# 5G India Forum (5GIF)

The **5GIF IEG** is one of the independent evaluation groups registered with ITU-R for IMT-2020 candidate radio technology evaluation. This group was formed by the **COAI** to evaluate the IMT-2020 candidates from the perspective of Indian network deployments. This is a group of operators, OEM’s, universities and individual experts participating in a collaborative manner, in the evaluation of the candidate IMT-2020 technologies of interest. This is a contribution driven activity, with decisions made through a consensus seeking approach.

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<https://5gif.github.io>

**Technical aspects of the work of the Independent Evaluation Group:**

What candidate technologies or portions of the candidate technologies this IEG is or might anticipate evaluating?

The 5GIG currently intends to evaluate candidate technologies as per the table below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **IMT-2020 SUBMISSION** | | | | | | |
| **3GPP** | | **CHINA** | **KOREA** | **TSDSI** | **ETSI (TC DECT), DECT FORUM** | **Nufront** |
| **RIT** | **SRIT** |
| IMT-2020/14 | IMT-2020/13 | IMT-2020/15 | IMT-2020/16 | IMT-2020/19 | IMT-2020/17 | IMT-2020/18 |
| ✔ | ✔\* | ✔ | ✔ |  | ✔\* |  |

\* Partial evaluation

**Documentation of any additional evaluation methodologies that are or might be developed by the Independent Evaluation Group to complement the evaluation guidelines;**

The 5GIF IEG has not used any additional evaluation methodologies in the interim report. It however aspires to provide certain additional results based on the resource availability within the group, between now and the final report submission. If such results are provided, then those scenarios will be properly reported and submitted to WP5D.

The 5GIF IEG can confirm that it has assessed the candidate technologies it intends to evaluate based on Reports ITU-R M.2410, ITU-R M.2411 and ITU-R M.2412



5GIF Evaluation Report

Technical - Revision 1.0

Background

Based on the information shared with ITU-R WP5D via LS [5D/1304](https://www.itu.int/md/R15-WP5D-C-1304/en), the intent of 5G India Forum (5GIF) IEG is to evaluate the candidate technologies as per the following table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| IMT-2020 SUBMISSION | | | | | | |
| 3GPP | | CHINA | KOREA | TSDSI | ETSI (TC DECT), DECT FORUM | Nufront |
| RIT | SRIT |
| IMT-2020/14 | IMT-2020/13 | IMT-2020/15 | IMT-2020/16 | IMT-2020/19 | IMT-2020/17 | IMT-2020/18 |
| ✔ | ✔\* | ✔ | ✔ |  | ✔\* |  |

\* Partial evaluation

5GIF utilized the ITU-R Guidelines for evaluation of radio interface technologies for IMT-2020 provided in ITU-R Report [M.2412](https://www.itu.int/pub/R-REP-M.2412).

# **Interim Evaluation Report**

This document is an interim evaluation report of the 3GPP RIT candidate technology (IMT-2020/14). This report has evaluation of the 3GPP NR technology and refers the various information from the corresponding 3GPP Specifications (as provided by the proponents), ITU-R submissions and Self-evaluation reports submitted by 3GPP with respect to the IMT-2020/14.

This evaluation is also applicable to other candidate technologies (IMT-2020/13[[1]](#footnote-1), IMT-2020/15, IMT-2020/16 and IMT-2020/17[[2]](#footnote-2)) that are technically identical to the 3GPP NR RIT (IMT-2020/14), as identified by WP5D in WP5D-32bis (Buzios).

Chapter 1

Verification of Compliance Templates of candidate Technology

## Verification as per Report ITU-R M.2411 of the compliance templates and the self-evaluation for the candidate technology under consideration

[Editor’s note:

• Identify gaps/deficiencies in submitted material and/or self-evaluation;

• Identify areas requiring clarifications;

• General questions

]

At the WP5D-32bis meeting, WP5D has already identified that the candidate submission IMT-2020/14 complies with the requirement in M.2411.

