UE: 1T = (1,1,1,1,1;1,1) | 1 X 4 SU-MIMO Type I codebook | 30 kHz (500 km/h) | FDD | 3.4676 | 3.4338 | 3.081 | 3.11574 |

Table II-E.12.4

Evaluation Result of Mobility (Rural, Configuration B, 4GHz)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI-NR | | ITRI-LTE | |
| NLOS | LOS | NLOS | LOS |
| gNB: 4R = (8,2,2,1,1;1,2) UE: 1T = (1,1,1,1,1;1,1) | 1 X 4 SU-MIMO Type I codebook | 15 kHz (120 km/h) | FDD | 2.092 | 2.092 | 2.0847 | 2.0847 |
| gNB: 4R = (8,2,2,1,1;1,2) UE: 1T = (1,1,1,1,1;1,1) | 1 X 4 SU-MIMO Type I codebook | 30 kHz (500 km/h) | FDD | 1.045 | 1.045 | 1.0393 | 1.0393 |

#### II-E.12.2 Assessment of mobility

With the investigation and research in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfil the requirements for Indoor Hotspot, Dense Urban, and Rural scenario test environments in eMBB Scenario.

– 3GPP LTE RIT can fulfil the requirements for Indoor Hotspot, Dense Urban, and Rural scenario test environments in eMBB Scenario.

Table II-E.12.5

Assessment of Mobility

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Environment | Configuration | | | LTE | | NR | |
| Indoor Hotspot | A (4GHz) | 10 km/h | ◎ | | ◎ | |
| Dense Urban | A (4GHz) | 30 km/h | ◎ | | ◎ | |
| Rural | A (700 MHz) | 120 km/h | ◎ | | ◎ | |
| 500 km/h | ◎ | | ◎ | |
| B (4GHz) | 120 km/h | ◎ | | ◎ | |
| 500 km/h | ◎ | | ◎ | |
| ◎ : Fulfill　　　○ : Fulfill with aggressive configurations　　　※ : Issue Founded | | | | | | | |

### II-E.13 Mobility interruption time

#### II-E.13.1 Definition and Requirement

As defined in Report ITU-R M.2410, the Mobility interruption time is the shortest time duration supported by the system during which a user terminal cannot exchange user plane packets with any base station during transitions.

The mobility interruption time includes the time required to execute any radio access network procedure, radio resource control signalling protocol, or other message exchanges between the mobile station and the radio access network, as applicable to the candidate RIT/SRIT.

The minimum requirement for mobility interruption time is 0 ms.

This requirement is defined for the purpose of evaluation in the eMBB and URLLC usage scenarios.

#### II-E.13.2 Analysis for NR

The evaluation of NR mobility interruption time is based on the procedure in Section 5.10 in TR 37.910 v2.0.0.

For NR RIT, the mobility interruption time in various scenario are evaluated, and the following results are investigated and endorsed.

For DL data transmission during UE mobility, gNB can configure different beams for this UE at different slots. It ensures appropriate transmit beam allocation to the UE for continuous DL transmission. Therefore, DL data packet transmission is kept during beam pair switching at different slots.

For UL data transmission, PUSCH is sent using the beam configured by SRI (SRS resource indicator) by gNB. Accordingly, an appropriate gNB-side beam is selected for UL data reception. gNB may select different beams at different slots depending on the UE mobility. Therefore, UL data packet transmission is kept during beam pair switching at different slots.

With beam mobility, the UE can always exchange user plane packets with gNB during the mobility transitions. Therefore, 0ms mobility interruption time is achieved by NR for this scenario.

Besides, the UE can always exchange user plane packets with the gNB during transitions during CA mobility procedures when the data transmission between the UE and the PCell is kept. Therefore, 0 ms mobility interruption time is achieved by NR also for this case.

#### II-E.13.3 Analysis for LTE

For LTE RIT, the mobility interruption time in various scenario are evaluated, and the following results are investigated and endorsed.

In Make-Before-Break handover, the connection to the source eNB is not released until DL synchronization is completed at the target eNB. For intra-frequency handover case, a dual RX UE can receive data from the source eNB and tracking RS from the target at the same time, while synchronizing with target eNB. Nevertheless, the UE releases the serving cell before performing the RACH procedure.

Besides, if the source eNB, target eNB and UE are synchronized, the UE may be able to obtain the target eNB timing advance (TA) without explicit TA command, so that a RACH-less handover can be applied: in some scenarios such as no or negligible UE TA difference between the source and target eNB, the UE can use its original TA for the source eNB to transmit the data to the target eNB. In this case, the delay of the RACH procedure can be avoided.

By combining Make-Before-Break and RACH-less handover for a dual RX UE in the scenario where there is no or negligible UE TA difference between the source and the target cell, the 0ms mobility interruption time is achieved by LTE for the PCell mobility scenario.

Furthermore, during the DC mobility procedures, the UE can always exchange user plane packets with MeNB during transitions. Therefore, 0ms mobility interruption time is also achieved by LTE for the DC mobility scenario.

#### II-E.13.4 Assessment of mobility interruption time

With the analysis in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

– 3GPP LTE RIT can fulfill the requirement.

### II-E.14 Bandwidth

#### II-E.14.1 Definition and Requirement

As defined in Report ITU-R M.2410, the minimum requirement on supported bandwidth is the maximum aggregated system bandwidth. The bandwidth may be supported by single or multiple radio frequency (RF) carriers. The bandwidth capability of the RIT/SRIT is defined for the purpose of IMT-2020 evaluation.

The requirement for bandwidth is at least 100 MHz.

The RIT/SRIT shall support bandwidths up to 1 GHz for operation in higher frequency bands (e.g. above 6 GHz).

The RIT/SRIT shall support scalable bandwidth. Scalable bandwidth is the ability of the candidate RIT/SRIT to operate with different bandwidths.

#### II-E.14.2 Inspection for NR

According to Section 5.3.2 of TS 38.104, the maximum bandwidth related to specific sub-carrier spacing (SCS) and frequency range (FR) for a component carrier is provided. Besides, according to Section 6.4 of TS38.331, carrier aggregation of up to sixteen component carriers is supported by NR Rel-15. Accordingly, the NR capability of maximum aggregated system bandwidth is presented in Table 8.1.1-1 TR 37.910. It is observed that the maximum aggregated bandwidth for FR 1 is 800 MHz to 1 600 MHz; while for FR 2, the maximum aggregated bandwidth is 3 200 MHz to 6 400 MHz. Therefore, the bandwidth requirement of at least 100 MHz is met by NR Rel-15 under all frequency ranges for all sub-carrier spacing values.

Table II-E.14.2

NR 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 |

#### II-E.14.3 Inspection for LTE

According to Section 5.6 of TS36.101, the maximum bandwidth of a component carrier is 20 MHz for LTE. Besides, according to Section 6.4 of TS 36.331, carrier aggregation of up to thirty-two component carriers is supported by LTE Rel-15. Accordingly, LTE Rel-15 reaches the capability of maximum aggregated system bandwidth of 640 MHz. Therefore, the bandwidth requirement of at least 100 MHz is met by LTE Rel-15.

Table II-E.14.3

LTE capability on bandwidth

|  |  |  |
| --- | --- | --- |
| Maximum bandwidth for one component carrier (MHz) | Maximum number of component carriers for carrier aggregation | Maximum aggregated bandwidth (MHz) |
| 20 | 32 | 640 |

#### II-E.14.4 Assessment of control plan latency

With the inspection in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

– 3GPP LTE RIT can fulfill the requirement.

### II-E.15 Support of wide range of services

#### II-E.15.1 Inspection for NR and LTE RITs

The ITU-R requirements on “support of wide range of services” are given in M.2410:

– Enhanced Mobile Broadband (eMBB).

– Ultra-reliable and low latency communications (URLLC).

– Massive machine type communications (mMTC).

Diverse services and applications for the three usage scenarios are envisaged, as shown in Fig. 2 in Recommendation ITU-R M.2083.

IMT-2020 RIT/SRIT shall support a wide range of services across different usage scenarios, for which the evaluation methodology is found in § 7.3.3 of Report ITU-R M.2412-0.

These results will be provided in the conclusion for Part III after all other characteristics have been investigated and evaluated.

#### II-E.15.2 Assessment of support of wide range of services

With the inspection in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

- 3GPP LTE RIT can fulfill the requirement.

### II-E.16 Supported spectrum bands

#### II-E.16.1 Definition and Requirement

The ITU-R requirements on “supported spectrum bands are” are given in M.2410:

– 450-470 MHz (see No. **5.286AA** of the Radio Regulations (RR))

– 470-698 MHz (see RR Nos. **5.295**, **5.308**, **5.296A**)

– 694/698-960 MHz (see RR Nos. **5.313A**, **5.317A**)

– 1 427-1 518 MHz (see RR Nos. **5.341A**, **5.346**, **5.341B**, **5.341C**, **5.346A**)

– 1 710-2 025 MHz (see RR Nos. **5.384A**, **5.388**)

– 2 110-2 200 MHz (see RR No. **5.388**)

– 2 300-2 400 MHz (see RR No. **5.384A**)

– 2 500-2 690 MHz (see RR No. **5.384A**)

– 3 300-3 400 MHz (see RR Nos. **5.429B**, **5.429D**, **5.429F**)

– 3 400-3 600 MHz (see RR Nos. **5.430A**, **5.431B**, **5.432A**, **5.432B**, **5.433A**)

– 3 600-3 700 MHz (see RR No. **5.434**)

– 4 800-4 990 MHz (see RR Nos. **5.441A**, **5.441B**).

