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| **Radiocommunication Study Groups** |  |
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| Received: 12 February 2020  Source: The Fifth Generation Mobile Communications Promotion Forum | **Document 5D/95-E** |
| **12 February 2020** |
| **English only** |
| The Fifth Generation Mobile Communications Promotion Forum (5GMF) | |
| FINAL evaluation Report from The Fifth Generation Mobile Communications Promotion Forum on the IMT-2020 proposal in Document IMT-2020/14 (“3GPP” under STEP 3 of the IMT-2020 PROCESS) | |
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This document describes the evaluation results and activities identified for IMT-2020 candidate technology submissions in Document IMT-2020/14 from 5GMF Evaluation Group.

**Part I**

Administrative aspects of the Independent Evaluation Group

# 1 Name of the Independent Evaluation Group

IMT-2020 Evaluation Group, The Fifth Generation Mobile Communications Promotion Forum (5GMF IEG)

# 2 Introduction and background of the Independent Evaluation Group

The Fifth Generation Mobile Communications Promotion Forum (5GMF) was founded in September 2014. 5GMF has been conducting research & development concerning 5G Communications Systems including the standardization thereof, along with liaison & coordination with related organizations, the collection of information, and the dissemination & enlightenment activities. In September 2017, 5GMF IMT-2020 Evaluation Group (5GMF IEG) was established under the Technical Committee of the 5GMF and registered as an Independent Evaluation Group (IEG) committing in the process of IMT-2020 evaluation.

The members of 5GMF IEG are experts from mobile communication industry, academia or research entities actively developing and promoting relevant technical enablers or services in 5GMF. 5GMF IEG has been reviewing proposed RIT by 3GPP and provides its evaluation results as this report attached.

# 3 Method of Work

The evaluation method in this report is in line with what are suggested in Report ITU-R M.2412 that are inspection, analysis and simulation. Regarding simulation works, all of the contributors participated 3GPP meetings and submitted their simulation results there. As the consequence the simulation outcomes in this report include part of the self-evaluation report from 3GPP.

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# 6 Other pertinent administrative information

None.

**Part II**

Technical aspects of the work of the Independent Evaluation Group

# A) Evaluated candidate technologies for IMT-2020

This report is a final evaluation report on 3GPP NR, as an RIT, the candidate technology submissions in Document. IMT-2020/14.

# B) Utilization of ITU-R evaluation guidelines

This final evaluation report contains evaluation performed in accord with in Report ITU‑R M.2412-0.

# C) Documentation of any additional evaluation methodologies

There are no additional evaluation methodologies developed to complement the evaluation guidelines in M.2412-0.

# D) Verification as per Report ITU-R M.2411 of the compliance templates

## 1. Gaps/deficiencies in submitted material and/or self-evaluation

No gaps/deficiencies have been identified in submitted material nor its corresponding self‑evaluation.

## 2. Areas requiring clarifications

No area that requiring clarifications is identified.

## 3. General questions

No specific questions that should be clarified were identified.

# E) Assessment as per Report ITU-R M.2410, ITU-R M.2411 and ITU-R M.2412

## 1. Provision of compliance template for services (Section 5.2.4.1 of Report ITU-R M.2411-0)

|  |  |  |
| --- | --- | --- |
|  | 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) | As provided in chapter 6 of this evaluation report, NR RIT has ability to support the usage scenarios of eMBB, URLLC and mMTC. |
| (1) As defined in Report ITU-R M.2410-0. | | |

## 2. Provision of compliance template for spectrum (Section 5.2.4.2 of Report ITU-R M.2411-0)

|  |  |
| --- | --- |
|  | 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. |
| **As shown in Annex A-1, the following frequency bands are supported by NR RIT, which contains certain frequency bands identified for IMT in the ITU Radio Regulations (Edition 2016).**   |  |  |  |  | | --- | --- | --- | --- | | 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 | |
| **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. |
| **As shown in the table below, frequency bands above 24.25GHz are supported by NR RIT.**   |  |  |  | | --- | --- | --- | | 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. Provision of compliance template for technical performance (Section 5.2.4.3 of Report ITU-R M.2411-0)