1. The 5GIF IEG did its independent verification and concluded that the compliance templates are complete and self sufficient
   1. The 5GIF IEG did not identify any technical deficiency with their submission.
   2. There were a few minor gaps identified in their link budget template documents (submitted as excel documents). The 5GIF IEG has provided link budget documents with this submission which fixes them. However, with those changes the impact to coverage / range of data / control observed are only marginal.
2. The 5GIF IEG found the self-evaluation report submitted by the proponents to be complete and sufficient for us to independently evaluate

The 5GIF hereby recommends for this candidate technology to move further in the IMT process, as previously identified by WP5D.

Chapter 2

Detailed Assessment of compliance Templates of candidate technology

[ Editor Note :

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

1. Detailed analysis/assessment and evaluation by the IEGs of the compliance templates submitted by the proponents per the Report ITU-R M.2411 section 5.2.4;
2. Additional comments in the templates along with supporting documentation for such comments;
3. Analysis of the proponent’s self-evaluation by the IEG;

]

As per the ITU-R Report M.2411, there are three main categories of evaluation methodologies corresponding to the 13 different key Minimum Technical Performance Indicators viz. Analytical, Inspection and Simulation. This report contains separate attachments (refer Chapter 4) for each of the individual methodology, summarized as per below.

Our final report may add some additional observations on this submission in this chapter.

# **2.1 Summary of Evaluation Methods**

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristic for evaluation | High-level assessment method | Evaluation methodology | Related section of Reports ITU-R M.2410-0 and ITU-R M.2411-0 |
| Peak data rate | Analytical | § 7.2.2 | Report ITU-R M.2410-0, § 4.1 |
| Peak spectral efficiency | § 7.2.1 | Report ITU-R M.2410-0, § 4.2 |
| User experienced data rate\* | § 7.2.3 | Report ITU-R M.2410-0, § 4.3 |
| Area traffic capacity | § 7.2.4 | Report ITU-R M.2410-0, § 4.6 |
| User plane latency | § 7.2.6 | Report ITU-R M.2410-0, § 4.7.1 |
| Control plane latency | § 7.2.5 | Report ITU-R M.2410-0, § 4.7.2 |
| Mobility interruption time | § 7.2.7 | Report ITU-R M.2410-0, § 4.12 |
| Energy efficiency | Inspection | § 7.3.2 | Report ITU-R M.2410-0, § 4.9 |
| Bandwidth | § 7.3.1 | Report ITU-R M.2410-0, § 4.13 |
| Support of wide range of services | § 7.3.3 | Report ITU-R M.2411-0, § 3.1 |
| Supported spectrum band(s)/range(s) | § 7.3.4 | Report ITU-R M.2411-0, § 3.2 |
| Average spectral efficiency | Simulation | § 7.1.1 | Report ITU-R M.2410-0, § 4.5 |
| 5th percentile user spectral efficiency | § 7.1.2 | Report ITU-R M.2410-0, § 4.4 |
| Connection density | § 7.1.3 | Report ITU-R M.2410-0, § 4.8 |
| Reliability | § 7.1.5 | Report ITU-R M.2410-0, § 4.10 |
| Mobility | § 7.1.4 | Report ITU-R M.2410-0, § 4.11 |

\**Analytical for single band and single-layer, Simulation for multi-layer*

# **2.2 Link Budget Tables**

The link budget tables for the candidate technology in IMT-2020/14 for the different channel models being considered is embedded below.

Channel model A:



Channel model B:



Note: the 5GIF evaluation team has identified some minor discrepancies in the link budget tables, when compared with the ones submitted by the proponents. 5GIF will engage the proponents to understand this better and make a final assessment later.

[Editor’s note: the link budget tables can change based on the discussions with the 3GPP proponent]

Chapter 3

COMPLIANCE TEMPLATES

This chapter provides templates for the responses that are needed to assess the compliance of a candidate RIT or SRIT with the minimum requirements of IMT-2020. This assessment is independently done based on the characteristic template and 3GPP specification referred in the submission by the proponents.