Frequency arrangements for these bands identified before WRC-15 are incorporated in Recommendation ITU-R M.1036-5. Work on frequency arrangements for the frequency bands that were identified by WRC-15 is currently ongoing in ITU-R.

Recommendation ITU-R M.2083 indicates a need of higher frequency bands to support the different usage scenarios with a requirement of several hundred MHz up to at least 1 GHz bandwidth corresponding wider and contiguous spectrum ability. Further, the development of IMT 2020 is expected to enable new use cases and applications associated with radio traffic growth.

Besides, spectrum requirement as defined in Report ITU-R M.2411 include:

– the capability of being able to utilize at least one frequency band identified for IMT in the ITU Radio Regulations, and

– the capability of being able to utilize the higher frequency range/band(s) above 24.25 GHz (NOTE: In the case of the candidate SRIT, at least one of the component RITs need to fulfil this requirement.)

#### II-E.16.2 Inspection for NR

The following frequency bands are currently specified, in accordance with spectrum requirements defined by Report ITU-R M.2411-0. Introduction of other ITU-R IMT identified bands are not precluded in the future. 3GPP technologies are also defined as appropriate to operate in other frequency arrangements and bands.

Table II-E.16.3.1

Supported spectrum bands for NR

a) 450-6000 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) operating band BS receive / UE transmit  FUL\_low – FUL\_high | Downlink (DL) operating band BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n1 | 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |
| n2 | 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| n5 | 824 MHz – 849 MHz | 869 MHz – 894 MHz | FDD |
| n7 | 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| n12 | 699 MHz – 716 MHz | 729 MHz – 746 MHz | FDD |
| n20 | 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |
| n25 | 1850 MHz – 1915 MHz | 1930 MHz – 1995 MHz | FDD |
| n28 | 703 MHz – 748 MHz | 758 MHz – 803 MHz | FDD |
| n34 | 2010 MHz – 2025 MHz | 2010 MHz – 2025 MHz | TDD |
| n38 | 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |
| n39 | 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |
| n40 | 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |
| n41 | 2496 MHz – 2690 MHz | 2496 MHz – 2690 MHz | TDD |
| n50 | 1432 MHz – 1517 MHz | 1432 MHz – 1517 MHz | TDD |
| n51 | 1427 MHz – 1432 MHz | 1427 MHz – 1432 MHz | TDD |
| n66 | 1710 MHz – 1780 MHz | 2110 MHz – 2200 MHz | FDD |
| n70 | 1695 MHz – 1710 MHz | 1995 MHz – 2020 MHz | FDD |
| n71 | 663 MHz – 698 MHz | 617 MHz – 652 MHz | FDD |
| n74 | 1427 MHz – 1470 MHz | 1475 MHz – 1518 MHz | FDD |
| n75 | N/A | 1432 MHz – 1517 MHz | SDL |
| n76 | N/A | 1427 MHz – 1432 MHz | SDL |
| n77 | 3300 MHz – 4200 MHz | 3300 MHz – 4200 MHz | TDD |
| n78 | 3300 MHz – 3800 MHz | 3300 MHz – 3800 MHz | TDD |
| n79 | 4400 MHz – 5000 MHz | 4400 MHz – 5000 MHz | TDD |
| n80 | 1710 MHz – 1785 MHz | N/A | SUL |
| n81 | 880 MHz – 915 MHz | N/A | SUL |
| n82 | 832 MHz – 862 MHz | N/A | SUL |
| n83 | 703 MHz – 748 MHz | N/A | SUL |
| n84 | 1920 MHz – 1980 MHz | N/A | SUL |
| n86 | 1710 MHz – 1780 MHz | N/A | SUL |

b) 24 250-52 600 MHz

|  |  |  |
| --- | --- | --- |
| NR operating band | Uplink (UL) and Downlink (DL) operating band BS transmit/receive UE transmit/receive  FUL\_low – FUL\_high  FDL\_low – FDL\_high | Duplex Mode |
| n257 | 26500 MHz – 29500 MHz | TDD |
| n258 | 24250 MHz – 27500 MHz | TDD |
| n260 | 37000 MHz – 40000 MHz | TDD |
| n261 | 27500 MHz – 28350 MHz | TDD |

#### II-E.16.3 Inspection for LTE

The following frequency bands are currently specified, in accordance with spectrum requirements defined by Report ITU-R M.2411-0. Introduction of other ITU-R IMT identified bands are not precluded in the future. 3GPP technologies are also defined as appropriate to operate in other frequency arrangements and bands.

Table II-E.16.3.2

Supported spectrum bands for LTE, 450 – 6000 MHz:

| LTE (E‑UTRA) Operating Band | | Uplink (UL) operating band BS receive, UE transmit | | | Downlink (DL) operating band BS transmit, UE receive | | | | Duplex Mode |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | | |
| 1 | | 1920 MHz | – | 1980 MHz | 2110 MHz | – | 2170 MHz | | FDD |
| 2 | | 1850 MHz | – | 1910 MHz | 1930 MHz | – | 1990 MHz | | FDD |
| 3 | | 1710 MHz | – | 1785 MHz | 1805 MHz | – | 1880 MHz | | FDD |
| 4 | | 1710 MHz | – | 1755 MHz | 2110 MHz | – | 2155 MHz | | FDD |
| 5 | | 824 MHz | – | 849 MHz | 869 MHz | – | 894MHz | | FDD |
| 61 | | 830 MHz | – | 840 MHz | 875 MHz | – | 885 MHz | | FDD |
| 7 | | 2500 MHz | – | 2570 MHz | 2620 MHz | – | 2690 MHz | | FDD |
| 8 | | 880 MHz | – | 915 MHz | 925 MHz | – | 960 MHz | | FDD |
| 9 | | 1749.9 MHz | – | 1784.9 MHz | 1844.9 MHz | – | 1879.9 MHz | | FDD |
| 10 | | 1710 MHz | – | 1770 MHz | 2110 MHz | – | 2170 MHz | | FDD |
| 11 | | 1427.9 MHz | – | 1447.9 MHz | 1475.9 MHz | – | 1495.9 MHz | | FDD |
| 12 | | 699 MHz | – | 716 MHz | 729 MHz | – | 746 MHz | | FDD |
| 13 | | 777 MHz | – | 787 MHz | 746 MHz | – | 756 MHz | | FDD |
| 14 | | 788 MHz | – | 798 MHz | 758 MHz | – | 768 MHz | | FDD |
| 17 | | 704 MHz | – | 716 MHz | 734 MHz | – | 746 MHz | | FDD |
| 18 | | 815 MHz | – | 830 MHz | 860 MHz | – | 875 MHz | | FDD |
| 19 | | 830 MHz | – | 845 MHz | 875 MHz | – | 890 MHz | | FDD |
| 20 | | 832 MHz | – | 862 MHz | 791 MHz | – | 821 MHz | | FDD |
| 21 | | 1447.9 MHz | – | 1462.9 MHz | 1495.9 MHz | – | 1510.9 MHz | | FDD |
| 22 | | 3410 MHz | – | 3490 MHz | 3510 MHz | – | 3590 MHz | | FDD |
| 231 | | 2000 MHz | – | 2020 MHz | 2180 MHz | – | 2200 MHz | | FDD |
| 24 | | 1626.5 MHz | – | 1660.5 MHz | 1525 MHz | – | 1559 MHz | | FDD |
| 25 | | 1850 MHz | – | 1915 MHz | 1930 MHz | – | 1995 MHz | | FDD |
| 26 | | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | | FDD |
| 27 | | 807 MHz | – | 824 MHz | 852 MHz | – | 869 MHz | | FDD |
| 28 | | 703 MHz | – | 748 MHz | 758 MHz | – | 803 MHz | | FDD |
| 29 | | N/A | | | 717 MHz | – | 728 MHz | | FDD1 |
| 3015 | | 2305 MHz | – | 2315 MHz | 2350 MHz | – | 2360 MHz | | FDD |
| 31 | | 452.5 MHz | – | 457.5 MHz | 462.5 MHz | – | 467.5 MHz | | FDD |
| 32 | |  | N/A |  | 1452 MHz | – | 1496 MHz | | FDD1 |
| 33 | | 1900 MHz | – | 1920 MHz | 1900 MHz | – | 1920 MHz | | TDD |
| 34 | | 2010 MHz | – | 2025 MHz | 2010 MHz | – | 2025 MHz | | TDD |
| 35 | | 1850 MHz | – | 1910 MHz | 1850 MHz | – | 1910 MHz | | TDD |
| 36 | | 1930 MHz | – | 1990 MHz | 1930 MHz | – | 1990 MHz | | TDD |
| 37 | | 1910 MHz | – | 1930 MHz | 1910 MHz | – | 1930 MHz | | TDD |
| 38 | | 2570 MHz | – | 2620 MHz | 2570 MHz | – | 2620 MHz | | TDD |
| 39 | | 1880 MHz | – | 1920 MHz | 1880 MHz | – | 1920 MHz | | TDD |
| 40 | | 2300 MHz | – | 2400 MHz | 2300 MHz | – | 2400 MHz | | TDD |
| 41 | | 2496 MHz |  | 2690 MHz | 2496 MHz |  | 2690 MHz | | TDD |
| 42 | | 3400 MHz | – | 3600 MHz | 3400 MHz | – | 3600 MHz | | TDD |
| 43 | | 3600 MHz | – | 3800 MHz | 3600 MHz | – | 3800 MHz | | TDD |
| 44 | | 703 MHz | – | 803 MHz | 703 MHz | – | 803 MHz | | TDD |
| 45 | | 1447 MHz | – | 1467 MHz | 1447 MHz | – | 1467 MHz | | TDD |
| 46 | | 5150 MHz | – | 5925 MHz | 5150 MHz | – | 5925 MHz | | TDD1 |
| 47 | | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | | TDD1 |
| 48 | | 3550 MHz | – | 3700 MHz | 3550 MHz | – | 3700 MHz | | TDD |
| 49 | | 3550 MHz | – | 3700 MHz | 3550 MHz | – | 3700 MHz | | TDD1 |
| 50 | | 1432 MHz | – | 1517 MHz | 1432 MHz | - | 1517 MHz | | TDD1 |
| 51 | | 1427 MHz | – | 1432 MHz | 1427 MHz | - | 1432 MHz | | TDD1 |
| 52 | | 3300 MHz | – | 3400 MHz | 3300 MHz | - | 3400 MHz | | TDD |
| 65 | 1920 MHz | | – | 2010 MHz | 2110 MHz | – | | 2200 MHz | FDD |
| 66 | 1710 MHz | | – | 1780 MHz | 2110 MHz | – | | 2200 MHz | FDD1 |
| 67 |  | | N/A |  | 738 MHz | – | | 758 MHz | FDD1 |
| 68 | 698 MHz | | – | 728 MHz | 753 MHz | – | | 783 MHz | FDD |
| 69 | N/A | | | | 2570 MHz | – | | 2620 MHz | FDD1 |
| 70 | 1695 MHz | | – | 1710 MHz | 1995 MHz | – | | 2020 MHz | FDD1 |
| 71 | 663 MHz | | – | 698 MHz | 617 MHz | – | | 652 MHz | FDD |
| 72 | 451 MHz | | – | 456 MHz | 461 MHz | – | | 466 MHz | FDD |
| 73 | 450 MHz | | – | 455 MHz | 460 MHz | – | | 465 MHz | FDD |
| 74 | 1427 MHz | | – | 1470 MHz | 1475 MHz | – | | 1518 MHz | FDD |
| 75 |  | | N/A |  | 1432 MHz | – | | 1517 MHz | FDD1 |
| 76 |  | | N/A |  | 1427 MHz | – | | 1432 MHz | FDD1 |
| 85 | 698 MHz | | – | 716 MHz | 728 MHz | – | | 746 MHz | FDD |
| NOTE 1: See details in Table 8.2.2-1 in TS 36.101. | | | | | | | | | |