| Minimum technical performance requirements item (5.2.4.3.x), units, and Report ITU-R M.2410-0 section reference(1) | Category | | | Required value | Value(2) | Requirement met? | Comments (3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Usage scenario | Test environment | Downlink or uplink |
| **5.2.4.3.1** Peak data rate (Gbit/s) *(4.1)* | eMBB | Not applicable | Downlink | 20 | 37.0~74.8 | 🗹 Yes  No | FR1, FDD using 16 carrier aggregation, with overhead applying ‘OH4’ case |
| Uplink | 10 | 16.6~64.6 | 🗹 Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 | 42.8~54.3 | 🗹 Yes  No | Overhead applying ‘OH4’ case |
| Uplink | 15 | 18.5~37.4 | 🗹 Yes  No |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 | 103.74~105.75 | 🗹 Yes  No | For evaluation configuration A (4 GHz) and C (multi-band/layer), Channel model A/B. |
| Uplink | 50 | 50.87~53.13 | 🗹 Yes  No |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.31~0.56 | 🗹 Yes  No | For evaluation configuration of 30 GHz, Large BW. |
| Uplink | 0.21 | 0.23~0.40 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.25~0.81 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Large BW. |
| Uplink | 0.15 | 0.16~0.6 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 | 0.14~0.28 | 🗹 Yes  No | For evaluation configuration of 700 MHz, Large BW. |
| Uplink | 0.045 | 0.09-0.15 | 🗹 Yes  No |
| Downlink | 0.12 | 0.24~0.81 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Large BW |
| Uplink | 0.045 | 0.07~0.34 | 🗹 Yes  No |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 12.27~16.87 | 🗹 Yes  No | For evaluation configuration of 30 GHz, Large BW. |
| Uplink | 6.75 | 6.08~10.19 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 10.38~22.33 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Large BW. |
| Uplink | 5.4 | 6.1~10.5 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 | 4.79~11.62 | 🗹 Yes  No | For evaluation configuration of 700 MHz, Large BW. |
| 11.1~21.1 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Large BW |
| Uplink | 1.6 | 4.3~6.3 | 🗹 Yes  No | For evaluation configuration of 700 MHz, Large BW. |
| 3.1~10.8 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Large BW |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 | 14.72~20.24 | 🗹 Yes  No |  |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 | <3.5 | 🗹 Yes  No |  |
| URLLC | Not applicable | Uplink and Downlink | 1 | <1 | 🗹 Yes  No |  |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | Not applicable | Not applicable | 20 | <19 | 🗹 Yes  No |  |
| URLLC | Not applicable | Not applicable | 20 | <19 | 🗹 Yes  No |  |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | 34,549,380 ~ 35,076,402 | 🗹 Yes  No | For evaluation configuration A (ISD=500m) with full buffer system level simulation followed by link level simulation; Channel model A/B. |
| 1,277,408 ~ 1,488,275 | 🗹 Yes  No | For evaluation configuration B (ISD=1732m) with full buffer system level simulation followed by link level simulation; Channel model A/B. |
| **5.2.4.3.10** Energy efficiency *(4.9)* | eMBB | Not applicable | Not applicable | Capability to support a high sleep ratio and long sleep duration |  | 🗹 Yes  No |  |
| **5.2.4.3.11** Reliability *(4.10)* | URLLC | Urban Macro –URLLC | Uplink | 1-10−5 success probability of transmitting a layer 2 PDU (protocol data unit) of size 32 bytes within 1 ms in channel quality of coverage edge | >99.999% ~ 99.9999999% | 🗹 Yes  No | For evaluation configuration A (4 GHz), Channel model A/B. |
| Uplink | 99.99967% ~ 99.9999999% | 🗹 Yes  No | For evaluation configuration B (700 MHz), Channel model A/B. |
| Downlink | 99.99965% ~ 99.999999% | 🗹 Yes  No | For evaluation configuration A (4 GHz), Channel model A/B. |
| Downlink | 99.99954% ~ 99.9999991% | 🗹 Yes  No | For evaluation configuration B (700 MHz), Channel model A/B. |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian | Stationary, Pedestrian | 🗹 Yes  No | For evaluation configurations A (4 GHz) and B (30 GHz) in Indoor Hotspot – eMBB. |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | 🗹 Yes  No | For evaluation configurations A (4 GHz) and B (30 GHz) in Dense Urban – eMBB |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular | Pedestrian, Vehicular, High speed vehicular | 🗹 Yes  No | For evaluation configurations A (700 MHz) and B (4 GHz) in Rural - eMBB |
| **5.2.4.3.13**  Mobility Traffic channel link data rates (bit/s/Hz) *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | 1.5 (10 km/h) | 1.59~2.07 | 🗹 Yes  No | For evaluation configuration A (4 GHz), Channel model A/B, LOS and NLOS. |
| 2.84~2.84 | 🗹 Yes  No | For evaluation configuration B (30 GHz), Channel model A/B, LOS and NLOS. |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | 1.79~2.22 | 🗹 Yes  No | For evaluation configuration A (4 GHz), Channel model A/B, LOS and NLOS. |
| 1.24~1.24 | 🗹 Yes  No | For evaluation configuration B (30 GHz), Channel model A/B, LOS and NLOS. |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | 2.06~2.22 | 🗹 Yes  No | For evaluation configuration A (700 MHz), Channel model A/B, LOS and NLOS. |
| 0.45 (500 km/h) | 1.62~2.00 | 🗹 Yes  No |
| 0.8 (120 km/h) | 1.16~1.74 | 🗹 Yes  No | For evaluation configuration B (4 GHz), Channel model A/B, LOS and NLOS. |
| 0.45 (500 km/h) | 0.83~1.33 | 🗹 Yes  No |  |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 | 0 | 🗹 Yes  No |  |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz | 800 MHz ~ 6.4 GHz  3~13 different component carrier bandwidth values | 🗹 Yes  No |  |
| Up to 1 GHz | 🗹 Yes  No |  |
| Support of multiple different bandwidth values(4) | 🗹 Yes  No |  |
| (1) As defined in Report ITU-R M.2410-0.  (2) According to the evaluation methodology specified in Report ITU-R M.2412-0.  (3) Proponents should report their selected evaluation methodology of the Connection density, the channel model variant used, and evaluation configuration(s) with their exact values (e.g. antenna element number, bandwidth, etc.) per test environment, and could provide other relevant information as well. For details, refer to Report ITU-R M.2412-0, in particular, § 7.1.3 for the evaluation methodologies, § 8.4 for the evaluation configurations per each test environment, and Annex 1 on the channel model variants.  (4) Refer to § 7.3.1 of Report ITU-R M.2412-0. | | | | | | | |

