|  |  |
| --- | --- |
| **Radiocommunication Study Groups** |  |
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|  |  |
| Subject: Document 5D/28 | **Document 5D/90-E** |
| **12 February 2020** |
| **English only**  **TECHNOLOGY ASPECTS** |
| Director, Radiocommunication Bureau[[1]](#footnote-1)\* | |
| CEG Evaluation Report on the Candidate Proposals for  IMT-2020 submitted to Working Party 5D | |
| Report with Final Results | |

Note: This evaluation report follows the structure suggested in Document [5D/TEMP/769(Rev1)](https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Documents/5D_TD_769Rev1e_LS_IEGs.docx).

Part I

Administrative aspects of the Independent Evaluation Group

# 1 Name of the Independent Evaluation Group

The evaluation group is known as the Canadian Evaluation Group or CEG.

# 2 Introduction/background of the Independent Evaluation Group

The CEG was founded in 1996 under the auspices of the Canadian National Organization (CNO) and is subject to the CNO process in its method of work. At the time it was established, the objective was to respond to the ITU-R request for evaluations of candidate IMT-2000 Radio Transmission Technology (RTT) submissions as per ITU-R Circular Letter 8/LCCE/47. Of the fifteen technologies that were submitted (ten terrestrial, five satellite), only the terrestrial technologies were evaluated using the method explained in Recommendation ITU-R M.1225. Both time (1 July – 30 September 1998) and resources being limited, the CEG decided to give priority to the most important evaluation criteria/attributes (each criterion had several attributes) as signified by the category G1 in Recommendation ITU-R M.1225. A coordinator was appointed for each criterion and tasked with the duty of developing a summary report for that criterion. The final report of the CEG on the candidate IMT-2000 technologies can be found on the CEG website as indicated in § 6.1 – a total of five technologies were identified as “IMT-2000”. Detailed specifications of these technologies can be found in Recommendation ITU-R M.1457 – which is being revised even to this day.

Subsequently, the CEG was re-convened in 2007 to evaluate a sixth candidate proposal. The same process was followed as previously with each coordinator evaluating category G1 criteria and as many of the G2, G3 and G4 categories as possible. This proposal was also accepted as an IMT-2000 technology – with the result that Recommendation ITU-ITU-R M.1457 now contains six Radio Transmission Technologies.

In 2008 the CEG continued its activities under the auspices of the CNO for the evaluation of candidate Radio Interface Technologies (RITs) for IMT-Advanced (cf. ITU-R Circular Letter [5/LCCE/2](https://www.itu.int/md/R00-SG05-CIR-0002/en)). For details refer to Document [5D/781](https://www.itu.int/md/R15-WP5D-C-0781/en) (3 June 2010), available on the CEG website as indicated in § 6.1.

At the outset, the CEG established an official list of participants and an “unofficial” list of contributors – who were required occasionally to help the participants answer questions or perform complex technical analyses in specific cases. The rules and procedures that governed the CEG work were based on the CNO manual. In a bid to ensure that its work emphasized the **independent** view sought by the ITU in its original call to establish Independent Evaluation Groups (IEGs), the CEG introduced a rule that its members should not participate in other EGs. Conversely, members of other EGs could not participate in the work of the CEG.

# 3 Method of work

The CEG continues its activities under the auspices of the CNO.

The method of work included:

1) Formal meetings at the CEG Plenary level.

2) Generation of detailed reports (containing analyses, theoretical calculations, etc.) that were then discussed by all participants.

3) Conference calls as required.

4) E-mail exchanges as required.

5) Face-to-face meetings at the coordinators’ level as required.

# 4 Administrative contact details

Dr. José Costa, webmaster of the CEG web site (see § 6.1). [jose.costa@ericsson.com](mailto:jose.costa@ericsson.com)

# 5 Technical contact details

Dr. Venkatesh Sampath, Chairman, Canadian Evaluation Group (CEG). [ven.sampath@ericsson.com](mailto:ven.sampath@ericsson.com)

# 6 Other pertinent administrative information

## 6.1 CEG web site

The CEG consolidated its former IMT-2000 and IMT-Advanced websites to include also IMT-2020 and future generations of IMT under a single web-site:

[www.IMT-CEG.ca](http://www.IMT-CEG.ca)

## 6.2 Candidate proposals submitted to ITU-R and actions taken

The following Table 6.2.1 summarizes the candidate submissions and the actions taken by WP 5D.

