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| **Radiocommunication Study Groups** |  |
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| Received: 3 December 2019  Source: Trans-Pacific Evaluation Group (TPCEG) | **Document 5D/25-E** |
| **3 December 2019** |
| **English only**  **TECHNOLOGY ASPECTS** |
| Industrial Technology Research Institute, Inc. (ITRI)[[1]](#footnote-1) | |
| interim evaluation Report from TPCEG  on the IMT-2020 proposal in Documents IMT-2020/3(Rev. 3) (“3GPP” under STEP 3 of the IMT-2020 PROCESS) | |
|  | |

This document describes the interim evaluation results and activities identified for IMT-2020 candidate technology submissions in [Document IMT-2020/3(Rev. 3)](https://www.itu.int/md/R15-IMT.2020-C-0023/en) from Trans-Pacific Evaluation Group (TPCEG)[[2]](#footnote-2).

# 1 Background

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 October 2018 (the 31th meeting of WP 5D), the collaboration between TPCEG proponents has been designated for evaluating the IMT-2020 candidate technology submissions. At the TPCEG meeting in December 2019, contributions with study results for the (S)RITs submitted by 3GPP have been reviewed by proponents, and this interim evaluation report is prepared under the coordination of ITRI Inc.

# 2 Administrative Aspects of the Independent Evaluation Group

## 2.1 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 WP 5D 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 this 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 conducts this interim evaluation report and submits this document to ITU-R WP 5D #33 for consideration.

The next step of TPCEG is to continue collaborating with other independent evaluation groups and provide final evaluation report by updating the data in ITU-R WP 5D #34 meeting.

## 2.2 Administrative Contact Details

TPCEG Moderator  
Tzu-Ming Lin (ITRI International Inc.)  
[tmlin@itri.com](mailto:tmlin@itri.com)

## 2.3 Technical Contact Details

Ting-Yu Yeh (Industrial Technology Research Institute, ITRI)  
tingyuyeh@itri.org.tw

Kelvin Chou (MediaTek Inc., MTK)  
[kelvin.chou@mediatek.com](mailto:IK.Fu@mediatek.com)

Jen-Yi Pan (National Chung-Cheng University, NCCU)

[jypan@ccu.edu.tw](mailto:jypan@ccu.edu.tw)

Kuang-Hao Liu (National Cheng-Kung University, NCKU)

[khliu@mail.ncku.edu.tw](mailto:khliu@mail.ncku.edu.tw)

Huan-Chun Wang (National Taiwan University of Science and Technology, NTUST)

hcwang@mail.ntust.edu.tw

# 3 Evaluation summary

## 3.1 Use of information in Report ITU-R M.2412

*Working Party 5D has defined evaluation guidelines for IMT-2020 candidate technology evaluation in the Report ITU-R M.2412. The latest version of this document is Report ITU-R M.2412-0.*

*Independent Evaluation Groups are requested to indicate in their inputs to WP 5D that they applied Report ITU-R M.2412-0 in their evaluation.*

Does Independent Evaluation Group confirm use of Report ITU-R M.2412-0 in their work?

🗹 Yes 🞎 No

## 3.2 Provision of compliance templates

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) | The candidate LTE and NR RITs can support the usage scenario of eMBB, mMTC, and uRLLC with the results in this interim evaluation report. |
| (1) Refer to the process requirements in Document IMT-2020/2. | | |

Provision of compliance template for spectrum (Section 5.2.4.2 of Report ITU-R M.2411)

|  |  |
| --- | --- |
|  | Spectrum capability requirements |
| **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.  ***For LTE*** ***component RIT:***  *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. Detailed information on the following bands can be found in [36.101] sub-clause 5.5.*   | *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 | 1 920 MHz | – | 1 980 MHz | 2110 MHz | – | 2170 MHz | FDD | | 2 | 1 850 MHz | – | 1 910 MHz | 1930 MHz | – | 1990 MHz | FDD | | 3 | 1 710 MHz | – | 1 785 MHz | 1805 MHz | – | 1880 MHz | FDD | | 4 | 1 710 MHz | – | 1 755 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 | 2 500 MHz | – | 2 570 MHz | 2620 MHz | – | 2690 MHz | FDD | | 8 | 880 MHz | – | 915 MHz | 925 MHz | – | 960 MHz | FDD | | 9 | 1 749.9 MHz | – | 1 784.9 MHz | 1844.9 MHz | – | 1879.9 MHz | FDD | | 10 | 1 710 MHz | – | 1 770 MHz | 2110 MHz | – | 2170 MHz | FDD | | 11 | 1 427.9 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. | | | | | | | |   *For NB-IoT, Category NB1 and NB2 are designed to operate in band 1, 2, 3, 4, 5, 8, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 31, 41, 66, 70, 71, 72 and 74 in the above table. See more details in [36.101] sub-clause 5.5F.*  *For eMTC, UE category M1 and M2 is designed to operate in band 1, 2, 3, 4, 5, 7, 8, 11, 12, 13, 14, 18, 19, 20, 21, 25, 26, 27, 28, 31, 39, 40, 41, 66, 71, 72 and 74 in the above table. See more details in [36.101] sub-clause 5.5E.*  *For V2X communication, the bands can be found in [36.101] sub-clause 5.5G.*  ***For NR component RIT:***  *The following frequency bands will be supported, 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.*  *450-6 000 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 |   *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 | 26 500 MHz – 29 500 MHz | TDD | | n258 | 24 250 MHz – 27 500 MHz | TDD | | n260 | 37 000 MHz – 40 000 MHz | TDD | | n261 | 27 500 MHz – 28 350 MHz | TDD |   *Additional frequency bands can be introduced in the future in release independent manner. Support for frequency bands above 52600 MHz is under study, and the support for frequency bands within 6000 MHz to 24250 MHz is planned to be studied.* |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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.  NOTE 1 – In the case of the candidate SRIT, at least one of the component RITs need to fulfil this requirement.  ***For NR component RIT:***  *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 | |

