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| **Radiocommunication Study Groups** |  |
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| **12 February 2020** |
| **English only** |
| Director, Radiocommunication Bureau[[1]](#footnote-1) | |
| FINAL evaluation Report from The Fifth Generation Mobile Communications Promotion Forum on the IMT-2020 proposal in Document IMT-2020/18(rev.1) (“Nufront” 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-2020/18(Rev.1) 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 Nufront and provides its partial 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 submitted their simulation results there.

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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 EUHT, as an RIT, the candidate technology submission in Document IMT-2020/18(Rev.1).

# 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

Several gaps or deficiencies in E) have been identified in submitted material and its corresponding self‑evaluation. In the evaluation captured in E) and Annex A, an MMSE algorithm of the best performance among many types of MMSE Receivers, such as MMSE‑IRC, is applied as per technical information given by the proponent.

## 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, Nufront RIT has no ability to support the usage scenarios of eMBB and URLLC. |
| (1) As defined in Report ITU-R M.2410-0. | | |

## 2 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 |  |  | Not assessed |
| Uplink | 10 |  |  |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 |  |  | Not assessed |
| Uplink | 15 |  |  |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 |  |  | Not assessed |
| Uplink | 50 |  |  |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.03~0.24 | Yes 🗹 No | For evaluation configuration of 4 GHz. Channel model A/B, 12/36 TRxP |
| Uplink | 0.21 | 0.08~0.18 | Yes 🗹 No |
| Downlink | 0.3 | 0.01~0.06 | Yes 🗹 No | For evaluation configuration of 30 GHz. Channel model A/B, 12/36 TRxP |
| Uplink | 0.21 | 0.05~0.10 | Yes 🗹 No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.22~0.292 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Channel model A/B. |
| Uplink | 0.15 | 0.08~0.1 | Yes 🗹 No |
| Downlink | 0.225 | 0.001 | Yes 🗹 No | For evaluation configuration of 30 GHz, Channel model A/B. |
| Uplink | 0.15 | 0 | Yes 🗹 No |
| eMBB | Rural – eMBB | Downlink | 0.12 |  |  | Not assessed |
| Uplink | 0.045 | 0.002~0.017 | Yes 🗹 No |  |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 4.93~7.35 | Yes 🗹 No | For evaluation configuration of 4 GHz. Channel model A/B, 12/36 TRxP |
| Uplink | 6.75 | 2.71~4.09 | Yes 🗹 No |
| Downlink | 9 | 4.77~5.42 | Yes 🗹 No | For evaluation configuration of 30 GHz. Channel model A/B, 12/36 TRxP |
| Uplink | 6.75 | 2.48~3.61 | Yes 🗹 No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 7.412~7.74 | Yes 🗹 No | For evaluation configuration of 4 GHz, Channel model A/B. |
| Uplink | 5.4 | 3.58~3.73 | Yes 🗹 No |
| Downlink | 7.8 | 5.53 | Yes 🗹 No | For evaluation configuration of 30 GHz, Channel model A/B. |
| Uplink | 5.4 | 1.7 | Yes 🗹 No |
| eMBB | Rural – eMBB | Downlink | 3.3 |  |  | Not assessed |
| Uplink | 1.6 | 3.26~3.60 | 🗹 Yes  No | For evaluation configuration of 4 GHz, Channel model A/B. |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 |  |  | Not assessed |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 |  |  | Not assessed |
| URLLC | Not applicable | Uplink and Downlink | 1 |  |  | Not assessed |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | Not applicable | Not applicable | 20 |  |  | Not assessed |
| URLLC | Not applicable | Not applicable | 20 |  |  | Not assessed |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 |  |  | Not assessed |
| **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 |  |  | Not assessed |
| **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 | 0.24% | Yes 🗹 No | For evaluation configuration A (4 GHz), Channel model A. |
| Downlink | 99.531% | Yes 🗹 No | For evaluation configuration A (4 GHz), Channel model A. |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian |  |  | Not assessed |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) |  |  | Not assessed |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular |  |  | Not assessed |
| **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) |  |  | Not assessed |
|  |  | Not assessed |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) |  |  | Not assessed |
|  |  | Not assessed |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) |  |  | Not assessed |
| 0.45 (500 km/h) |  |  |
| 0.8 (120 km/h) |  |  | Not assessed |
| 0.45 (500 km/h) |  |  | Not assessed |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 |  |  | Not assessed |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz |  |  | Not assessed |
| Up to 1 GHz |  | Not assessed |
| Support of multiple different bandwidth values(4) |  | Not assessed |
| (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-2020/18(Rev.1).

## Summary the Final 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 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 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-2 Average spectral efficiency

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

## A-3 Reliability

Simulation results of Reliability 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 (source 1) | Value (source 2) | Simulation results (in Excel files) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Usage scenario | Test environment | Downlink or uplink |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.03~0.24 | 0.237 | SpectralEfficiency - 01 InH-eMBB-v01\_.xlsx |
| Uplink | 0.21 | 0.08~0.18 | 0.173 |
| Downlink | 0.3 | 0.01~0.06 | None |
| Uplink | 0.21 | 0.05~0.10 | None |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.22~0.25 | 0.292 | SpectralEfficiency - 02 DenseUrban-eMBB-v01.xlsx |
| Uplink | 0.15 | 0.08~0.1 | 0.088 |
| Downlink | 0.225 | 0.001 | None |  |
| Uplink | 0.15 | 0 | None |
| eMBB | Rural – eMBB | Downlink | 0.12 | None | None | SpectralEfficiency - 03 Rural-eMBB-v01.xlsx |
| Uplink | 0.045 | 0.002~0.017 | None |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 4.93~7.35 | 7.344 | SpectralEfficiency - 01 InH-eMBB-v01.xlsx |
| Uplink | 6.75 | 2.71~3.98 | 4.09 |
| Downlink | 9 | 4.77~5.42 | None |
| Uplink | 6.75 | 2.48~3.61 | None |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 7.68~7.74 | 7.412 | SpectralEfficiency - 02 DenseUrban-eMBB-v01.xlsx |
| Uplink | 5.4 | 3.58~3.71 | 3.73 |
| Downlink | 7.8 | 5.53 | None |
| Uplink | 5.4 | 1.7 | None |
| eMBB | Rural – eMBB | Downlink | 3.3 |  | None | SpectralEfficiency - 03 Rural-eMBB-v01.xlsx |
| Uplink | 1.6 | 3.26~3.60 | None |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | None | None |  |
| None | None |
| **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 | 92.37% | None | Reliability - UrbanMacro-URLLC.xlsx |
| Downlink | 99.54% | None |
| **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) | None | None |  |
| None | None |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | None | None |  |
| None | None |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | None | None |  |
| 0.45 (500 km/h) | None | None |
| 0.8 (120 km/h) | None | None |
| 0.45 (500 km/h) | None | None |

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1. Submitted on behalf of The Fifth Generation Mobile Communications Promotion Forum (5GMF). [↑](#footnote-ref-1)