Table 6.2.1

Candidate technologies to be evaluated (as determined by the ITU-R)

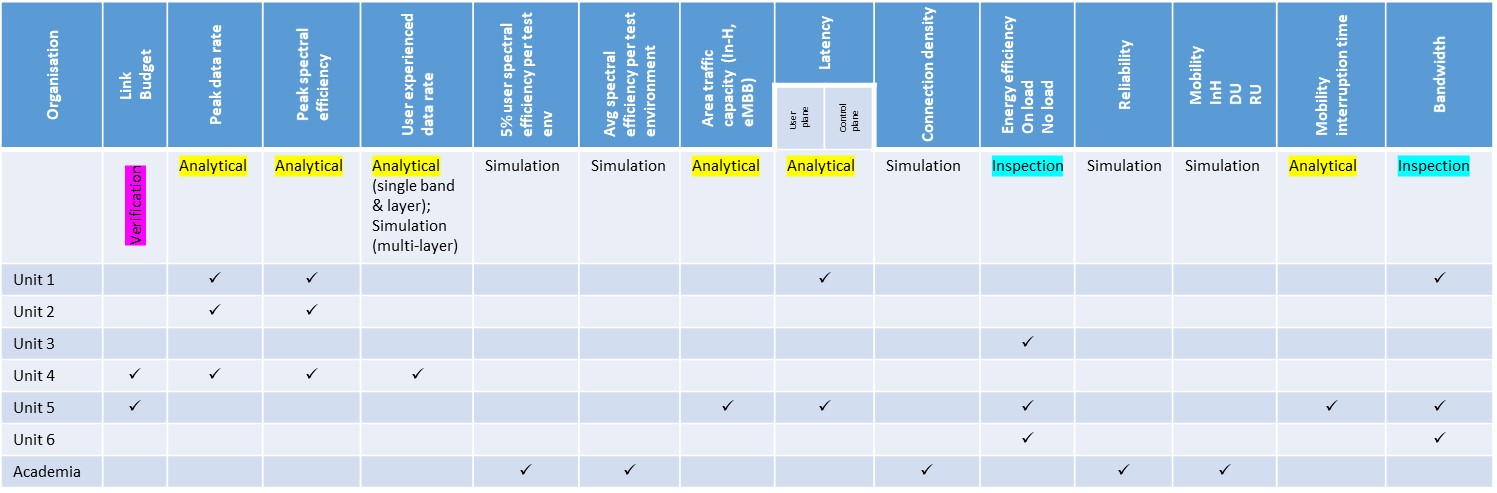
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Proponent | 3GPP | 3GPP | China | Korea | ETSI  (TC DECT) | Nufront | TSDSI |
| Original submission in | Documents [5D/1215](https://www.itu.int/md/R15-WP5D-C-1215/en) and [5D/1216](https://www.itu.int/md/R15-WP5D-C-1216/en) | Documents [5D/1215](https://www.itu.int/md/R15-WP5D-C-1215/en) and [5D/1217](https://www.itu.int/md/R15-WP5D-C-1217/en) | Document [5D/1268](https://www.itu.int/md/R15-WP5D-C-1268/en) | Document [5D/1233](https://www.itu.int/md/R15-WP5D-C-1233/en) | Documents [5D/1230](https://www.itu.int/md/R15-WP5D-C-1230/en) and [5D/1253](https://www.itu.int/md/R15-WP5D-C-1253/en) | Document [5D/1238](https://www.itu.int/md/R15-WP5D-C-1238/en) | Document [5D/1231](https://www.itu.int/md/R15-WP5D-C-1231/en) |
| WP 5D acknowledgement | Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) | Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) | Document [IMT-2020/15](https://www.itu.int/md/R15-IMT.2020-C-0015/en) | Document [IMT-2020/16](https://www.itu.int/md/R15-IMT.2020-C-0016/en) | Document [IMT-2020/17](https://www.itu.int/md/R15-IMT.2020-C-0017/en) | Document [IMT-2020/18](https://www.itu.int/md/R15-IMT.2020-C-0018/en) | Document [IMT-2020/19](https://www.itu.int/md/R15-IMT.2020-C-0019/en) |
| Complete submission? | Yes | Yes | Yes | Yes | Determination Pending | Determination Pending | Determination Pending |
| Classification / Technology label | SRITT:  NR component RIT and  E-UTRA/LTE component RIT | RIT | RIT | RIT | SRIT:  “DECT-2020 NR” component RIT and  “3GPP 5G NR” component RIT | RIT | RIT |
| WP 5D Observations | Document [IMT-2020/23](https://www.itu.int/md/R15-IMT.2020-C-0023/en) | Document [IMT-2020/23](https://www.itu.int/md/R15-IMT.2020-C-0023/en) | Document [IMT-2020/24](https://www.itu.int/md/R15-IMT.2020-C-0024/en) | Document [IMT-2020/25](https://www.itu.int/md/R15-IMT.2020-C-0025/en) | Document  [IMT-2020/26](https://www.itu.int/md/R15-IMT.2020-C-0026/en) | Document [IMT-2020/27](https://www.itu.int/md/R15-IMT.2020-C-0027/en) | Document [IMT-2020/28](https://www.itu.int/md/R15-IMT.2020-C-0028/en) |
| 10 Sep 2019 updates |  |  |  |  | Document [5D/1299](https://www.itu.int/md/R15-WP5D-C-1299/en) | Document [5D/1300](https://www.itu.int/md/R15-WP5D-C-1300/en) | Document [5D/1301](https://www.itu.int/md/R15-WP5D-C-1301/en) |