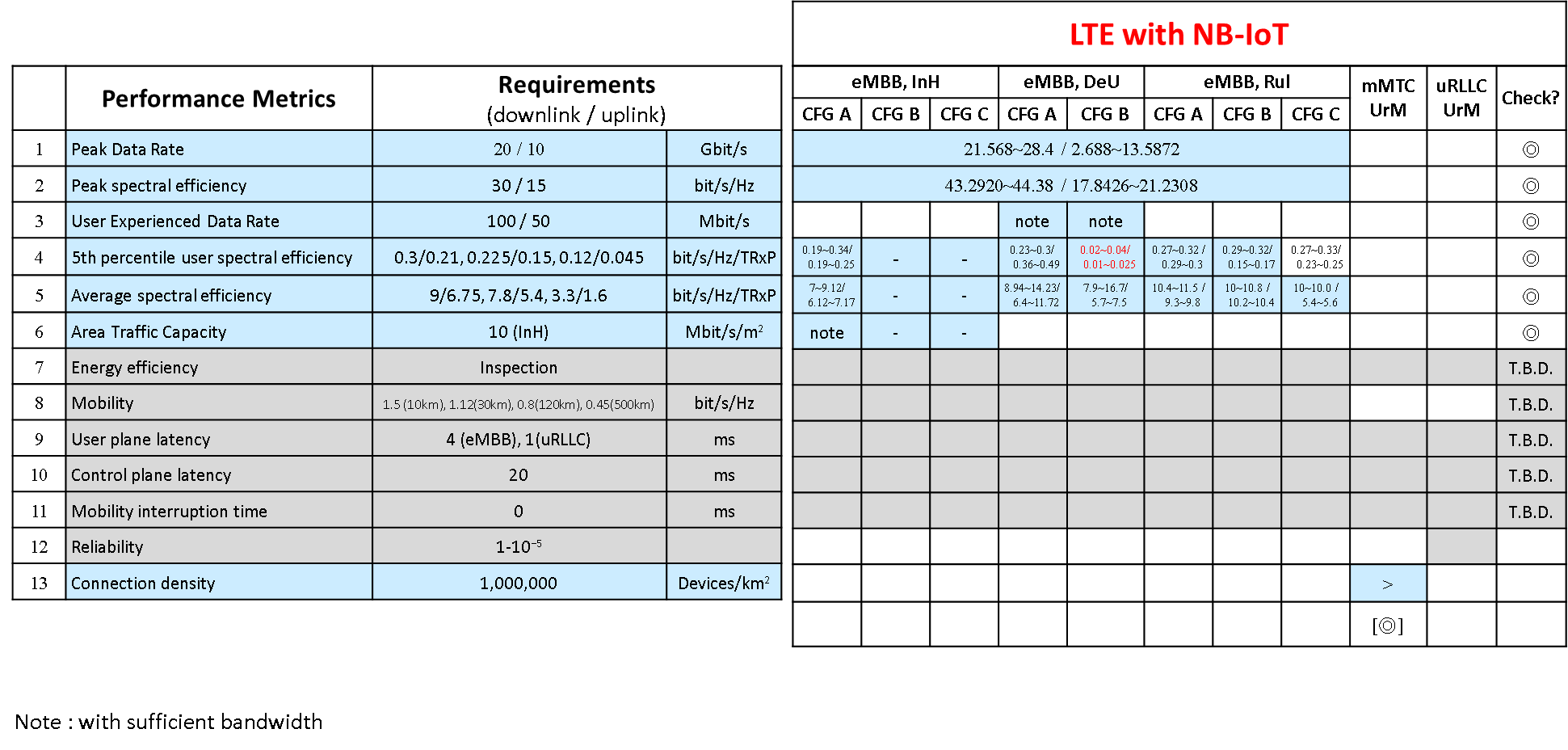
## 3.3 Summary of the Interim Evaluation Report