#### II-E.16.4 Assessment of supported spectrum bands

With the inspection in this section, TPCEG concluded as followed:

– 3GPP NR RIT can fulfill the requirement.

– 3GPP LTE RIT can fulfill the requirement.

## II-F Questions and feedback to WP 5D and/or the proponents or other IEGs

The minimum requirements of 3GPP NR RIT in the test environment of Dense Urban-eMBB for configuration B (30 GHz) cannot meet the requirement as specified in Report ITU-R M.2410-0. However, 3GPP NR RIT can still fulfil the requirement if the penetration loss condition is changed from “20% high loss, 80% low loss” to “100% low loss,” base on the self-Evaluation from 3GPP.

## II-G In the interim report, kindly provide the proposed next steps towards the final report to be sent to WP 5D for the February 2020 meeting

This report is submitted as complete and final.

Part III: Conclusion

## III-A Completeness of submission

Trans-Pacific Evaluation Group finds that the submission from [3GPP](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0003), [Korea](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0004), and [China](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0005) are ‘complete’ according to ITU-R Acknowledgements to proponents, i.e. [5D/TEMP/792](https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Documents/5D_TD_792e_LS.docx) (3GPP), [5D/TEMP/795](https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Documents/5D_TD_795e_LS.docx) (Korea), and [5D/TEMP/791](https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Documents/5D_TD_791e_LS.docx) (China), under Step 3 of the IMT-2020 process.

## III-B Compliance with requirements

These are the main conclusions on the Trans-Pacific Evaluation Group evaluation of the evaluated proposal. The overall assessments are summarized in Table III-B.1 with referring the related sections for evaluations details.

The other compliance templates for service, spectrum, and technical performance are also elaborated in this section.

### III-B.1 Overall compliance

Table III-B.1

Trans-Pacific Evaluation Group assessment of compliance with requirements

| Characteristic for evaluation | TPCEG assessment  for NR RIT | TPCEG assessment  for LTE RIT | Section |
| --- | --- | --- | --- |
| Peak data rate | Requirements fulfilled[[6]](#footnote-6) | Requirements fulfilled | Part II-E.1 |
| Peak spectral efficiency | Requirements fulfilled | Requirements fulfilled | Part II-E.2 |
| User experienced data rate | Requirements fulfilled | Requirements fulfilled | Part II-E.3 |
| 5th percentile user spectral efficiency | Requirements fulfilled | Requirements fulfilled | Part II-E.4 |
| Average spectral efficiency | Requirements fulfilled | Requirements fulfilled | Part II-E.5 |
| Area traffic capacity | Requirements fulfilled | Requirements fulfilled | Part II-E.6 |
| User plane latency | Requirements fulfilled | Requirements fulfilled | Part II-E.7 |
| Control plane latency | Requirements fulfilled | Requirements fulfilled | Part II-E.8 |
| Connection density | Requirements fulfilled | Requirements fulfilled | Part II-E.9 |
| Energy efficiency | Requirements fulfilled | Requirements fulfilled | Part II-E.10 |
| Reliability | Requirements fulfilled | Not applicable[[7]](#footnote-7) | Part II-E.11 |
| Mobility | Requirements fulfilled | Requirements fulfilled | Part II-E.12 |
| Mobility interruption time | Requirements fulfilled | Requirements fulfilled | Part II-E.13 |
| Bandwidth | Requirements fulfilled | Requirements fulfilled | Part II-E.14 |
| Support of wide range of services | Requirements fulfilled | Requirements fulfilled | Part II-E.15 |
| Supported spectrum band(s)/range(s) | Requirements fulfilled | Requirements fulfilled | Part II-E.16 |

### III-B.2 Detailed compliance templates

#### III-B.2.1 Compliance template for services[[8]](#footnote-8)

Provision of compliance template for services (Section 5.2.4.1 of Report ITU-R M.2411)

|  |  |  |
| --- | --- | --- |
|  | Service capability requirements | Evaluator’s comments |
| **5.2.4.1.1** | **Support for wide range of services**  Is the proposal able to support a range of services across different usage scenarios (eMBB, URLLC, and mMTC)?: 🗹YES / NO  Specify which usage scenarios (eMBB, URLLC, and mMTC) the candidate RIT or candidate SRIT can support.(1) | Both LTE RIT and NR RIT can support the usage scenario of eMBB, mMTC, and URLLC with the evaluation results in this evaluation report. |
| (1) Refer to the process requirements in IMT-2020/2. | | |

#### III-B.2.2 Compliance template for spectrum

|  |  |  |
| --- | --- | --- |
|  | Spectrum capability requirements | Evaluator’s comments |
| **5.2.4.2.1** | **Frequency bands identified for IMT**  Is the proposal able to utilize at least one frequency band identified for IMT in the ITU Radio Regulations?: 🗹 YES / NO  Specify in which band(s) the candidate RIT or candidate SRIT can be deployed. | Both LTE RIT and NR RIT can support the frequency bands identified for IMT with the evaluation results in this evaluation report. |
| **5.2.4.2.2** | **Higher Frequency range/band(s)**  Is the proposal able to utilize the higher frequency range/band(s) above 24.25 GHz?:  🗹 YES / NO  Specify in which band(s) the candidate RIT or candidate SRIT can be deployed.  Details are provided in Section II-E.16. | Both LTE RIT and NR RIT can support the higher frequency range/band(s) with the evaluation results in this evaluation report. |