## 6.3 CEG Members

The CEG’s members are shown in Table 6.3.1, as are the responsibilities each accepted.

Table 6.3.1

Matrix of Responsibilities

Technical performance requirements (TPRs) to evaluate for IMT-2020

NOTE 1: For each test environment (5 in all), up to 3 evaluation configurations could be specified, but only 1 for candidate to pass (and 1 for each IEG to evaluate).

NOTE 2: Simulations conducted by the CEG academic partners – Institut national de recherche scientifique (INRS) and University of Toronto.

Part II

Technical aspects of the work of the Independent Evaluation Group

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

# 7 Technologies evaluated by the CEG

Notes to Table 7.1.

NOTE 1 – As illustrated in table 7.1, the CEG will evaluate both the SRIT and the RIT submitted by 3GPP. It is the CEG’s understanding that such evaluation applies to the candidates from China and Korea, so no separate activity is foreseen on those two submissions.

NOTE 2 – Further, the CEG intends to evaluate the submissions from TSDSI and ETSI (TC DECT)/DECT FORUM (though in the case of the latter, it will be only the DECT component RIT, as the CEG’s assumption is that the 3GPP evaluation will apply to the 3GPP component). Finally, time permitting, the CEG will also evaluate the candidate submission from Nufront.

Table 7.1

CEG intention to evaluate technologies or parts thereof

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| IMT-2020 SUBMISSION (document number in parentheses) | | | | | | | |
|  | 3GPP | | CHINA (#15) | KOREA (#16) | TSDSI (#19) | ETSI-DECT (#17) | Nufront (#18) |
| RIT (#14) | SRIT (#13) |
| [Canadian Evaluation Group](https://www.itu.int/oth/R0A06000072/en) ([CEG web site](http://www.imt-ceg.ca/)) | Will evaluate | Will evaluate | Not evaluate (because WP 5D has determined that the 3GPP evaluation applies to this candidate, too) See Note 1 | Not evaluate (because WP 5D has determined that the 3GPP evaluation applies to this candidate, too) See Note 1 | Partial evaluation See Note 2 | Partial evaluation (only the DECT component RIT) See Note 2 | Partial evaluation See Note 2 |
| **Parameters via Inspection** |  |  |  |  |  |  |  |
| Bandwidth | 🗸 | 🗸 |  |  |  | 🗸 | 🗸 |
| Energy Efficiency | 🗸 | 🗸 |  |  |  | N/A | 🗸 |
| Spectrum | 🗸 | 🗸 |  |  |  | 🗸 | 🗸 |
| Services | 🗸 | 🗸 |  |  |  | 🗸 | 🗸 |
| **Parameters via Analysis** |  |  |  |  |  |  |  |
| Peak data rate | 🗸 | 🗸 |  |  |  |  | 🗸 |
| Peak spectral efficiency | 🗸 | 🗸 |  |  |  |  | 🗸 |
| User experienced data rate | 🗸 | 🗸 |  |  |  |  |  |
| Area traffic capacity | 🗸 | 🗸 |  |  |  |  |  |
| Latency (UP and CP) | 🗸 | 🗸 |  |  |  |  |  |
| Mobility interruption time | 🗸 | 🗸 |  |  |  |  |  |
| **Parameters via Simulation** |  |  |  |  |  |  |  |
| Average spectral efficiency | 🗸 | 🗸 |  |  |  | N/A | Incomplete data |
| 5% spectral efficiency | 🗸 | 🗸 |  |  |  | N/A | Incomplete data |
| Mobility | 🗸 | 🗸 |  |  |  | N/A | Incomplete data |
| Reliability | 🗸 | N/A |  |  |  | 🗸 | Incomplete data |
| Connection density | 🗸 | 🗸 |  |  |  | Incomplete data | Incomplete data |

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

# 8 Evaluation Guidelines

The CEG confirms it has utilized the ITU-R evaluation guidelines in Report ITU-R [M.2412](https://www.itu.int/pub/R-REP-M.2412).