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

|  |  |
| --- | --- |
| 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 |

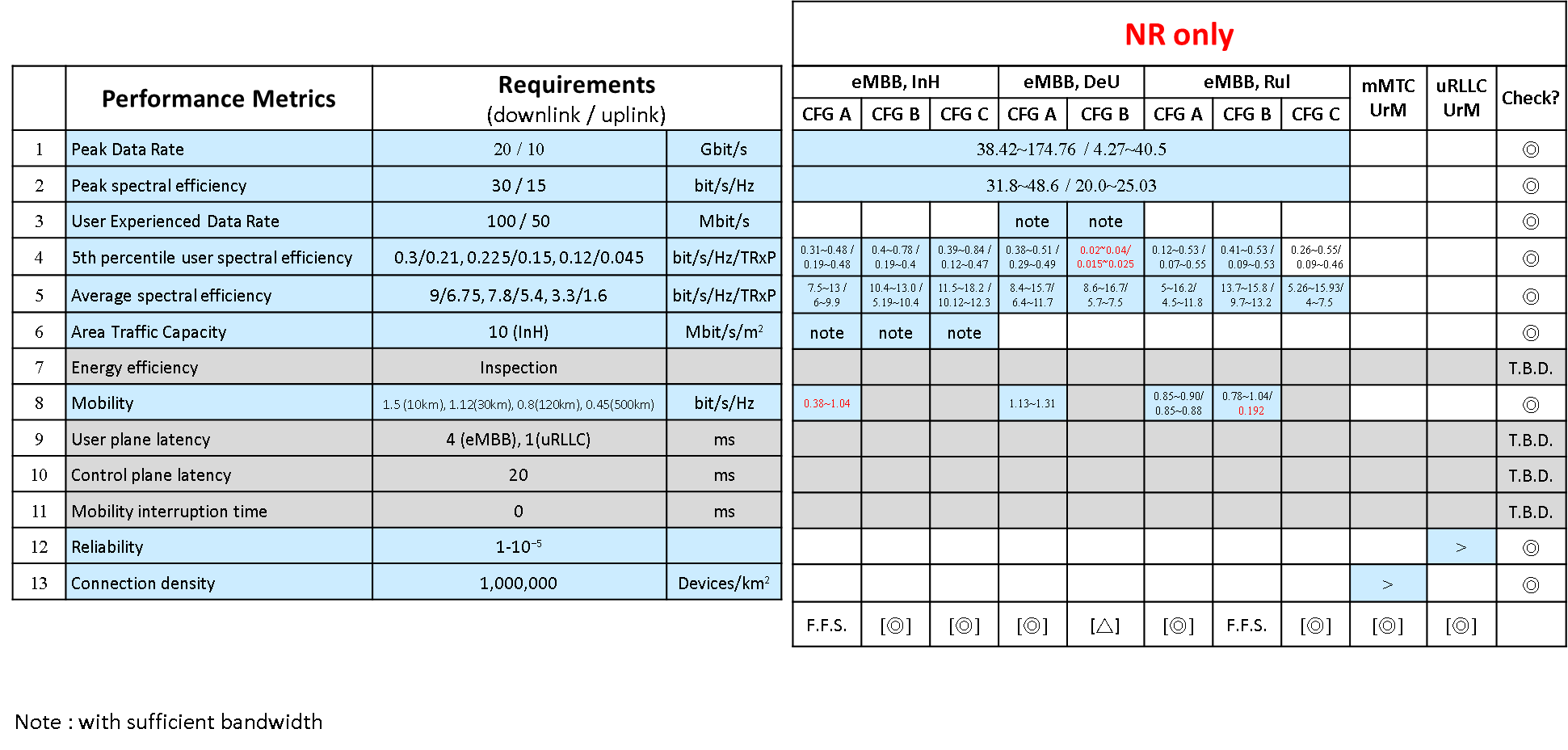
### 3.3.1 Evaluation Summary for LTE RIT (with NB-IoT)

For 3GPP LTE RIT, the performances of Peak Data Rate, Peak Spectral Efficiency, User Experienced Data Rate, 5th Percentile User Spectral Efficiency, Area Traffic Capacity, and Connection Density are evaluated and checked. Most of the evaluated performances can fulfill the minimum technical requirements specified in Report ITU-R M.2410. The remaining performances will be evaluated and determined in TPCEG final evaluation report.



### 3.3.2 Evaluation Summary – NR RIT

For 3GPP NR RIT, the performances of Peak Data Rate, Peak Spectral Efficiency, User Experienced Data Rate, 5th Percentile User Spectral Efficiency, Area Traffic Capacity, Mobility, Reliability, and Connection Density are evaluated and checked. Most of the evaluated performances can fulfill the minimum technical requirements specified in Report ITU-R M.2410. The remaining performances will be evaluated and determined in TPCEG final evaluation report.



## 3.4 Additional evaluation methodologies and assumptions

Have any additional evaluation methodologies or assumptions that had not been included in the Report ITU-R M.2412-0 been used in evaluation?

🗹 Yes 🞎 No

Annex A

Evaluation Results Contributed by TPCEG Proponents

## A-1 Introduction

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 A-1-1 shows the different sources of the evaluation results correspond to contributors from the different affiliations.

Table A-1-1

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[[4]](#footnote-4) to conduct the results while MTK use in-house simulator for the evaluation. The more detail information of WiSE simulator is overviewed in Annex B-3, and all the methodologies, assumption, and configurations are summarized in Annexes B-1 and B-2.