#### III-B.2.3 Compliance template for technical performance

##### III-B.2.3.1 NR RIT Results

| Minimum technical performance requirements item (5.2.4.3.x), units, and Report ITU-R M.2410-0 section reference(1) | Category | | | Required value | Value(2) | Requirement met? | Comments (3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Usage scenario | Test environment | Downlink or uplink |  |  |  |  |
| **5.2.4.3.1** Peak data rate (Gbit/s) *(4.1)* | eMBB | - | Downlink | 20 | 38.42~  174.76 | 🗹 Yes  No | c.f.  II-E.1 |
| Uplink | 10 | 4.27~  40.5 | 🗹 Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | - | Downlink | 30 | 31.8~ 48.6 | 🗹 Yes  No | c.f.  II-E.2 |
| Uplink | 15 | 20~ 25.3 | 🗹 Yes  No |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 | >100**(5)** | 🗹 Yes  No | c.f.  II-E.3  Not fulfilled in config-B, c.f. explanation |
| Uplink | 50 | >50**(5)** | 🗹 Yes  No |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.31~ 0.84 | 🗹 Yes  No | c.f.  II-E.4 |
| Uplink | 0.21 | 0.19~  0.48 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.02~  0.51 | 🗹 Yes  No | c.f.  II-E.4  Not fulfilled in config-B, c.f. explanation |
| Uplink | 0.15 | 0.015~ 0.49 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 | 0.12~ 0.53 | 🗹 Yes  No | c.f.  II-E.4 |
| Uplink | 0.045 | 0.07~ 0.55 | 🗹 Yes  No |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 7.5~ 18.2 | 🗹 Yes  No | c.f.  II-E.5 |
| Uplink | 6.75 | 5.19~ 12.3 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 8.4~ 16.7 | 🗹 Yes  No | c.f.  E-II.5  Not fulfilled in Config-B, c.f. explanation |
| Uplink | 5.4 | 5.7~  11.7 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 | 5~ 16.2 | 🗹 Yes  No | c.f.  E-II.5 |
| Uplink | 1.6 | 4~ 13.2 | 🗹 Yes  No | c.f.  E-II.5 |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 | >10(5) | 🗹 Yes  No | c.f.  E-II.6 |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | - | Uplink and Downlink | 4 | <4 | 🗹 Yes  No | c.f.  E-II.7 |
| URLLC | - | Uplink and Downlink | 1 | <1 | 🗹 Yes  No | c.f.  E-II.7 |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | - | - | 20 | <20 | 🗹 Yes  No | c.f.  E-II.8 |
| URLLC | - | - | 20 | <20 | 🗹 Yes  No | c.f.  E-II.8 |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | >1 000 000 | 🗹 Yes  No | c.f.  E-II.9 |
| **5.2.4.3.10** Energy efficiency *(4.9)* | eMBB | - | - | Capability to support a high sleep ratio and long sleep duration | Support | 🗹 Yes  No | c.f.  E-II.10 |
| **5.2.4.3.11** Reliability *(4.10)* | URLLC | Urban Macro –URLLC | Uplink or 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 edge | > 1-10−5 | 🗹 Yes  No | c.f.  E-II.11 |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian | Support | 🗹 Yes  No | c.f.  E-II.12 |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | Support | 🗹 Yes  No | c.f.  E-II.12 |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular | Support | 🗹 Yes  No | c.f.  E-II.12 |
| **5.2.4.3.13**  Mobility Traffic channel link data rates (bit/s/Hz) *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | 1.5 (10 km/h) | 1.5315 ~1.6505 | 🗹 Yes  No | c.f.  E-II.13 |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | 2.0048~ 2.069 | 🗹 Yes  No | c.f.  E-II.13 |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | 2.092~ 3.4685 | 🗹 Yes  No | c.f.  E-II.13 |
| 0.45 (500 km/h) | 1.045~ 3.4676 | 🗹 Yes  No | c.f.  E-II.13 |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | - | - | 0 | 0 | 🗹 Yes  No | c.f.  E-II.14 |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | - | - | - | At least 100 MHz | Support | 🗹 Yes  No | c.f.  II-E.16 |
| Up to 1 GHz | Support | 🗹 Yes  No | c.f.  II-E.16 |
| Support of multiple different bandwidth values(4) | Support | 🗹 Yes  No | c.f.  II-E.16 |
| (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.  (5) With sufficient bandwidth | | | | | | | |

##### III-B.2.3.1 LTE RIT Results

| Minimum technical performance requirements item (5.2.4.3.x), units, and Report ITU-R M.2410-0 section reference(1) | Category | | | Required value | Value(2) | Requirement met? | Comments (3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Usage scenario | Test environment | Downlink or uplink |  |  |  |  |
| **5.2.4.3.1** Peak data rate (Gbit/s) *(4.1)* | eMBB | - | Downlink | 20 | 21.56~ 28.4 | 🗹 Yes  No | c.f.  II-E.1 |
| Uplink | 10 | 2.688~ 13.5872 | 🗹 Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | - | Downlink | 30 | 43.292~ 44.38 | 🗹 Yes  No | c.f.  II-E.2 |
| Uplink | 15 | 17.842~ 21.23 | 🗹 Yes  No |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 | >100**(5)** | 🗹 Yes  No | c.f.  II-E.3  Not fulfilled in config-B, c.f. explanation |
| Uplink | 50 | >50**(5)** | 🗹 Yes  No |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.19~ 0.34 | 🗹 Yes  No | c.f.  II-E.4 |
| Uplink | 0.21 | 0.19~ 0.25 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.23~ 0.3 | 🗹 Yes  No | c.f.  II-E.4  Not fulfilled in config-B, c.f. explanation |
| Uplink | 0.15 | 0.36~ 0.49 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 | 0.27~ 0.32 | 🗹 Yes  No | c.f.  II-E.4 |
| Uplink | 0.045 | 0.15~ 0.3 | 🗹 Yes  No |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 7~ 9.12 | 🗹 Yes  No | c.f.  II-E.5 |
| Uplink | 6.75 | 6.12~ 7.17 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 7.9~ 16.7 | 🗹 Yes  No | c.f.  E-II.5  Not fulfilled in Config-B, c.f. explanation |
| Uplink | 5.4 | 5.7~ 11.72 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 | 10~ 11.5 | 🗹 Yes  No | c.f.  E-II.5 |
| Uplink | 1.6 | 5.4~ 10.4 | 🗹 Yes  No | c.f.  E-II.5 |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 | >10(5) | 🗹 Yes  No | c.f.  E-II.6 |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | - | Uplink and Downlink | 4 | <4 | Yes  No | c.f.  E-II.7 |
| URLLC | - | Uplink and Downlink | 1 | <1 | Yes  No | c.f.  E-II.7 |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | - | - | 20 | <20 | 🗹 Yes  No | c.f.  E-II.8 |
| URLLC | - | - | 20 | <20 | 🗹 Yes  No | c.f.  E-II.8 |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | >1 000 000 | 🗹 Yes  No | c.f.  E-II.9 |
| **5.2.4.3.10** Energy efficiency *(4.9)* | eMBB | - | - | Capability to support a high sleep ratio and long sleep duration | Support | 🗹 Yes  No | c.f.  E-II.10 |
| **5.2.4.3.11** Reliability *(4.10)* | URLLC | Urban Macro –URLLC | Uplink or 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 edge | Not Available | Yes  No | c.f.  E-II.11 |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian | Support | 🗹 Yes  No | c.f.  E-II.12 |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | Support | 🗹 Yes  No | c.f.  E-II.12 |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular | Support | 🗹 Yes  No | c.f.  E-II.12 |
| **5.2.4.3.13**  Mobility Traffic channel link data rates (bit/s/Hz) *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | 1.5 (10 km/h) | 1.662~ 1.6787 | 🗹 Yes  No | c.f.  E-II.13 |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | 2.1305~ 2.2032 | 🗹 Yes  No | c.f.  E-II.13 |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | 2.0847~ 3.8143 | 🗹 Yes  No | c.f.  E-II.13 |
| 0.45 (500 km/h) | 1.0393~ 3.1157 | 🗹 Yes  No | c.f.  E-II.13 |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | - | - | 0 | 0 | 🗹 Yes  No | c.f.  E-II.14 |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | - | - | - | At least 100 MHz | Support | 🗹 Yes  No | c.f.  II-E.16 |
| Up to 1 GHz | Support | 🗹 Yes  No | c.f.  II-E.16 |
| Support of multiple different bandwidth values(4) | Support | 🗹 Yes  No | c.f.  II-E.16 |
| (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.  (5) With sufficient bandwidth | | | | | | | |

### III-B.3 Number of test environments meeting all IMT-2020 requirements

#### III-B.3.1 NR RIT Assessment

This report concludes that NR RIT can fulfill IMT-2020 requirements specified in Report ITU-R M.2410 for three usage scenario with five test environments:

– Indoor Hotspot-eMBB

– Dense Urban-eMBB

– Rural-eMBB

– Urban Macro-mMTC

– Urban Macro-URLLC

This conclusion is supported by the assessments in Table III-B.3.1, which shows the summary of the evaluation results and study in Part II.

Table III-B.3.1

Trans-Pacific Evaluation Group assessments for NR RIT

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | eMBB,  Indoor Hotspot | | | eMBB,  Dense Urban | | eMBB,  Rural | | | mMTC Urban Macro | URLLC Urban Macro |
|  |  | CFG A | CFG B | CFG C | CFG A | CFG B | CFG A | CFG B | CFG C | - | - |
| 1 | Peak Data Rate | ◎ | | | ◎ | | ◎ | | |  |  |
| 2 | Peak spectral efficiency | ◎ | | | ◎ | | ◎ | | |  |  |
| 3 | User Experienced Data Rate |  |  |  | ◎ | ◎ |  |  |  |  |  |
| 4 | 5th percentile user spectral efficiency | ◎ | ◎ | ◎ | ◎ | ※[[9]](#footnote-9) | ◎ | ◎ | ◎ |  |  |
| 5 | Average spectral efficiency | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ | ◎ |  |  |
| 6 | Area Traffic Capacity | ◎ | ◎ | ◎ |  |  |  |  |  |  |  |
| 7 | Energy efficiency | ◎ | | | ◎ | | ◎ | | |  |  |
| 8 | Mobility | ◎ | N/A | N/A | ◎ | N/A | ◎ | ◎ | N/A |  |  |
| 9 | User plane latency | ◎ | | | ◎ | | ◎ | | |  | ◎ |
| 10 | Control plane latency | ◎ | | | ◎ | | ◎ | | |  | ◎ |
| 11 | Mobility interruption time | ◎ | | | ◎ | | ◎ | | |  | ◎ |
| 12 | Reliability |  |  |  |  |  |  |  |  |  | ◎ |
| 13 | Connection density |  |  |  |  |  |  |  |  | ◎ |  |
| **Fulfilled Test Environment** | | 🗹 | | | 🗹 | | 🗹 | | | 🗹 | 🗹 |
| ◎ : Fulfilled　　　N/A : Not Available　　　※ : Issue Founded　　　🗹: Checked and Fulfilled | | | | | | | | | | | |

#### III-B.3.2 LTE RIT Assessment

This report concludes that LTE RIT can fulfil IMT-2020 requirements specified in Report ITU-R M.2410 for two usage scenario with four test environments:

– Indoor Hotspot-eMBB

– Dense Urban-eMBB

– Rural-eMBB

– Urban Macro-mMTC

This conclusion is supported by the assessments in Table III-B.3.2, which shows the summary of the evaluation results and study in Part II.