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

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

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

– Identify areas requiring clarifications;

– General questions.

# 9 Identify areas requiring clarifications

TSDSI – average spectral efficiency and mobility evaluations via simulation (against 30 km/h, since there is no technical performance requirement in Report ITU-R [M.2410](https://www.itu.int/pub/R-REP-M.2410))

TSDSI – link budget calculations for LMLC (“uploaded” question sent to TSDSI proponent and their response to the [Evaluation Groups Discussion Area](https://extranet.itu.int/itu-r/imt2020-evalgroup/SitePages/Home.aspx?RootFolder=%2Fitu%2Dr%2Fimt2020%2Devalgroup%2FLists%2FComments%2FClarification%20request%20and%20response%20from%20TSDSI%20proponent%20on%20link%2Dbudget%20CEG%2019Oct19&FolderCTID=0x012002008CFD5FDD9B14EE47987B1CC61E92434A&View=%7b55CE2E3D-3BA8-4AC1-B42B-0787393E9FDE%7d)).

At the 33rd meeting of WP 5D of the ITU in Geneva, the CEG and TSDSI had further discussions on the above question, in particular the additional 12 dB used in the link-budget, but could not reach an agreement on the interpretation of the channel model in Report ITU-R [M.2412](https://www.itu.int/pub/R-REP-M.2412).

# 10 Compliance templates

## 10.1 Compliance templates for 3GPP SRIT

All three compliance templates are enclosed in the sections that follow.

### 10.1.1 Services

#### Compliance template for services[[2]](#footnote-2)

|  |  |  |
| --- | --- | --- |
|  | 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 CEG has verified that the SRIT can support the eMBB, URLLC and mMTC usage scenarios, both from the point of view of the applications supported in these scenarios and the technical performance requirements. NR component supports all three, LTE component supports eMBB and mMTC. |
| (1) Refer to the process requirements in IMT-2020/2. | | |

### 10.1.2 Spectrum

#### 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 SRIT can operate in all the bands identified for IMT within the range 450 – 6000 MHz and specifications already exist for some of the bands identified for IMT in the range 24250 – 52600 MHz. Support for frequency bands identified for IMT above 52600 MHz is under study in 3GPP. |
| **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 mentioned above, the SRIT can operate in bands in the range 24250 – 52600 MHz, while support for frequency bands above 52600 MHz is under study in 3GPP. |

### 10.1.3 Technical Performance

In this section, note that the parameters to be evaluated by inspection and analysis are fulfilled by both the NR component RIT and the LTE component RIT. In the case of parameters to be evaluated by simulation, the CEG concentrated on the LTE component RIT, since a separate compliance template is anyway included for 3GPP NR RIT in § 10.2 (and for technical performance specifically, in § 10.2.3).