## A-2 Results of Peak Spectral Efficiency for eMBB Test Environments

The peak spectral efficiency for NR in FR1 and FR2 for DL and UL are shown in Tables A-2-1 to A-2-3 and Tables A-2-4 to A-2-6 respectively. 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. From Tables A-2-1 to A-2-6, it can be seen that NR RIT with FDD and TDD duplexing fulfils the peak spectral efficiency requirements of 30 bits/s/Hz for DL and 15 bits/s/Hz for UL for both FR1 and FR2 and all supported SCS and BW combinations.

Table A-2-1

Peak spectral efficiency for FR1 DL cases – FDD

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 A-2-2

Peak spectral efficiency for FR1 DL cases – TDD (DDDSU)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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** |

Table A-2-3

Peak spectral efficiency for FR2 DL cases – TDD (DDDSU)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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** |

Table A-2-4

Peak spectral efficiency for FR1 UL cases – FDD

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 A-2-5

Peak spectral efficiency for FR1 UL cases – TDD (DDDSU)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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** |

Table A-2-6

Peak spectral efficiency for FR2 UL cases – TDD (DDDSU)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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** |

The peak spectral efficiency for LTE in FR1 for DL and UL are shown in Tables A-2-7 and A‑2-8 respectively. 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. From Tables A-2-7 and A-2-8, it can be seen that LTE RIT with FDD and TDD duplexing fulfils the peak spectral efficiency requirements of 30 bits/s/Hz for DL and 15 bits/s/Hz for UL for both FR1 and FR2 and all supported SCS and BW combinations.

Table A-2-7

Peak spectral efficiency for FR1 DL cases – FDD and TDD (DDDSU)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

Table A-2-8

Peak spectral efficiency for FR1 UL cases - FDD and TDD (DDDSU)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

## A-3 Results of Peak Data Rate for eMBB Test Environments

Based on the calculation of peak spectral efficiency in Annex B-1, the analysis of peak data rate for NR DL and UL cases are shown in Tables A-3-1 and A-3-2 respectively.

Table A-3-1

Peak data rate calculation for DL case – FDD and TDD (DDDSU)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Duplexing | SCS [kHz] | | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 16 CCs (Gbit/s) | Req. (Gbit/s) |
| **FDD** | **FR1** | **15** | 50 | 2.4016 | 38.4256 | **20** |
| **30** | 100 | 4.8600 | 77.76 |
| **60** | 100 | 4.7646 | 76.2336 |
| **TDD  (DDDSU)** | **FR1** | **15** | 50 | 1.8249 | 29.1984 |
| **30** | 100 | 3.6936 | 59.0976 |
| **60** | 100 | 3.6182 | 57.8912 |
| **FR2** | **60** | 200 | 5.453 | 87.248 |
| **120** | 400 | 10.923 | 174.768 |

Table A-3-2

Peak data rate calculation for UL case – FDD and TDD (DDDSU)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Duplexing | SCS [kHz] | | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 16 CCs (Gbit/s) | Req. (Gbit/s) |
| **FDD** | **FR1** | **15** | 50 | 1.2379 | 19.8064 | **10** |
| **30** | 100 | 2.5032 | 40.0512 |
| **60** | 100 | 2.4750 | 39.6 |
| **TDD (DDDSU)** | **FR1** | **15** | 50 | 0.2671 | 4.2736 |
| **30** | 100 | 0.54 | 8.64 |
| **60** | 100 | 0.534 | 8.544 |
| **FR2** | **60** | 200 | 1.0059 | 16.095 |
| **120** | 400 | 2.0118 | 32.189 |

Based on the calculation of peak spectral efficiency in Annex B-1, the analysis of peak data rate for NR DL and UL cases are shown in Tables A-3-1 and A-3-2 respectively.

Table A-3-3

Peak data rate calculation for LTE DL case – FDD and TDD (DDDSU)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 |

Table A-3-4

Peak data rate calculation for LTE UL case – FDD and TDD (DDDSU)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 |

## A-4 Results of Average Spectral Efficiency for eMBB Test Environments

Based on the configuration and assumption in Annex B, the evaluation results of Average Spectral Efficiency in Indoor Hotspot-eMBB, Dense Urban-eMBB, and Rural-eMBB test environment are shown in Tables A-4-1 to A4-16. In order to verify the technical performance of LTE and NR RIT, different combinations of 3GPP features, i.e. MIMO schemes, are evaluated.

Table A-4-1

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

| Antenna  Configu- ration | 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 A-4-2

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

| Antenna  Configu- ration | 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 A-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 |  |  |  | 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 A-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 |  |  |  | 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 A-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 |  |  |  | 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 A-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 |  |  |  | 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 A-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: 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 A-4-8

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 A-4-9

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 A-4-10

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 A-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 |  |  | 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 A-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 |  |  |  | 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 A-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 |  | 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 A-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 |  |  |  |  |  | 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 A-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 |  |  | 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 A-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 |  |  |  |  |  | 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 |  |  |  |  |  |  |

## A-5 Results of 5th User Spectral Efficiency for eMBB Test Environments

Based on the configuration and assumption in Annex B, the evaluation results of 5th User Spectral Efficiency in Indoor Hotspot-eMBB, Dense Urban-eMBB, and Rural-eMBB test environment are shown in Tables A-5-1 to A-5-16. In order to verify the technical performance of LTE and NR RIT, different combinations of 3GPP features, i.e. MIMO schemes, are evaluated.