Table III-B.3.2

Trans-Pacific Evaluation Group assessments for LTE RIT

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | eMBB,  Indoor Hotspot | | | eMBB,  Dense Urban | | eMBB,  Rural | | | mMTC Urban Macro | URLLC Urban Macro |
|  |  | CFG A | CFG B | CFG C | CFG A | CFG B | CFG A | CFG B | CFG C |  |  |
| 1 | Peak Data Rate | ◎ | | | ◎ | | ◎ | | |  |  |
| 2 | Peak spectral efficiency | ◎ | | | ◎ | | ◎ | | |  |  |
| 3 | User Experienced Data Rate |  |  |  | ◎ | N/A |  |  |  |  |  |
| 4 | 5th percentile user spectral efficiency | ◎ | N/A | N/A | ◎ | N/A | ◎ | ◎ | ◎ |  |  |
| 5 | Average spectral efficiency | ◎ | N/A | N/A | ◎ | N/A | ◎ | ◎ | ◎ |  |  |
| 6 | Area Traffic Capacity | ◎ | N/A | N/A |  |  |  |  |  |  |  |
| 7 | Energy efficiency | ◎ | | | ◎ | | ◎ | | |  |  |
| 8 | Mobility | ◎ | N/A | N/A | ◎ | N/A | ◎ | ◎ | N/A |  |  |
| 9 | User plane latency | ◎ | | | ◎ | | ◎ | | |  | ◎ |
| 10 | Control plane latency | ◎ | | | ◎ | | ◎ | | |  | ◎ |
| 11 | Mobility interruption time | ◎ | | | ◎ | | ◎ | | |  | ◎ |
| 12 | Reliability |  |  |  |  |  |  |  |  |  | N/A |
| 13 | Connection density |  |  |  |  |  |  |  |  | ◎ |  |
| **Fulfilled Test Environment** | | 🗹 | | | 🗹 | | 🗹 | | | 🗹 |  |
| ◎ : Fulfilled　　　N/A : Not Available　　　※ : Issue Founded　　　🗹: Checked and Fulfilled | | | | | | | | | | | |

## III-D Summary of the Evaluation Report

Which test environments have been considered in the Final Evaluation Report? What is outcome of the evaluation?

### III-D.1 Evaluation Summary for NR RIT

For 3GPP NR RIT, the performances of all the requirements specified in Report ITU-R M.2410 are evaluated and checked in this report. The evaluation results show that all the evaluated performances can fulfil the minimum technical requirements.

|  |  |
| --- | --- |
| Test environment | Does the Evaluation Report indicate that the minimum technical performance requirements are met in the test environment? |
| 🗹 Indoor Hotspot-eMBB | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Dense Urban-eMBB | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Rural-eMBB | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Urban Macro–mMTC | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Urban Macro–URLLC | 🗹 Yes 🞎 No 🞎 Partial evaluation |

### III-D.2 Evaluation Summary for LTE RIT

For 3GPP LTE RIT, the performances of most the requirements specified in Report ITU-R M.2410 are evaluated and checked in this report. This evaluation results do not endorse the performance of Reliability for LTE RIT in Urban Macro-URLLC test environment. Besides that, the evaluation results show that the evaluated performances of LTE RIT in the test environments of Indoor Hotspot-eMBB, Dense Urban-eMBB, Rural-eMBB, and Urban Macro-mMTC, can fulfil the minimum technical requirements.

|  |  |
| --- | --- |
| Test environment | Does the Evaluation Report indicate that the minimum technical performance requirements are met in the test environment? |
| 🗹 Indoor Hotspot-eMBB | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Dense Urban-eMBB | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Rural-eMBB | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🗹 Urban Macro–mMTC | 🗹 Yes 🞎 No 🞎 Partial evaluation |
| 🞎 Urban Macro–URLLC | 🞎 Yes 🞎 No 🞎 Partial evaluation |

Annex A   
  
Evaluation Methodology, Assumption, and Configuration

## A-1 Evaluation Methodology

### A-1.1 Peak Spectral Efficiency and Peak Data Rate

#### A-1.1.1 Introduction

According to Report ITU-R M.2412, more detailed evaluation methodologies are defined. Also, in Report ITU-R M.2410, the minimum requirements of peak spectral efficiency and peak data rate are provide and summarized in .1.1.

Table A-1.1.1

The requirements of peak spectral efficiency and peak data rate

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Performance Metric | Evaluation Method | Scenario | Minimum Requirement | |
| Downlink | Uplink |
| Peak Spectral Efficiency (bits/s/Hz) | Analytical | N/A. | 30 | 15 |
| Peak Data Rate (Gbit/s) | N/A. | 20 | 10 |

In this section, we briefly review the analytical evaluation methodology for peak spectral efficiency and peak data rate, the evaluation results of peak spectral efficiency and peak data rate for both NR and LTE component RITs are provided.

#### A-1.1.2 Methodology for Peak Data Rate and Spectral Efficiency Evaluation

Besides the definitions and evaluation methodologies in Report ITU-R M.2412, there was also discussion in 3GPP RAN1 RP-172172[[10]](#footnote-10). 3GPP has discussed the approximate data rate for a given number of aggregated component carriers in a band or band combination. It could be a starting point for potential peak data calculation. The calculation method is show as follows:



wherein

J is the number of aggregated component carriers in a band or band combination

Rmax is the highest coding rate

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 signalling

 is the numerology (as defined in TS38.211)

 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 TR 38.817-01 section 4.5.1 (to be eventually defined in TS 38.101), 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 

is the normalized scalar considering the DL/UL ratio; for FDD for DL and UL; and for TDD and other duplexing for DL and UL is calculated based on the DL/UL configuration.

The peak spectral efficiency can be derived from the peak data equation for a specific component carrier and its corresponding bandwidth:



The NR transmission bandwidth configuration NRB for each BS channel bandwidth and subcarrier spacing is specified in Table A-1.1.2 for FR1 and Table A-1.1.3 for FR2.

Table A-1.1.2

NR Transmission bandwidth configuration NRB for FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS [kHz] | BS / UE Channel bandwidths [MHz] | | | | | | | | | | | | |
| 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 701 | 80 | 901 | 100 |
| 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 |
| NOTE 1: 70MHz and 90MHz are defined only as BS channel bandwidths in release 15. | | | | | | | | | | | | | |

Table A-1.1.3

NR Transmission bandwidth configuration NRB for FR2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS [kHz] | BS / UE Channel bandwidths [MHz] | | | |
| 50 | 100 | 200 | 400 |
| 60 | 66 | 132 | 264 | N/A |
| 120 | 32 | 66 | 132 | 264 |

The LTE transmission bandwidth configuration NRB for each BS channel bandwidth and subcarrier spacing is specified in Table A-1.1.4.

Table A-1.1.4

LTE Transmission bandwidth configuration NRB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS [kHz] | BS / UE Channel bandwidths [MHz] | | | |
| 5 | 10 | 15 | 20 |
| 15 | 25 | 50 | 75 | 100 |

The detailed assumptions are provided in Annex A-2.2 and A-2.3.

### A-1.2 Area Traffic Capacity and User Experienced Data Rate

#### A-1.2.1 Introduction

According to Report ITU-R M.2412, more detailed evaluation methodologies are defined. Also, in Report ITU-R M.2410, the minimum requirements of area traffic capacity and user experienced data rate are provide and summarized in .2.1 and Table A-1.2.2 respectively.

Table A‑1.2.1

The requirement of area traffic capacity

|  |  |
| --- | --- |
| Test environment | Downlink (Mbit/s) |
| Indoor Hotspot – eMBB | 10 |

Table A‑1.2.2

The requirements of user experienced data rate

|  |  |  |
| --- | --- | --- |
| Test environment | Downlink (Mbit/s) | Uplink (Mbit/s) |
| Dense Urban – eMBB | 100 | 50 |

In Report ITU-R M.2410, the definition for area traffic capacity and user experienced data rate are shown as follows.

*Carea*= ρ × *W* × *SEavg*

wherein

ρ is the TRxP density (TRxP/);

*W* is the channel bandwidth;

*SEavg* is the average spectral efficiency as defined in subsection 4.5 in Report ITU-R M.2410.

*Ruser* = *W* × *SEuser*

wherein

*W* is the channel bandwidth;

*SEuser*is the 5th percentile user spectral efficiency as defined in subsection 4.4 in Report ITU-R M.2410.

In this section, we briefly review the analytical evaluation methodology for area traffic capacity and user experienced data rate, the evaluation results of area traffic capacity and user experienced data rate for both NR and LTE are provided.

#### A-1.2.2 Methodology for Area Traffic Capacity Evaluation

According to the Figure 1 illustrated in Report ITU‑R M.2412, The Indoor Hotspot eMBB deployment is shown in Figure A-1.2.1.

Figure A-1.2.1

Indoor Hotspot sites layout



Based on this deployment scenario 12 cell sites are deployed over an indoor area of *S*=120×(15+20+15)=6000 m2. For the case where we have 1 TRxP per cell site i.e., 12 TRxP deployment, we have ρ=12 TRxP/6000 m2=0.002 TRxP/m2 and for the case of 3 TRxP per cell-site i.e., 36 TRxP deployment, we have 36 TRxP/6000 m2=0.006 TRxP/m2.

Based on the corresponding simulation results of SEavg, W, ρ for a deployment scenario, the evaluation results of area traffic capacity for Indoor Hotspot-eMBB test environments are analysed and shown in Table II-E.6.1 to Table II-E.6.3. Note that the values in brackets denote the required bandwidth to achieve the target area traffic capacity for downlink.