The compliance templates are:

– Compliance template for services;

– Compliance template for spectrum; and,

– Compliance template for technical performance.

As per the ITU-R Report M.2411, Section 5.2.4, the 5GIF IEG evaluation summary is as below:

# **3.1 Services**

***Note***: The below template are from relevant sections from M.2411.

5.2.4.1 Compliance template for services[[3]](#footnote-3)

|  |  |  |
| --- | --- | --- |
|  | **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)?  [x] YES / ~~No~~  Specify which usage scenarios (eMBB, URLLC, and mMTC) the candidate RIT or candidate SRIT can support.(1) | [x] YES / ~~No~~  The 3GPP NR (RIT) supports all the three usage scenarios (eMBB,URLLC and mMTC) through configurable slot types (DL/UL combinations), different bandwidth combinations and schemes to support large number devices for mMTC |
| (1) Refer to the process requirements in IMT-2020/2. | | |

# **Spectrum**

5.2.4.2 Compliance template for spectrum3

|  |  |
| --- | --- |
|  | **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.  *The proponent has identified support for the following bands in their submission.*   |  |  |  |  | | --- | --- | --- | --- | | **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 | | 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 | | 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 |   *Inference: Thus, the proponents RIT has support for bands identified for IMT-2020.*  *Note 1: The evaluation group made use of 3GPP TS 38.104 for this inference*  *Note 2: Text highlighted in blue are possible candidate bands in India, and the 5GIF Evaluation will prioritize our studies on them* |
| **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.  *The proponent has identified support for the following bands in their submission.*   |  |  |  | | --- | --- | --- | | **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 |   *Thus, the proponents RIT has support for bands identified for IMT-2020.*  *Inference: Thus, the proponents RIT has support for bands identified for IMT-2020.*  *Note 1: The evaluation group made use of 3GPP TS 38.104 for this inference.* |

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# **3.3 Technical Performance**