Table A-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 |  |  |  |  |  | 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 A-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 |  |  | 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 A-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 |  |  |  | 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 A-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 |  |  |  | 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 A-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 |  |  |  | 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 A-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 |  |  |  | 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 A-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: 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 A-5-8

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 A-5-9

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: 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 |  |  |  |  | 0.290063 |  |
| 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 |  |  |  |  | 0.283782 |  |
| 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 A-5-10

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: 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 |  |  |  |  | 0.280743 |  |
| 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 |  |  |  |  | 0.266813 |  |
| 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 A-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 |  |  | 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 A-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 |  |  | 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 A-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 |  | 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 A-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 |  |  |  |  |  | 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 A-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 |  |  | 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 A-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 |  |  |  |  |  | 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 |  |  |  |  |  |  |

## A-6 Results of Area Traffic Capacity for eMBB Test Environments

Based on the simulation results in Annex A-4, the evaluation results of Area Traffic Capacity for Indoor Hotspot-eMBB test environments are analysed and shown in Tables A-6-1 to A-6-13. Note that the values in brackets denote the required bandwidth to achieve the capacity.

Table A-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 A-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 A-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) |  |  |  |  |

## A-7 Results of User Experienced Data Rate for eMBB Test Environments

Based on the simulation results in Annex A-5, the evaluation results of User Experienced Data Rate for Dense Urban-eMBB test environments are analysed and shown in Tables A-7-1 to A-7-4. Note that the values in brackets denote the required bandwidth to achieve the data rate.

Table A-7-1

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 A-7-2

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 A-7-3

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 A-7-4

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) |

## A-8 Results of Mobility for eMBB Test Environments

Based on the configuration and assumption in Annex B, the evaluation results of Mobility in Indoor Hotspot-eMBB, Dense Urban-eMBB, and Rural-eMBB test environment are shown in Tables A‑8‑1 to A-8-4. From the results in the four tables, it can be seen that NR RIT fulfils the mobility requirements of different spectral efficiency with the configuration of particular speeds.

Table A-8-1

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | |
| 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 | 15kHz | FDD | 1.0450757 | 0.3871 |

Table A-8-2

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | |
| 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 | 15kHz | FDD | 1.1312 | 1.312 |

Table A-8-3

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | |
| 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 | 15kHz | FDD | 0.85063 | 0.90163 |
| 30kHz | 0.8501 | 0.88531 |

Table A-8-4

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TXRU mapping | Tx scheme | Numerology | Duplexing | ITRI -NR | |
| 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 | 30kHz | FDD | 1.045039 | 0.7874 |
| 60kHz | 0.192 |  |

## A-9 Results of Connection Density for mMTC Test Environments

The connection density results for NR and LTE are shown in Tables A-9-1 and A-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 500 m ISD and 1 732 m ISD.

Table A-9-1

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 A-9-2

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 |

## A-10 Results of Reliability for uRLLC Test Environments

The rreliability results for NR are shown in Tables A-10-1 to A-10-4 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.

Table A-10-1

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 A-10-2

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 A-10-3

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 A-10-4

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 | 15kHz, SCS | FDD |  | 99.99999984% |

Annex B

Evaluation Methodology and Configuration

## B-1 Methodology for Peak SE and Data Rate Evaluation

It have been discussed the data rate calculation method considering aggregated component carriers in a band or band combination[[5]](#footnote-5). The calculation method is show as follows:



where in

– 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 *µ*, i.e. . Note that normal cyclic prefix is assumed.

•  is the maximum RB allocation in bandwidth  with numerology *µ*, 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 and takes the values from RP-172172.

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



## B-2 Evaluation Assumptions and Configuration

**A) Base line Configuration**

Table B-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 | 23 dBm | 23 dBm | 21 dBm |
| ISD | 20 m | 20 m | 20 m |
| 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 B-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 | 23 dBm | 23 dBm | 23 dBm (for Both) | |
| Penetration Loss | 20% high loss, 80% low loss | 20% high loss, 80% low loss | 20% high loss, 80% low loss | |
| ISD | 200 m | 200 m | 200 m (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 4/30 GHz) | |
| 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 B-3-3

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 | 23 dBm | 23 dBm | 23 dBm |
| Penetration Loss | 100 low loss | 100 low loss | 100 low loss |
| ISD | 1732 m | 1732 m | 6000 m |
| 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 |

**B) Further Configurations and Assumption Details**

1. Indoor Hotspot-eMBB



2. Dense Urban-eMBB



3. Rural-eMBB



4. Urban Macro-mMTC



5. Urban Macro-uRLLC



6. Mobility



## B-3 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 B-3-1 to Figure B-3-4. The detailed simulation results can be found in Annex A. Currently, WiSE is equipped with NR R15 functions and has finished the interim 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 B-3-1