#### A-1.2.3 Methodology for User Experienced Data Rate

Based on the corresponding simulation results of SEuser, W for a deploymentscenario, the evaluation results of user experienced data rate for Dense Urban-eMBB test environments are analysed and shown in Table II-E.3.1 to Table II-E.3.4. Note that the values in brackets denote the required bandwidth to achieve the target user experienced data rate for downlink and uplink.

## A-2 Evaluation Assumptions and Configuration

### A-2.1 Base line Configuration

Table A-2.1

Configuration for Indoor Hotspot-eMBB

|  |  |  |  |
| --- | --- | --- | --- |
| Indoor Hotspot | ITU-R M.2412 | | |
| Configuration A | Configuration B | Configuration C |
| Carrier Frequency | 4 GHz | 30 GHz | 70 GHz |
| Transmit Power per TRxP | 24 dBm for 20 MHz  21 dBm for 10 MHz | 23 dBm for 80 MHz  20 dBm for 40 MHz | 21 dBm for 80 MHz  18 dBm for 40 MHz |
| UE Power Class | 23dBm | 23dBm | 21dBm |
| ISD | 20m | 20m | 20m |
| Number of antenna elements per TRxP | Up to 256 Tx/Rx | Up to 256 Tx/Rx | Up to 1024 Tx/Rx |
| Number of UE antenna elements | Up to 8 Tx/Rx | Up to 32 Tx/Rx | Up to 64 Tx/Rx |
| UE speeds of interest | 100% indoor, 3 km/h | 100% indoor, 3 km/h | 100% indoor, 3 km/h |
| BS/UE antenna element gain | 5/0 dBi | 5/5 dBi | 5/5 dBi |
| Simulation bandwidth | 20 MHz for TDD,  10 MHz+10 MHz for FDD | 80 MHz for TDD,  40 MHz+40 MHz for FDD | 80 MHz for TDD,  40 MHz+40 MHz for FDD |

Table A-2.2

Configuration for Dense Urban-eMBB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dense Urban | ITU-R M.2412 (Evaluation) | | | |
| Configuration A | Configuration B | Configuration C  (for Multi-Band Case) | |
| Carrier Frequency | 1 layer (Macro) with 4 GHz | 1 layer (Macro) with 30 GHz | 4 GHz and 30 GHz available in macro and micro layers (1 or 2 layers) | |
| Transmit Power per TRxP | 44 dBm for 20 MHz, 41 dBm for 10 MHz | 40 dBm for 80 MHz, 37 dBm for 40 MHz | 4GHz | 30GHz |
| 44 dBm for 20 MHz; 41 dBm for 10 MHz (Ma)  33 dBm for 20 MHz; 30 dBm for 10 MHz (Mi) | 40 dBm for 80 MHz; 37 dBm for 40 MHz (Ma)  33 dBm for 80 MHz; 30 dBm for 40 MHz (Mi) |
| UE Power Class | 23dBm | 23dBm | 23dBm (for Both) | |
| Penetration Loss | 20% high loss, 80% low loss | 20% high loss, 80% low loss | 20% high loss, 80% low loss | |
| ISD | 200m | 200m | 200m (Macro) | |
| Number of antenna elements per TRxP | Up to 256 Tx/Rx | Up to 256 Tx/Rx | Up to 256 Tx/Rx | |
| Number of UE antenna elements | Up to 8 Tx/Rx | Up to 32 Tx/Rx | Up to 8/32 Tx/Rx (for 4/30GHz) | |
| UE speeds of interest | 80% indoor, 3 km/h,  20% outdoor, 30 km/h | 80% indoor, 3 km/h,  20% outdoor, 30 km/h | 80% indoor, 3 km/h, 20% outdoor, 30 km/h | |
| BS/UE antenna element gain | 8/0 dBi | 8/5 dBi | 8/0 dBi | 8/5 dBi |
| Simulation bandwidth | 20 MHz for TDD,  10 MHz+10 MHz for FDD | 80 MHz for TDD,  40 MHz+40 MHz for FDD | 20 MHz for TDD,  10 MHz+10 MHz for FDD | 80 MHz for TDD,  40 MHz+40 MHz for FDD |

Table A-2.3

Configuration for Rural-eMBB

|  |  |  |  |
| --- | --- | --- | --- |
| Rural | ITU-R M.2412 | | |
| Configuration A | Configuration B | Configuration C (LMLC) |
| Carrier Frequency | 700 MHz | 4 GHz | 700MHz |
| Transmit Power per TRxP | 49 dBm for 20 MHz  46 dBm for 10 MHz | 49 dBm for 20 MHz  46 dBm for 10 MHz | 49 dBm for 20 MHz  46 dBm for 10 MHz |
| UE Power Class | 23dBm | 23dBm | 23dBm |
| Penetration Loss | 100 low loss | 100 low loss | 100 low loss |
| ISD | 1732m | 1732m | 6000m |
| Number of antenna elements per TRxP | Up to 64 Tx/Rx | Up to 256 Tx/Rx | Up to 64 Tx/Rx |
| Number of UE antenna elements | Up to 4 Tx/Rx | Up to 8 Tx/Rx | Up to 4 Tx/Rx |
| UE speeds of interest | 50% indoor, 3 km/h,  50% outdoor, 120 km/h | 50% indoor, 3 km/h,  50% outdoor, 120/500 km/h | 40% indoor, 3 km/h,  40%/20% outdoor, 3/30 km/h |
| BS/UE antenna element gain | 8/0 dBi | 8/0 dBi | 8/0 dBi |
| Simulation bandwidth | 20 MHz for TDD,  10 MHz+10 MHz for FDD | 20 MHz for TDD,  10 MHz+10 MHz for FDD | 20 MHz for TDD,  10 MHz+10 MHz for FDD |

### A-2.2 Evaluation Assumption for NR

#### A-2.2.1 NR Downlink

Table A-2.4

NR Parameters for DL peak spectral efficiency and peak data rate evaluation

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remarks |
| Max. number of layers | For FR1: 8  For FR2: 6 |  |
| Highest modulation order | 8 | 256QAM |
| Scaling factor of modulation | 1 |  |
| Max. coding rate *Rmax* | 948/1024 = 0.9258 |  |
|  | 0, 1, 2, 3 | SCS = ×15 kHz |
|  | See Table 8.1.1-2 for FR1 and FR2 for specific component carrier bandwidth and SCS. | The maximum number of RBs for the specific component carrier bandwidth and SCS is used. |

Table A-2.5

Overhead assumption for NR DL evaluation

|  |  |  |  |
| --- | --- | --- | --- |
|  | Applied duplexing | FR1 | FR2 |
| OH | FDD, TDD (DDDSU) | 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. | PDCCH: CORESET of 24 PRBs (4 CCE) in every slot  12 RE/PRB/slot  TRS burst of 2 slots with periodicity of 10ms and occupies 52 PRBs  12 RE/PRB/slot  DMRS: Type 2, 12 RE/PRB/slot for 6 layers  CSI-RS: 8 CSI-RS ports with periodicity of 10ms  8 RE/PRB/10 ms  8 SSB per 20ms; one SSB occupies 960REs = 4 OFDM symbols × 20 PRB × 12 REs/PRB  PTRS: 1 port, frequency density is 4 PRB, and time domain density is 1 symbol  CSI-RS for BM: 1 CSI-RS port with periodicity of 10ms  2 RE/PRB/10ms  NOTE: If the channel bandwidth is less than TRS bandwidth, the TRS bandwidth is assumed to be equal to the channel bandwidth. |

#### A-2.2.2 NR Uplink

Table A-2.6

NR Parameters for UL peak spectral efficiency and peak data rate evaluation

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remarks |
| Max. number of layers | 4 |  |
| Highest modulation order | 8 | 256QAM |
| Scaling factor of modulation | 1 |  |
| Max. coding rate *Rmax* | 948/1024 = 0.9258 |  |
|  | 0, 1, 2, 3 | SCS = ×15 kHz |
|  | See Table 8.1.1-2 for FR1 and FR2 for specific component carrier bandwidth and SCS. | The maximum number of RBs for the specific component carrier bandwidth and SCS is used. |

Table A-2.7

Overhead assumption for NR UL evaluation

|  |  |  |  |
| --- | --- | --- | --- |
|  | Applied duplexing | FR1 | FR2 |
| OH | 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 | 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 5ms  PTRS: 2 ports PTRS, frequency density is 4 PRB, and time domain density is 1 symbol |

### A-2.3 Evaluation Assumption for LTE

#### A-2.3.1 LTE Downlink

Table A-2.8

LTE Parameters for DL peak spectral efficiency and peak data rate evaluation

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remarks |
| Max. number of layers | 8 |  |
| Highest modulation order | 8  10 | 256QAM  1024QAM |
| Scaling factor of modulation | 1 |  |
| Max. coding rate *Rmax* | According to Transport block size (TBS) table defined in TS36.213 |  |
|  | See Table 8.1.2-2 for specific component carrier bandwidth. | The maximum number of RBs for the specific component carrier bandwidth is used. |

Table A-2.9

Overhead assumption for LTE DL evaluation

|  |  |  |
| --- | --- | --- |
|  | Applied duplexing | FR1 |
| OH | FDD, TDD | PBCH: 240 RE per 10ms (not include CRS)  PSS/SSS: 288 RE per 10ms  PDCCH: 1 complete symbols  CRS: 1 port for non-MBSFN; 6 RE/PRB; 0 port for MBSFN.  DMRS: 8ports, 24RE per PRB  MBSFN: 6 subframes for MBSFN for FDD; 4 subframes for MBSFN for TDD. |