**Part III**

Conclusion

The followings are the evaluation summary for a RIT for IMT-2020 candidate technology in Document IMT-2020/14.

# 1 Summary the Initial Evaluation Report

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

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

🗹 Yes 🞎 No

## 1.2 Provision of compliance templates

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

🗹 Yes 🞎 No

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

🗹 Yes 🞎 No

Provision of compliance template for technical performance (section 5.2.4.3 of Report ITU-R M.2411)

🗹 Yes 🞎 No

## 1.3 Summary of conclusions of the evaluation report

Does the Evaluation Report indicate that the candidate technology meet minimum service and spectrum requirements?

Service requirements: 🗹 Yes 🞎 No

Spectrum requirements: 🗹 Yes 🞎 No

Which test environments have been considered in the 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 |
| 🗹 Dense Urban – eMBB | 🗹 Yes 🞎 No |
| 🗹 Rural – eMBB | 🗹 Yes 🞎 No |
| 🗹Urban Macro – mMTC | 🗹 Yes 🞎 No |
| 🗹 Urban Macro – URLLC | 🗹 Yes 🞎 No |

## 1.4 Additional evaluation methodologies and assumptions

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

🞎 Yes 🗹 No

Annex A

Evaluation Results

# A-1 Frequency bands identified for IMT

## A-1.1 450 – 6000 MHz

As can be seen in Table A.1-1, the **l**lowing frequency bands are supported by NR RIT, which either contains, or part of, or overlaps certain frequency bands identified for IMT in the ITU Radio Regulations (Edition 2016).