Indoor Hotspot-eMBB Calibration

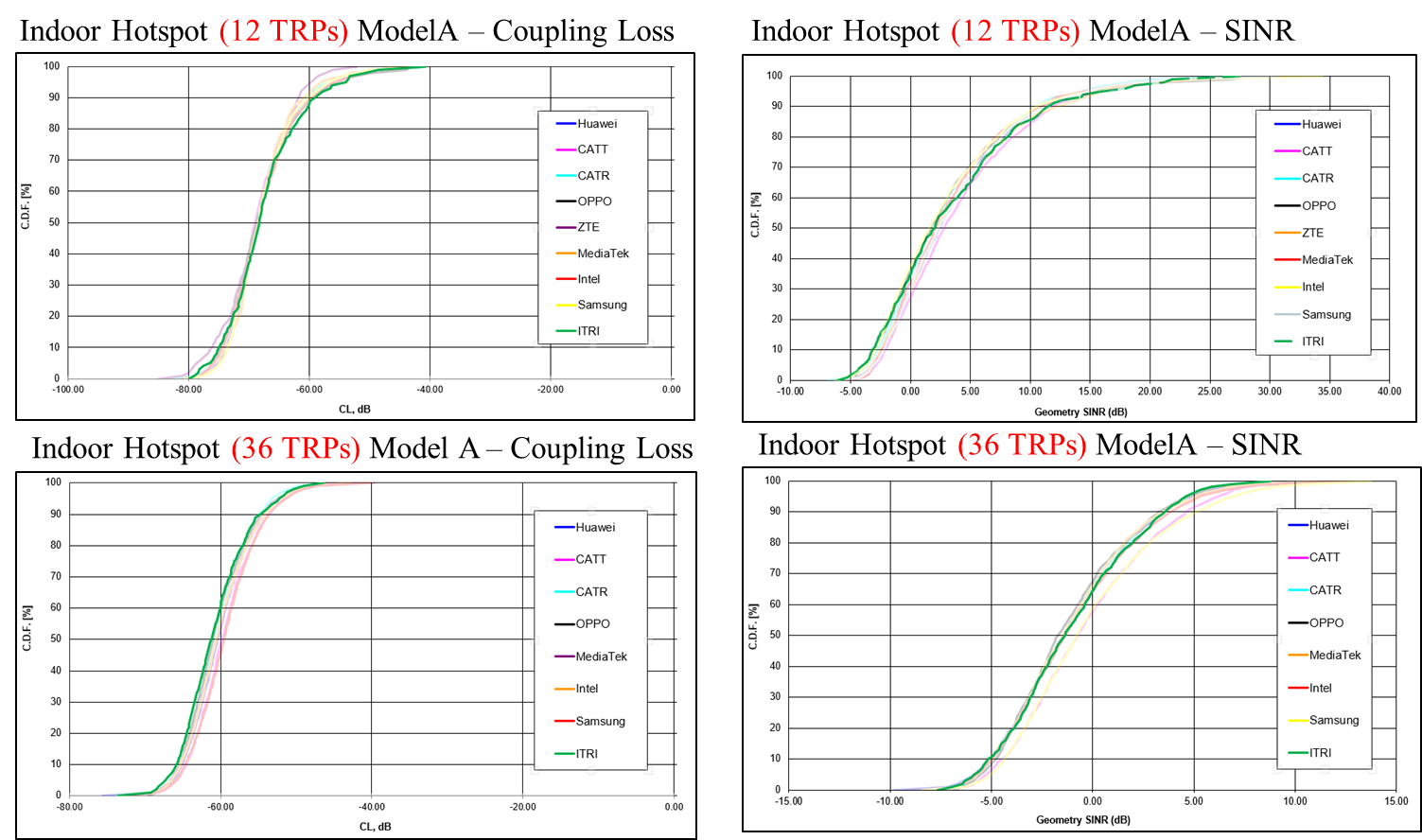


Figure B-3-2

Dense Urban-eMBB Calibration

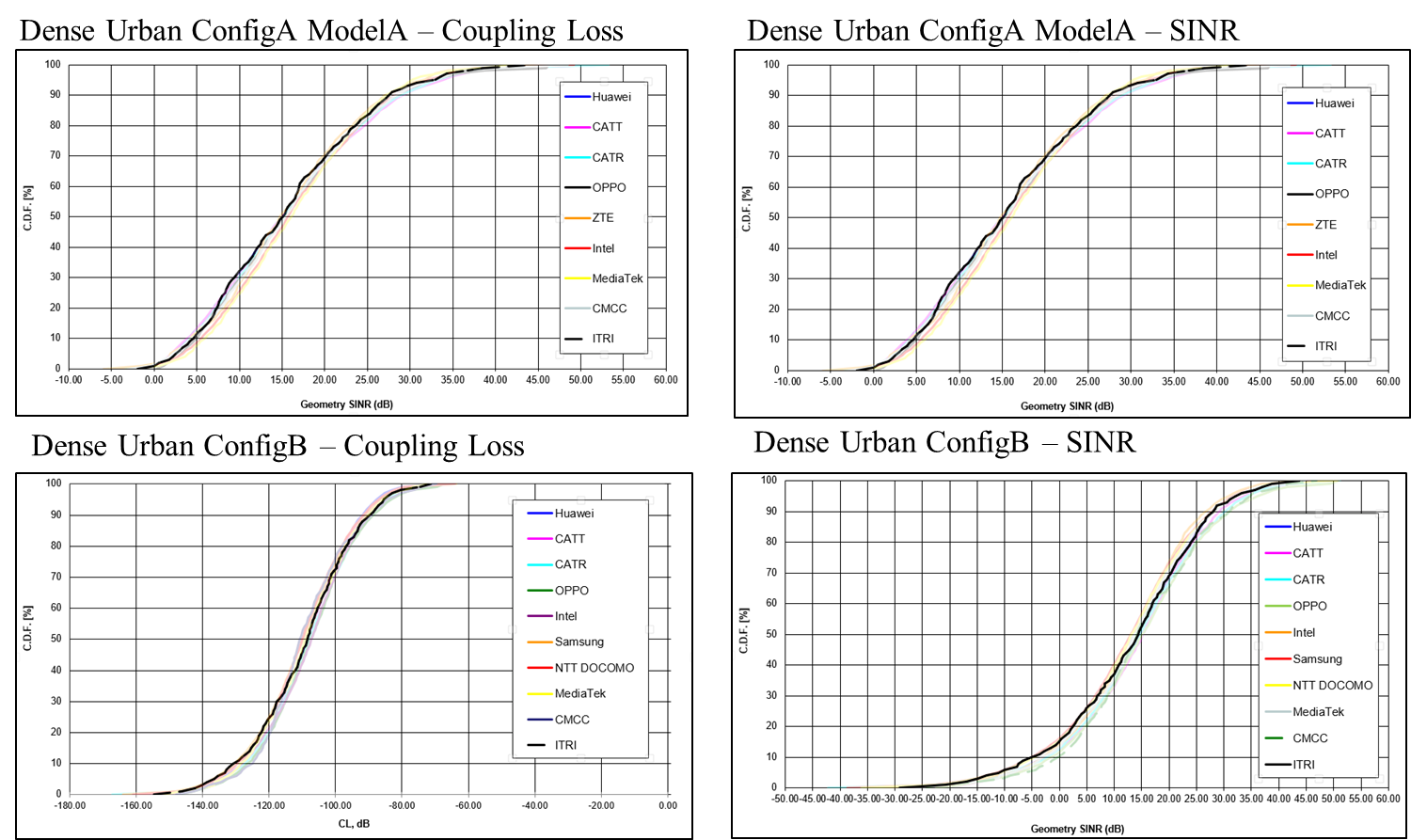


Figure B-3-3

Rural-eMBB Calibration

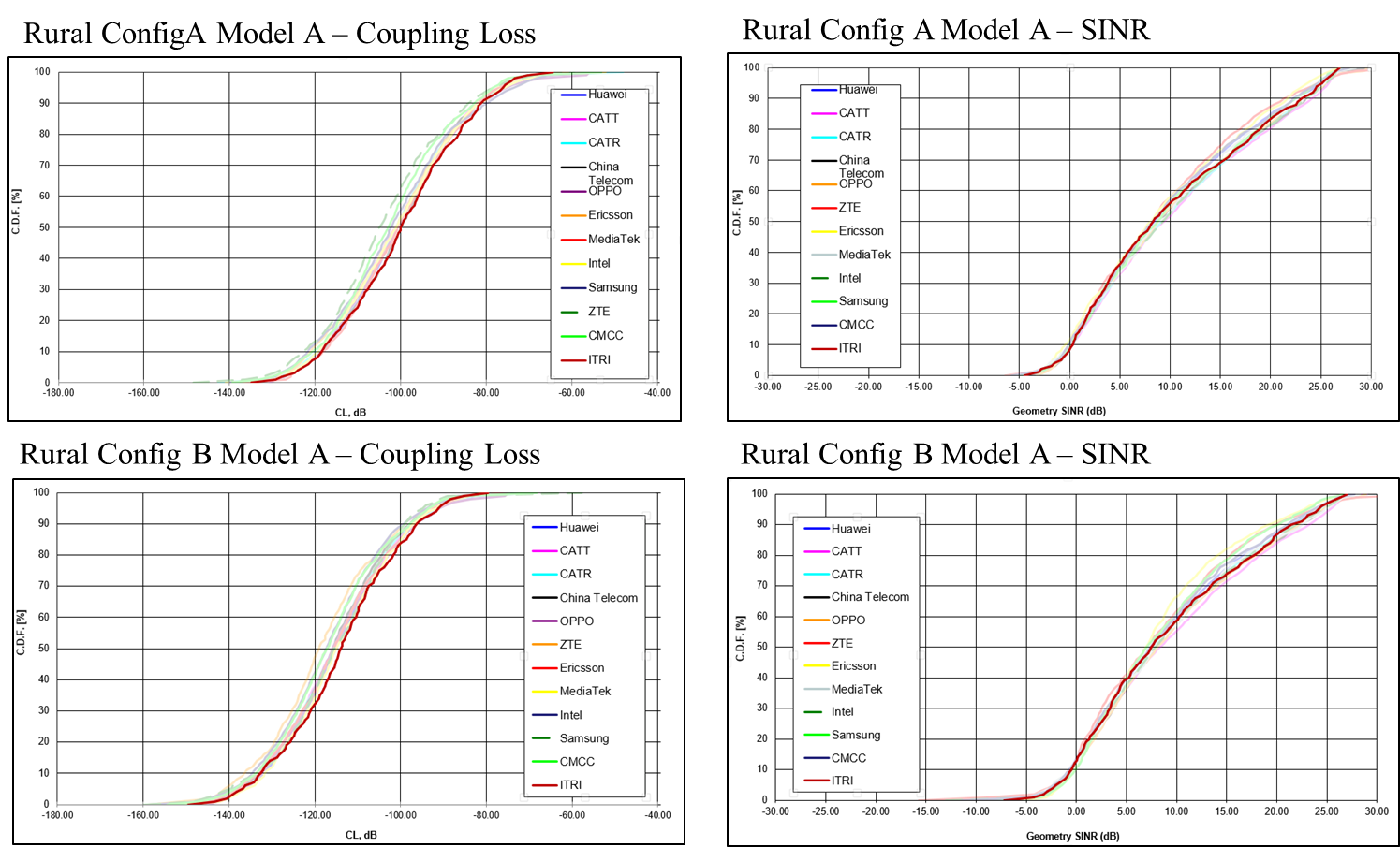
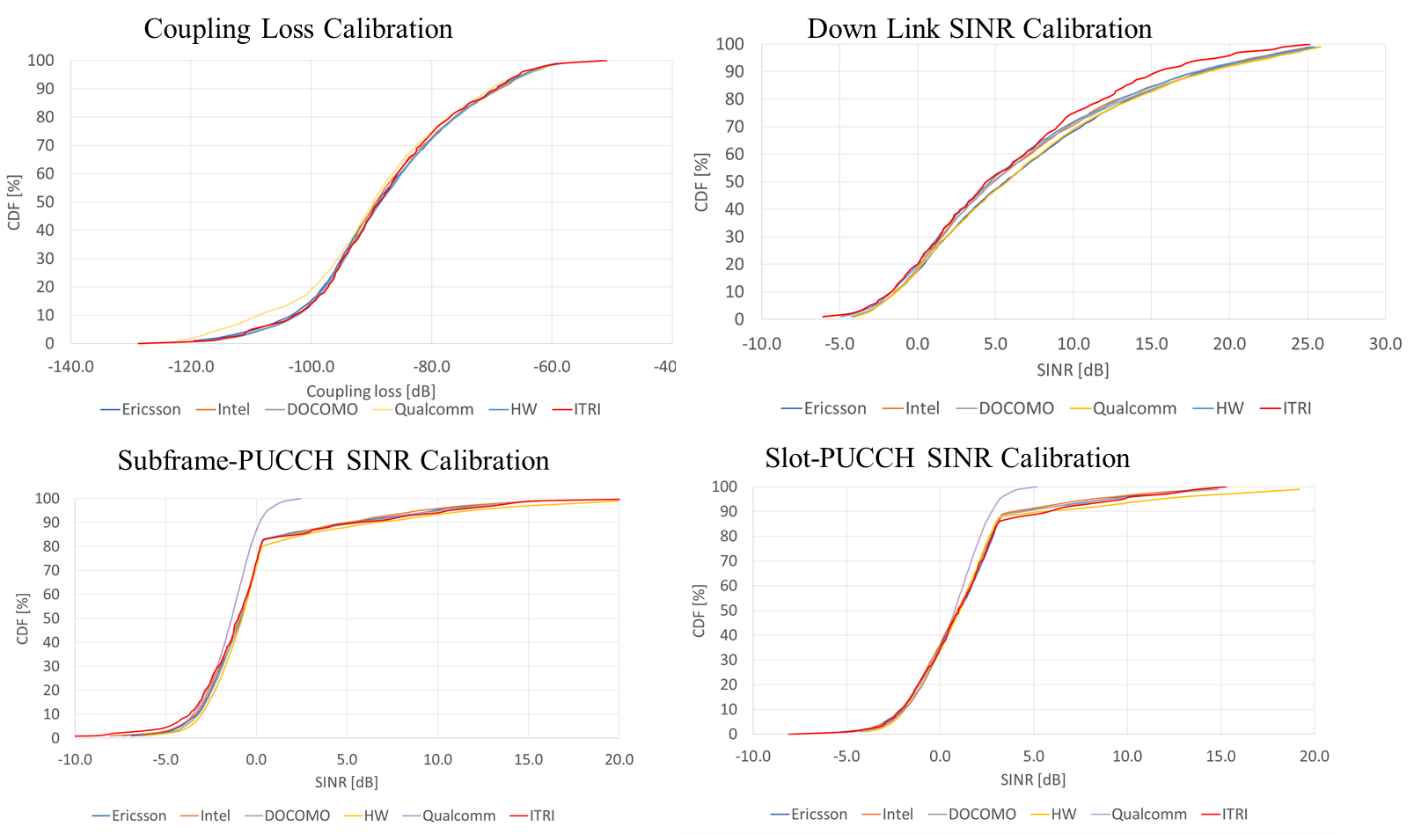


Figure B-3-4

Urban Macro-uRLLC Calibration



\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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 the study results or consolidated consensus, it may also develop the local standard or study report per request. TAICS is open for the registration by all the companies/organizations with division in Taiwan (China). More information can be found in <https://www.taics.org.tw/eng/>. [↑](#footnote-ref-3)
4. 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-4)
5. RP-172172, “Reply to LS on NR UE Category”, Ericsson, Intel. [↑](#footnote-ref-5)