#### A-2.3.2 LTE Uplink

Table A-2.10

LTE Parameters for UL peak spectral efficiency and peak data rate evaluation

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remarks |
| Max. number of layers | 4 |  |
| Highest modulation order | 8 | 256QAM |
| Scaling factor of modulation | 1 |  |
| Max. coding rate *Rmax* | According to Transport block size (TBS) table defined in TS36.213 |  |
|  | See Table 8.1.2-2 for specific component carrier bandwidth. | The maximum number of RBs for the specific component carrier bandwidth is used. |

Table A-2.11

Overhead assumption for LTE UL evaluation

|  |  |  |
| --- | --- | --- |
|  | Applied duplexing | FR1 |
| OH | FDD, TDD | PUCCH: 2 PRBs and 14 symbols  DMRS: 2 complete symbols  SRS: 1 symbol per 10ms |

## A-3 Details of Evaluation Configurations and Results

1 Indoor Hotspot-eMBB



2 Dense Urban-eMBB



3 Rural-eMBB



4 Urban Macro-mMTC



5 Urban Macro-URLLC



6 Mobility



## A-4 System Level Simulator Calibration

ITRI has developed a system level simulator (SLS), named “WiSE”, to evaluate the metrics that need SLS simulation results such as 5th percentile user spectral efficiency, average spectral efficiency, mobility, connection density and reliability. WiSE simulator has been calibrated via *Self evaluation calibration* and the results are well aligned with other 3GPP companies. Part of the calibration results are shown in Figure A-4.1 to Figure A-4.4. The detailed simulation results can be found in Annex A-3. Currently, WiSE is equipped with NR R15 functions and has finished all the evaluation for eMBB, mMTC and URLLC. For interested companies, the free trial version of WiSE simulator can also be downloaded from <https://www.commresearch.com.tw/>.

Note that the calibration results of MEDIATEK are also aligned with 3GPP companies, and included in the curves of 3GPP RAN1 Members.