Table A.1-1

Frequency bands of NR RIT for FR1 and IMT bands related articles in Radio Regulations

| **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** |  | **IMT related articles (notes) in Radio Regulations\*** |
| --- | --- | --- | --- | --- | --- |
| n71 | 663 MHz – 698 MHz | 617 MHz – 652 MHz | FDD |  | **460-890 MHz: 5.295** (470-608 MHz, or portions thereof) **5.296A** (470-698 MHz, or portions thereof, and 610-698 MHz, or portions thereof) **5.308A** (614-698 MHz) **5.313A** (698-790 MHz) **5.317A** (698-960 MHz in Region 2, 694-790 MHz in Region 1 and 790-960 MHz in Regions 1 and 3) |
| n12 | 699 MHz – 716 MHz | 729 MHz – 746 MHz | FDD |  |
| n28 | 703 MHz – 748 MHz | 758 MHz – 803 MHz | FDD |  |
| n83 | 703 MHz – 748 MHz | N/A | SUL |  |
| n20 | 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |  |
| n5 | 824 MHz – 849 MHz | 869 MHz – 894 MHz | FDD |  |
| n82 | 832 MHz – 862 MHz | N/A | SUL |  |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |  |
| n81 | 880 MHz – 915 MHz | N/A | SUL |  |
| n51 | 1427 MHz – 1432 MHz | 1427 MHz – 1432 MHz | TDD |  | **1 300-1 525 MHz: 5.341A** (1 427-1 452 MHz and 1 492-1 518 MHz in Region 1) **5.341B** (1 427-1 518 MHz in Region 2) **5.341C** (1 427-1 452 MHz and 1 492-1 518 MHz in Region 3 **5.346** (1 452-1 492 MHz) **5.346A** (1 452-1 492 MHz) |
| n74 | 1427 MHz – 1470 MHz | 1475 MHz – 1518 MHz | FDD |  |
| n76 | N/A | 1427 MHz – 1432 MHz | SDL |  |
| n50 | 1432 MHz – 1517 MHz | 1432 MHz – 1517 MHz | TDD |  |
| n75 | N/A | 1432 MHz – 1517 MHz | SDL |  |
| n70 | 1695 MHz – 1710 MHz | 1995 MHz – 2020 MHz | FDD |  | **1 710-2 170 MHz: 5.384A** (1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz) **5.388** (1 885-2 025 MHz and 2 110-2 200 MHz) **5.388A** (1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and, 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2) |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |  |
| n66 | 1710 MHz – 1780 MHz | 2110 MHz – 2200 MHz | FDD |  |
| n80 | 1710 MHz – 1785 MHz | N/A | SUL |  |
| n86 | 1710 MHz – 1780 MHz | N/A | SUL |  |
| n2 | 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |  |
| n25 | 1850 MHz – 1915 MHz | 1930 MHz – 1995 MHz | FDD |  |
| n39 | 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |  |
| n1 | 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |  |
| n84 | 1920 MHz – 1980 MHz | N/A | SUL |  |
| n34 | 2010 MHz – 2025 MHz | 2010 MHz – 2025 MHz | TDD |  |
| n40 | 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |  |  |
| n41 | 2496 MHz – 2690 MHz | 2496 MHz – 2690 MHz | TDD |  |
| n7 | 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |  |
| n38 | 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |  |
| n77 | 3300 MHz – 4200 MHz | 3300 MHz – 4200 MHz | TDD |  | **2 700-3 600 MHz: 5.429B** (3 300-3 400 MHz), **5.429D** (3 300-3 400 MHz), **5.429F** (3 300-3 400 MHz), **5.430A** (3 400-3 600 MHz), **5.431B** (3 400-3 600 MHz), **5.432A** (3 400-3 500 MHz), **5.432B** (3 400-3 500 MHz), **5.433A** (3 500-3 600 MHz) **3 600-4 800 MHz**: **5.434** (3 600-3 700 MHz) **4 800-5 250 MHz**: **5.441A** (4 800-4 900 MHz) **5.441B** (4 800-4 990 MHz) |
| n78 | 3300 MHz – 3800 MHz | 3300 MHz – 3800 MHz | TDD |  |
| n79 | 4400 MHz – 5000 MHz | 4400 MHz – 5000 MHz | TDD |  |
|  |  |  | |  |
| \* Excerpted from Radio Regulations Article 1 (Edition of 2016) |

## A-1.2 24250 – 52600 MHz

**Higher Frequency range/band(s)**

As shown in the table below, frequency bands above 24.25GHz are supported by NR RIT.