**5.2.4.3 Compliance template for technical performance3**

| **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 | 21.1 – 34.98 | ✓ Yes | See Chapter 4 - Analytical Report  Using multiple CC for bandwidth (500-800 MHz) |
| Uplink | 10 | 10.8 – 19.0 | ✓ Yes |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 | 31.7 – 47.9 | ✓ Yes | Chapter 4 - Analytical Report |
| Uplink | 15 | 18.2 – 22.8 | ✓ Yes |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 |  | Yes  No |  |
| Uplink | 50 |  | Yes  No |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 |  | Yes  No | Chapter 4 – Simulation Report  Will be included in the final report |
| Uplink | 0.21 |  | Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 |  | Yes  No |
| Uplink | 0.15 |  | Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 |  | Yes  No |
| Uplink | 0.045 |  | Yes  No |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 |  | Yes  No |
| Uplink | 6.75 |  | Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 |  | Yes  No |
| Uplink | 5.4 |  | Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 |  | Yes  No |
|  | Yes  No |
| Uplink | 1.6 |  | Yes  No |
|  | Yes  No |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 |  | Yes  No | Will be included in the final report |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 | 0.82 – 3.9 | ✓ Yes | See Chapter 4 – Analysis Report  Using various TTI duration (mini-slots), flexible UL & DL format and SCS allows to achieve UP latency below 4ms in both FDD & TDD |
| URLLC | Not applicable | Uplink and Downlink | 1 | 0.31 – 0.96 | ✓ Yes | See Chapter 4 – Analysis Report  Using various TTI duration (mini-slots), flexible UL & DL format and SCS allows to achieve UP latency below 1ms in both FDD & TDD |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | Not applicable | Not applicable | 20 | 8.5 – 20 | ✓ Yes | See Chapter 4 – Analysis Report  Using various TTI duration (mini-slots), flexible UL & DL format and SCS allows to achieve UP latency below 1ms in both FDD & TDD |
| URLLC | Not applicable | Not applicable | 20 | 6.7 – 10 | ✓ Yes | See Chapter 4 – Analysis Report  Using various TTI duration (mini-slots), flexible UL & DL format and SCS allows to achieve UP latency below 1ms in both FDD & TDD |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | 1 465 000 – 35 021 000 | ✓ Yes | See Chapter 4 –  Simulation Report-Connection Density  Corresponds to cells ISD, 1732 m and 500 m, respectively. |
| **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 | ✓ Yes | See Chapter 4 –  Inspection Report  For all bandwidth configurations 3GPP NR supports sleep ratio of more than 99% at symbol and slot level |
| **5.2.4.3.11** Reliability *(4.10)* | URLLC | Urban Macro –URLLC | Uplink or Downlink | 1-10−5 success probability of transmitting a layer 2 PDU (protocol data unit) of size 32 bytes within 1 ms in channel quality of coverage edge | Yes | ✓ Yes | See Chapter 4 –  Simulation Report-Reliability  3GPP NR supports multiple code rates for which reliable packet transmission targeting 10-5 BLER is possible by allocating different number of PRB’s for the same user |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian | Yes | ✓ Yes | See Chapter 4 –  Simulation Report-Mobility |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | Yes | ✓ Yes |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular | Yes | ✓ Yes |
| **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 – 2.05 | ✓ Yes | See Chapter 4 –  Simulation Report-Mobility  The achievable link data rates exceed the ITU requirement over multiple configuration (700 MHz & 4 GHz); duplex schemes (FDD/TDD); LoS/N-LoS |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | 1.82 – 2.22 | ✓ Yes |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | 1.18 – 2.90 | ✓ Yes |
| 0.45 (500 km/h) | 0.92 – 2.39 | ✓ Yes |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 | 0 | ✓ Yes | See Chapter 4 – Analysis Report  3GPP NR supports beam mobility and CA mobility to allow make-before-break resulting into 0 ms mobility interruption time |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz | 100 MHz and more | ✓ Yes | See Chapter 4 – Inspection Report  3GPP NR supports different component carrier bandwidth from 5 MHz to 100 MHz (in FR1), and allows up to 16 component carrier aggregation |
| Up to 1 GHz | 1 GHz and more | ✓ Yes | See Chapter 4 – Inspection Report  3GPP NR supports different component carrier bandwidth from 50 MHz to 400 MHz (in FR2), and allows up to 16 component carrier aggregation |
| Support of multiple different bandwidth values(4) | Supported | ✓ Yes |  |
| (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. | | | | | | | |

Chapter 4

Detailed Evaluation Report of IMT-2020/14 (3GPP NR RIT)

This chapter provides the details of the evaluation and 5GIF findings on the 3GPP RIT candidate IMT-2020/14.

1. Analysis Report



1. Inspection Report



1. Simulation Report

[Editor Note – Insert/Embed Simulation Report for Spectral Efficiency]

|  |  |  |  |
| --- | --- | --- | --- |
| **Connection Density** | **Mobility** | **Reliability** | **Spectral Efficiencies** |
|  |  |  | Work in progress |

Chapter 5

Verification & Assessment of Submission of other candidate Technologies

[

Editor Note :

5GIF Observations on other candidate technologies

1. gaps/deficiencies in submitted material and/or self-evaluation;
2. Identify areas requiring clarifications;
3. Analysis/assessment and evaluation the compliance templates submitted by the proponents per the Report ITU-R M.2411 section 5.2.4;
4. Additional comments to the compliance templates
5. Analysis and Observations of the proponent’s self-evaluation

]

Conclusion

The simulation-based performance evaluation remains work under progress. This will be completed in time for WP5D#34, when WP5D needs the final report. Once this is completed, the 5GIF will be able to make a complete recommendation of IMT-2020 candidate technologies of our interest.

1. 3GPP NR RIT is a component RIT of the SRIT in IMT-2020/13 [↑](#footnote-ref-1)
2. 3GPP NR RIT is the eMBB component of IMT-2020/17 [↑](#footnote-ref-2)
3. If a proponent determines that a specific question does not apply, the proponent should indicate that this is the case and provide a rationale for why it does not apply. [↑](#footnote-ref-3)