Figure A-4.1

Indoor Hotspot-eMBB Calibration

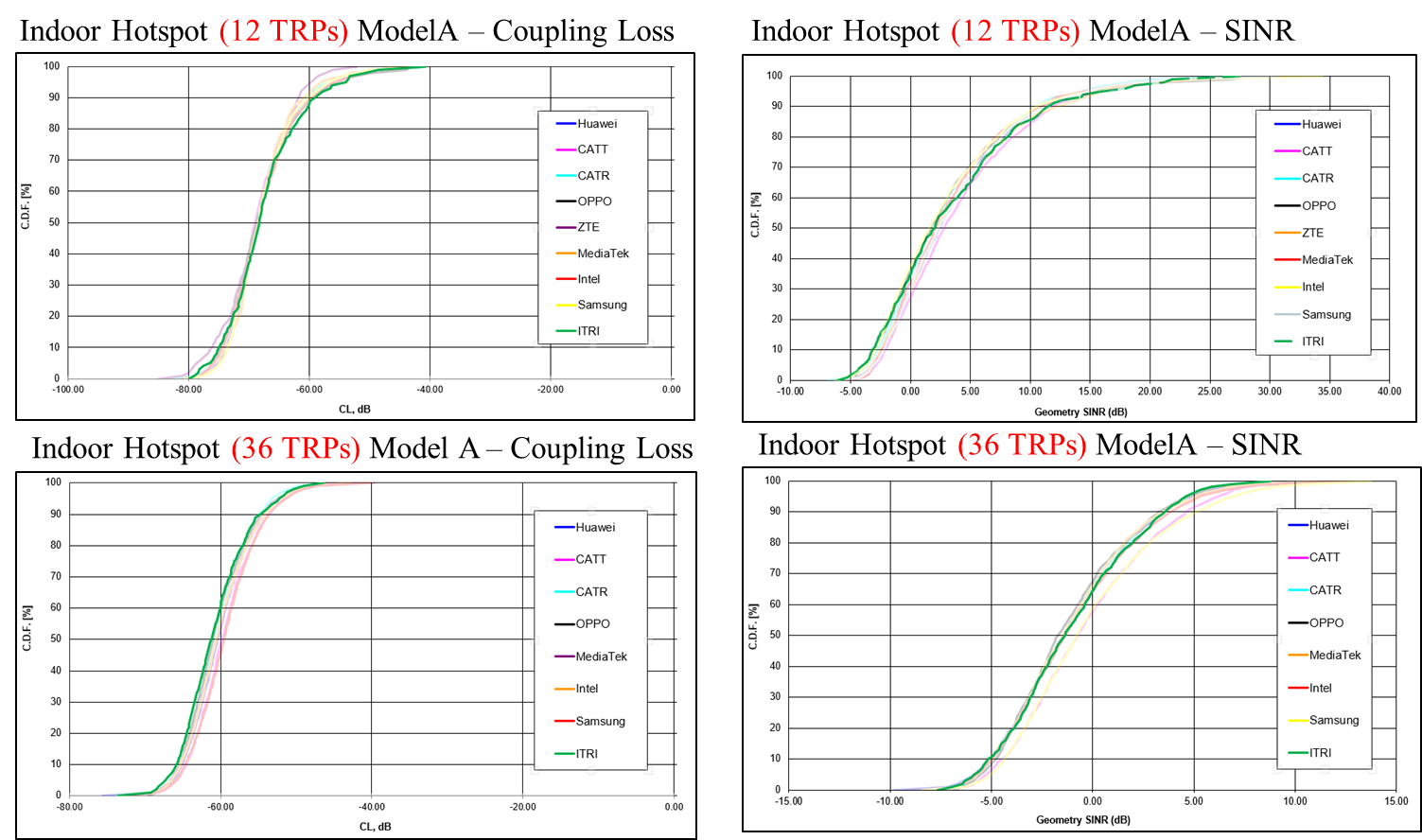


Figure A-4.2

Dense Urban-eMBB Calibration

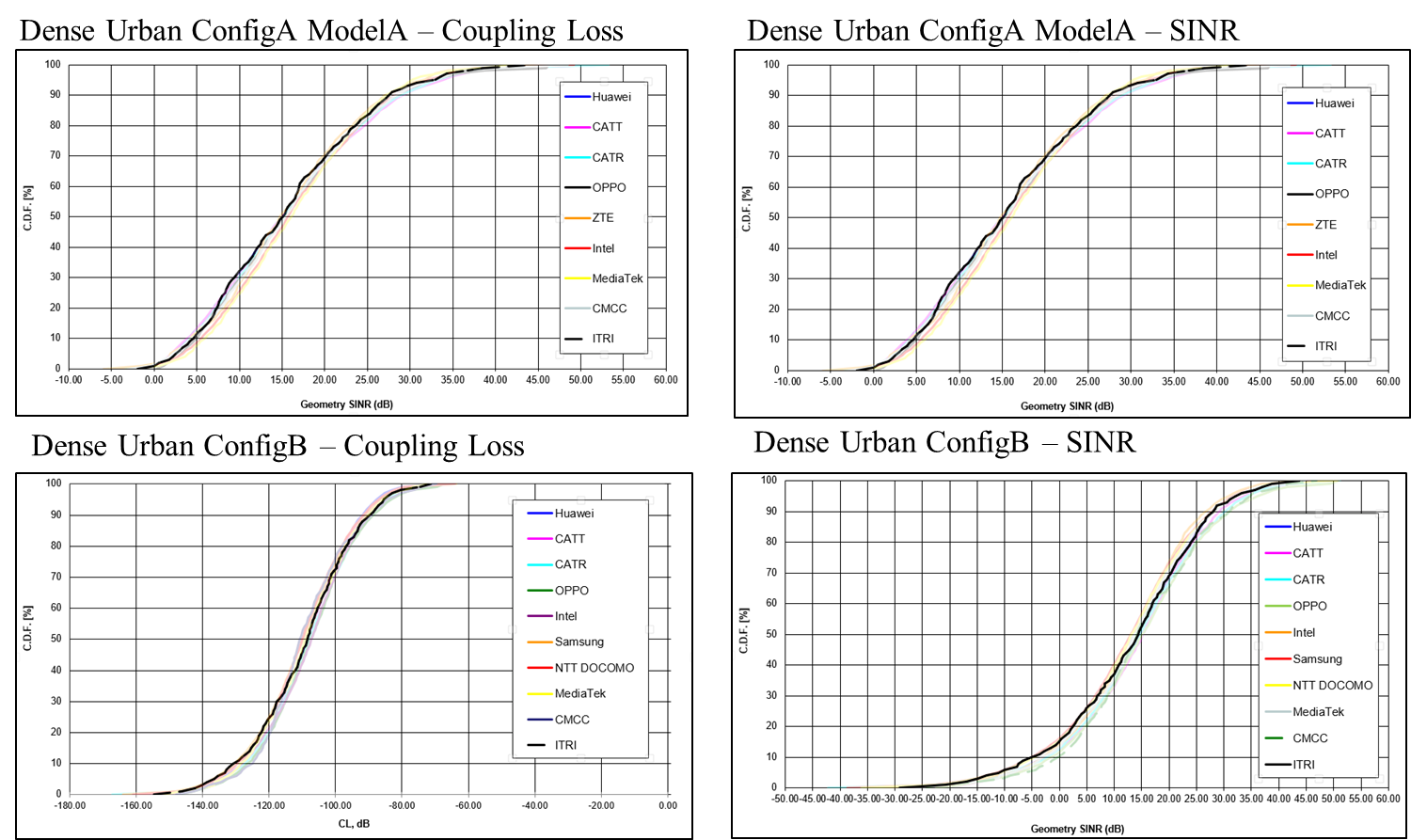


Figure A-4.3

Rural-eMBB Calibration

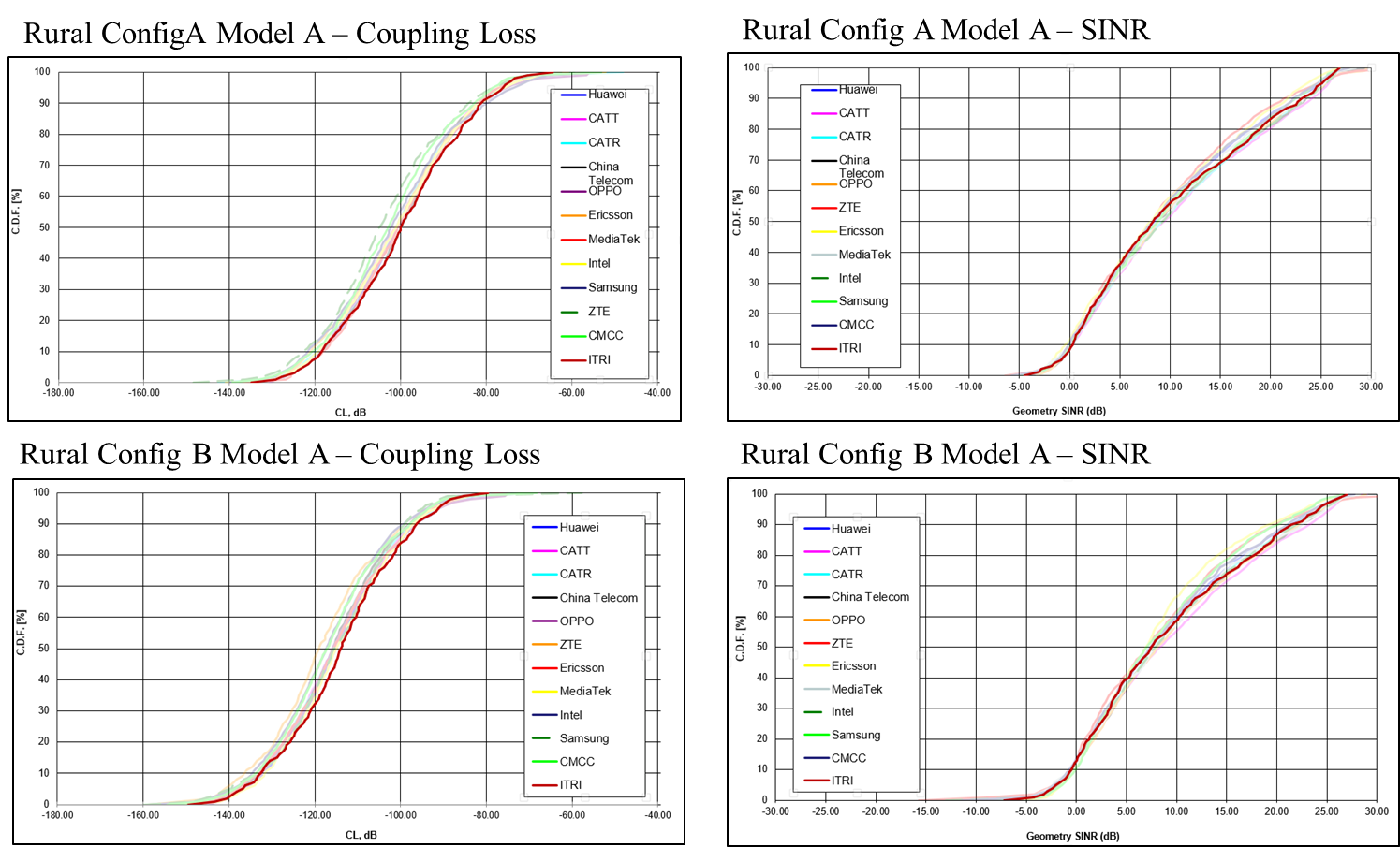
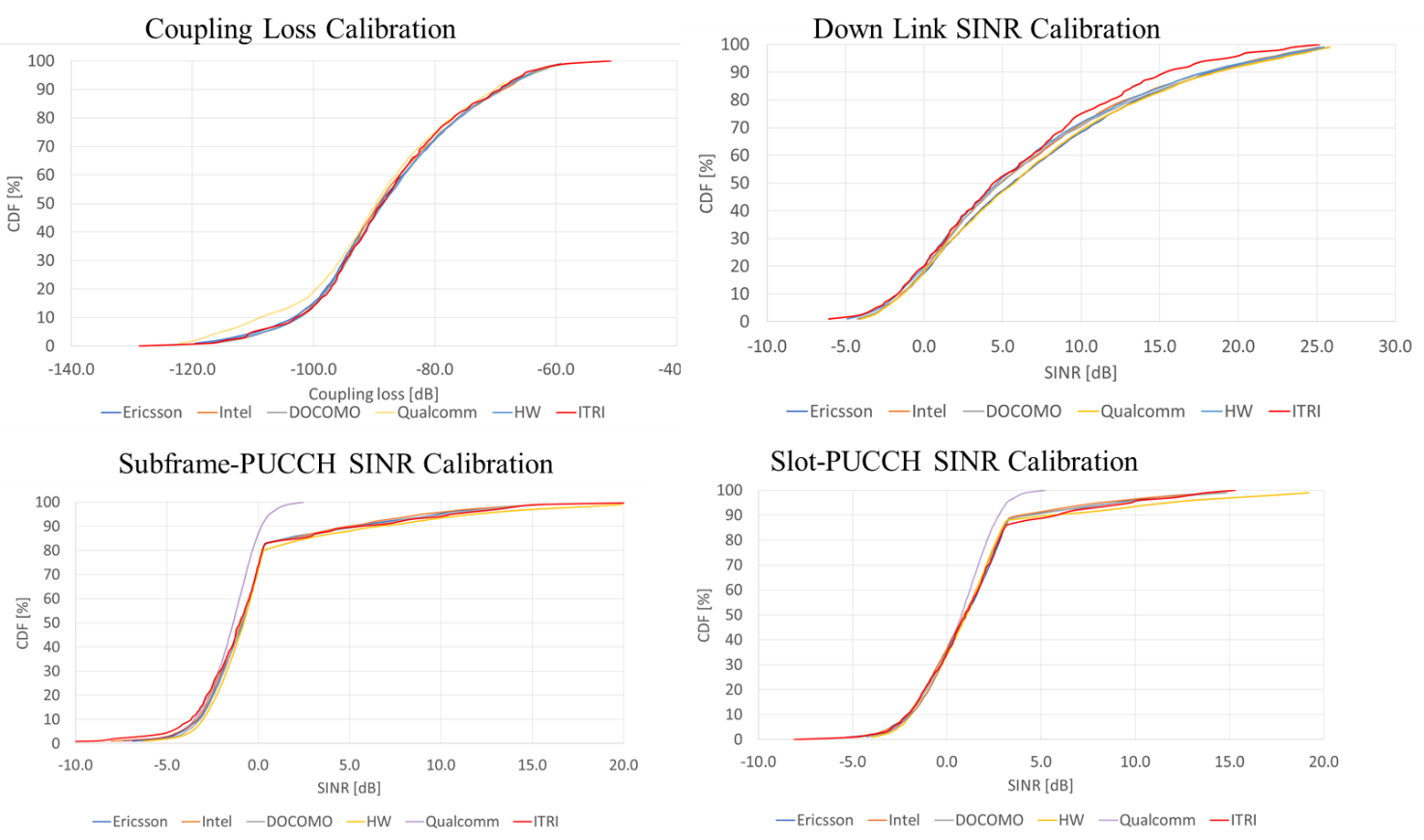


Figure A-4.4

Urban Macro-URLLC Calibration



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1. Submitted on behalf of Trans-Pacific Evaluation Group (TPCEG). [↑](#footnote-ref-1)
2. More information can be found on TPCEG public website http://tpceg.org. [↑](#footnote-ref-2)
3. Taiwan Association of Information and Communication Standards (TAICS) is an industry organization founded in June 2015 with the members from industry, research and academia organizations in Taiwan (China). The objective of TAICS is to bridge the local industry with global standard initiatives/organizations by contributing relative study and results, and also developing standard and report for local industry. In 2019, there are more than 87 companies/organizations joining TAICS and contributing technologies and researches for Taiwan (China) industry. More information can be found in <https://www.taics.org.tw/eng/>. [↑](#footnote-ref-3)
4. ITU-R WP 5D: Information of the evaluation for the terrestrial components of the radio interface(s) for IMT-2020. Liaison statement to registered Independent Evaluation Groups. Document 5D/TEMP/769(Rev.1), 16 July 2019. [↑](#footnote-ref-4)
5. C. K. Jao, C. Y. Wang, T. Y. Yeh, C. C. Tsai, L. C. Lo, J. H. Chen, W. C. Pao, W. H. Sheen, “WiSE: A System-Level Simulator for 5G Mobile Networks,” IEEE Wireless Communications, vol. 25, no. 2, pp. 4-7, Apr. 2018. [↑](#footnote-ref-5)
6. The phrase ‘Requirements fulfilled’ indicates that TPCEG assessment confirms the associated claim of fulfilling the requirement from the proponent. [↑](#footnote-ref-6)
7. The phrase ‘Not applicable’ indicates that TPCEG assessment cannot confirm the associated claim of fulfilling the requirement from the proponent. [↑](#footnote-ref-7)
8. If a proponent determines that a specific question does not apply, the proponent should indicate that this is the case and provide a rationale for why it does not apply. [↑](#footnote-ref-8)
9. Refer to Part II, II-E.4 [↑](#footnote-ref-9)
10. RP-172172, “Reply to LS on NR UE Category”, Ericsson, Intel. [↑](#footnote-ref-10)