Table A.1-2 Frequency bands of NR RIT for FR2

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

# A-2 Peak spectral efficiency

Peak spectral efficiency of NR RIT is estimated using the equation of 5.1.1.1-1 and Annex B.3 given in the technical report of TR37.910 provided by 3GPP.

## A-2.1 DL peak spectral efficiency

Estimated DL peak spectral efficiency (NR FDD, FR1) with over head of OH4 is shown in Table A‑2.1-1.

Table A-2.1-1

NR FDD DL peak spectral efficiency (bit/s/Hz) [Overhead:OH4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| FR1 | 15 | 49.3 | 51.5 | 52.3 | 52.6 | 52.9 | 53.0 | 53.7 | 53.7 | - | - | - | - |
| 30 | 42.8 | 47.3 | 50.1 | 50.5 | 51.6 | 51.6 | 52.6 | 52.9 | 53.7 | 53.9 | 54.1 | 54.3 |
| 60 | - | 42.8 | 47.1 | 47.3 | 49.0 | 50.1 | 50.5 | 51.6 | 52.3 | 53.1 | 53.4 | 53.7 |

Estimated DL peak spectral efficiency (NR TDD, FR1, DSUUD, 6DL:2GP:6U) with over head of OH4 is shown in Table A-2.1-2.

Table A-2.1-2

NR TDD DL peak spectral efficiency (bit/s/Hz) [DSUUD, 6DL:2GP:6UL, Overhead:OH4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| FR1 | 15 | 49.2 | 51.5 | 52.2 | 52.6 | 52.8 | 53.0 | 53.7 | 53.7 | - | - | - | - |
| 30 | 42.7 | 47.2 | 50.1 | 50.5 | 51.5 | 51.6 | 52.6 | 52.8 | 53.7 | 53.9 | 54.1 | 54.3 |
| 60 | - | 42.7 | 47.0 | 47.2 | 48.9 | 50.1 | 50.5 | 51.5 | 52.2 | 53.1 | 53.4 | 53.6 |

Estimated DL peak spectral efficiency (NR TDD, FR2, DSUUD, 6DL:2GP:6U) with over head of OH4 is shown in Table A-2.1-3.

Table A-2.1-3

NR TDD DL peak spectral efficiency (bit/s/Hz) [DSUUD, 6DL:2GP:6UL, Overhead:OH4]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| FR2 | 60 | 52.1 | 52.3 | 52.4 | - |
| 120 | 50.1 | 52.1 | 52.3 | 52.4 |

## A-2.2 UL peak spectral efficiency

Estimated UL peak spectral efficiency (NR FDD, FR1) with over head of OH4 is shown in Table A‑2.2-1.

Table A-2.2.1

NR FDD UL peak spectral efficiency (bit/s/Hz) [Overhead:OH4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| FR1 | 15 | 24.6 | 25.7 | 26.1 | 26.3 | 26.4 | 26.5 | 26.8 | 26.8 | - | - | - | - |
| 30 | 21.3 | 23.6 | 25.0 | 25.2 | 25.8 | 25.8 | 26.3 | 26.4 | 26.8 | 27.0 | 27.1 | 27.1 |
| 60 | - | 21.3 | 23.5 | 23.6 | 24.5 | 25.0 | 25.2 | 25.8 | 26.1 | 26.6 | 26.7 | 26.8 |

Estimated UL peak spectral efficiency (NR TDD, FR1, DSUUD, 6DL:2GP:6U) with over head of OH4 is shown in Table A-2.2-2.

Table A-2.2-2

NR TDD UL peak spectral efficiency (bit/s/Hz) [DSUUD, 6DL:2GP:6UL, Overhead:OH4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| FR1 | 15 | 24.6 | 25.7 | 26.1 | 26.3 | 26.4 | 26.5 | 26.8 | 26.8 | - | - | - | - |
| 30 | 21.3 | 23.6 | 25.0 | 25.2 | 25.8 | 25.8 | 26.3 | 26.4 | 26.8 | 27.0 | 27.1 | 27.1 |
| 60 | - | 21.3 | 23.5 | 23.6 | 24.5 | 25.0 | 25.2 | 25.8 | 26.1 | 26.6 | 26.7 | 26.8 |

Estimated UL peak spectral efficiency (NR TDD, FR2, DSUUD, 6DL:2GP:6U) with over head of OH4 is shown in Table A-2.2-3.

Table A-2.2-3

NR TDD UL peak spectral efficiency (bit/s/Hz) [DSUUD, 6DL:2GP:6UL, Overhead:OH4]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| SCS [kHz] | | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| FR2 | 60 | 26.2 | 26.2 | 26.3 | - |
| 120 | 25.3 | 26.2 | 26.2 | 26.3 |

# A-3 Peak data rate

Peak data rate of NR RIT is estimated using the equation of 5.2-1 and Annex B.3 given in the technical report of TR37.910 provided by 3GPP.

## A-3.1 DL peak data rate

Estimated DL peak data rate of NR RIT with over head of OH4 is shown in Table A-3.1-1.

Table A-3.1-1

NR DL peak data rate (bit/s/Hz) [Overhead:OH4]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Duplexing | SCS [kHz] | | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 16 CCs (Gbit/s) | Required DL bandwidth to meet the requirement (MHz)1 | Req. (Gbit/s) |
| FDD | FR1 | 15 | 50 | 2.31 | 36.98 | 432.7 | 20 |
| 30 | 100 | 4.67 | 74.78 | 427.9 |
| 60 | 100 | 4.62 | 73.96 | 432.7 |
| TDD  DSUUD  6DL:2GP:6UL | FR1 | 15 | 50 | 1.16 | 18.49 | 865.3 |
| 30 | 100 | 2.34 | 37.39 | 855.8 |
| 60 | 100 | 2.31 | 36.98 | 865.3 |
| FR2 | 60 | 200 | 4.52 | 72.32 | 885.0 |
| 120 | 400 | 9.04 | 144.64 | 885.0 |
| NOTE 1: The value only indicates the required bandwidth to meet the DL peak data rate. It is not necessarily supported as NR Transmission bandwidth. | | | | | | | |

## A-3.2 UL peak data rate

Estimated DL peak data rate of NR RIT with over head of OH4 is shown in Table A-3.1-1.

Table A-3.2-1

NR UL peak data rate (bit/s/Hz) [Overhead:OH4]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Duplexing | SCS [kHz] | | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 16 CCs (Gbit/s) | Required UL bandwidth to meet the requirement (MHz)1 | Req. (Gbit/s) |
| FDD | FR1 | 15 | 50 | 1.16 | 18.49 | 432.7 | 10 |
| 30 | 100 | 2.34 | 37.39 | 427.9 |
| 60 | 100 | 2.31 | 36.98 | 432.7 |
| TDD  DSUUD  6DL:2GP:6UL | FR1 | 30 | 100 | 1.17 | 18.70 | 855.8 |
| 60 | 100 | 1.16 | 18.49 | 865.3 |
| FR2 | 60 | 200 | 2.26 | 36.16 | 885.0 |
| 120 | 400 | 4.52 | 72.32 | 885.0 |
| NOTE 1: The value only indicates the required bandwidth to meet the DL peak data rate. It is not necessarily supported as NR Transmission bandwidth. | | | | | | | |

# A-4 User experienced data rate

Simulation results of User experienced data rat can be found in an Excel file in Table A-1.

# A-5 5th percentile user spectral efficiency

Simulation results of 5th percentile user spectral efficiency can be found in an Excel file in Table A-1.

# A-6 Average spectral efficiency

Simulation results of Average spectral efficiency can be found in an Excel file in Table A-1.

# A-7 Connection density

Simulation results of Connection density can be found in an Excel file in Table A-1.

# A-8 Reliability

Simulation results of Reliability can be found in an Excel file in Table A-1.

# A-9 Mobility (in the context of Traffic channel link data rates)

Simulation results of Mobility (in the context of Traffic channel link data rates) can be found in an Excel file in Table A-1.

Table A-1

Simulation items and Excel files capturing the results

| Minimum technical performance requirements item (5.2.4.3.x), units, and Report ITU-R M.2410-0 section reference(1) | Category | | | Required value | Value | Simulation results (in Excel files) |
| --- | --- | --- | --- | --- | --- | --- |
| Usage scenario | Test environment | Downlink or uplink |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 | 103.74~105.75 | UserExperiencedDataRate\_v5\_r3\_200119SUN135551\_attn.xlsx |
| Uplink | 50 | 50.87~57.45 |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.31~0.56 | SpectralEfficiency - 01 InH-eMBB\_v44\_r18\_200111SAT233633\_attn.xlsx |
| Uplink | 0.21 | 0.23~0.40 |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.25~0.81 | SpectralEfficiency - 02 DenseUrban-eMBB\_v47\_r14-corr\_200111SAT233749\_attn.xlsx |
| Uplink | 0.15 | 0.16~0.6 |
| eMBB | Rural – eMBB | Downlink | 0.12 | 0.14~0.28 | SpectralEfficiency - 03 Rural-eMBB\_v46\_r14\_200111SAT233856\_attn.xlsx |
| Uplink | 0.045 | 0.09-0.15 |
| Downlink | 0.12 | 0.24~0.81 |
| Uplink | 0.045 | 0.07~0.34 |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 12.27~16.87 | SpectralEfficiency - 01 InH-eMBB\_v44\_r18\_200111SAT233633\_attn.xlsx |
| Uplink | 6.75 | 6.08~10.19 |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 10.38~22.33 | SpectralEfficiency - 02 DenseUrban-eMBB\_v47\_r14-corr\_200111SAT233749\_attn.xlsx |
| Uplink | 5.4 | 6.1~10.5 |
| eMBB | Rural – eMBB | Downlink | 3.3 | 4.79~11.62 | SpectralEfficiency - 03 Rural-eMBB\_v46\_r14\_200111SAT233856\_attn.xlsx |
| 11.1~21.1 |
| Uplink | 1.6 | 4.3~6.3 |
| 3.1~10.8 |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | 34,549,380 ~ 35,076,402 | ConnectionDensity -UrbanMacro-mMTC - Fullbuffer SLS+LLS-v9\_r1\_200111SAT234249\_attn.xlsx |
| 1,277,408 ~ 1,488,275 |
| **5.2.4.3.11** Reliability *(4.10)* | URLLC | Urban Macro –URLLC | Uplink | 1-10−5 success probability of transmitting a layer 2 PDU (protocol data unit) of size 32 bytes within 1 ms in channel quality of coverage edge | >99.999% ~ 99.9999999% | Reliability - UrbanMacro-URLLC\_v19\_200111SAT234206\_attn.xlsx |
| Uplink | 99.99967% ~ 99.9999999% |
| Downlink | 99.99965% ~ 99.999999% |
| Downlink | 99.99954% ~ 99.9999991% |
| **5.2.4.3.13**  Mobility Traffic channel link data rates (bit/s/Hz) *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | 1.5 (10 km/h) | 1.59~2.07 | Mobility - 01 IndoorHotspot-eMBB\_v19\_200111SAT234059\_attn.xlsx |
| 2.84~2.84 |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | 1.79~2.22 | Mobility - 02.DenseUrban-eMBB\_v18\_200111SAT234117\_attn.xlsx |
| 1.24~1.24 |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | 2.06~2.22 | Mobility -03\_Rural-eMBB\_v18\_200111SAT234132\_attn.xlsx |
| 0.45 (500 km/h) | 1.62~2.00 |
| 0.8 (120 km/h) | 1.16~1.74 |
| 0.45 (500 km/h) | 0.83~1.33 |

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