| 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 | 74.72-173-6 | 🗹 Yes  No | § 11.1.5 & Annex 1 |
| Uplink | 10 | 13.44-30.24 | 🗹 Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 | 37.66~50 | 🗹 Yes  No | § 11.1.6 & Annex 1 |
| Uplink | 15 | 20.14~25 | 🗹 Yes  No |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 | LTE comp: 326 MHz of bw at 0.307 bit/s/Hz (5% SE) | 🗹 Yes  No | § 11.1.7 (& NR in § 11.2.7 matches or exceeds) |
| Uplink | 50 | LTE comp: 174 MHz of bw at 0.288 bit/s/Hz (5% SE) | 🗹 Yes  No |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 | 0.380 | 🗹 Yes  No | § 11.1.12.2 for LTE comp RIT |
| Uplink | 0.21 | 0.357 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.307 | 🗹 Yes  No |
| Uplink | 0.15 | 0.288 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 | 0.201-0.334 | 🗹 Yes  No |
| Uplink | 0.045 | 0.093-0.108 | 🗹 Yes  No |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 9.120 | 🗹 Yes  No | § 11.1.12.2 for LTE comp RIT |
| Uplink | 6.75 | 7.538 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 7.923 | 🗹 Yes  No |
| Uplink | 5.4 | 6.756 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 | 10.664-12.027 | 🗹 Yes  No |
|  | Yes  No |
| Uplink  LMLC | 1.6 | 2.041-5.037 | 🗹 Yes  No |
| 3.836 | 🗹 Yes  No |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 | 10.59-10.83 (400 MHz bw)  10.54 (360 MHz bw) | 🗹 Yes  No | § 11.1.8 |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 | 0.63~3.73  0.63~3.14 | 🗹 Yes  No | § 11.1.9 |
| URLLC | Not applicable | Uplink and Downlink | 1 | 0.63~0.94  0.63-0.94 | 🗹 Yes  No |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | Not applicable | Not applicable | 20 | 11.3~18.8 | 🗹 Yes  No |
| URLLC | Not applicable | Not applicable | 20 | 11.3~18.8 | 🗹 Yes  No |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | 34 378 000 (ISD=500 m)  1 422 700 (ISD=1 732 m) | 🗹 Yes  No | § 11.1.13 |
| **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 | Network side: Sleep ratios from 80%-99.87%, sleep duration from 4-159 ms  UE side: Sleep ratios from 84.2%-99.1% | 🗹 Yes  No | § 11.1.2 |
| **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 | NR component RIT: 99.999% or greater on the DL and UL  LTE component RIT: N/A | 🗹 Yes  No | § 11.1.14 |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian | Stationary, Pedestrian | 🗹 Yes  No |  |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | Stationary, Pedestrian,  Vehicular (up to 30 km/h) | 🗹 Yes  No |  |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular | Pedestrian, Vehicular, High speed vehicular | 🗹 Yes  No |  |
| **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) | LoS: 2.297 | 🗹 Yes  No | § 11.1.15 |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | LoS: 1.746  NLoS: 1.457 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | LoS: 2.718  NLoS: 1.924-2.495 | 🗹 Yes  No |
| 0.45 (500 km/h) | Not evaluated | Yes  No |  |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 | 0 | 🗹 Yes  No | § 11.1.10 |
| **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 | 🗹 Yes  No |  |
| Up to 1 GHz | 800 MHz ~ 6.4 GHz | 🗹 Yes  No |  |
| Support of multiple different bandwidth values(4) | 3~13 different component carrier bandwidth values | 🗹 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. | | | | | | | |

## 10.2 Compliance templates for 3GPP RIT

All three compliance templates are enclosed in the sections that follow.

### 10.2.1 Services

#### 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)?: 🗹YES / NO  Specify which usage scenarios (eMBB, URLLC, and mMTC) the candidate RIT or candidate SRIT can support.(1) | Based on the submission in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014), the CEG considered the NR RIT for inspection and it was verified that it supports a wide range of services in all three usage scenarios: eMBB, mMTC and URLLC. |
| (1) Refer to the process requirements in IMT-2020/2. | | |

### 10.2.2 Spectrum

#### 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.  Based on the submission in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014), the CEG considered the NR RIT for inspection. As discussed in § 11.1.3.2.1 of the CEG report, NR supports all the frequency bands identified for IMT below 6 GHz either entirely or partially except for the band 450-470 MHz. The minimum requirement is the support for one frequency band. Therefore, the NR RIT submission supports the requirements in § 5.2.4.2.1 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411). |
| **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 NR RIT supports the following frequency ranges above 24.25 GHz: 24.25-27.5 GHz, 27.5-29.5 GHz and 37-40 GHz. Support for frequency bands above 52600 MHz is under study in 3GPP. Therefore, the NR RIT submission supports the requirements in § 5.2.4.2.2 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411). |

### 10.2.3 Technical performance

| 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 |  | 🗹 Yes  No | §s 11.1.5 & 11.2.5 of CEG report |
| Uplink | 10 |  | 🗹 Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 | 37.66 bit/s/Hz and 46.74 bit/s/Hz | 🗹 Yes  No | For the FR1 ranges |
| Uplink | 15 | 20.14 bit/s/Hz and 25 bit/s/Hz | 🗹 Yes  No |
| **5.2.4.3.3** User experienced data rate (Mbit/s) *(4.3)* | eMBB | Dense Urban – eMBB | Downlink | 100 | 100 | 🗹 Yes  No | Note[[4]](#footnote-4) |
| Uplink | 50 | 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 | 0.331-0.359/ 0.381-0.416 | 🗹 Yes  No | FDD/ TDD Table 11.2.12-1  Conf. A |
| Uplink | 0.21 | 0.308-0.380/ 0.581 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 | 0.248-0.380/ 0.380-0.430 | 🗹 Yes  No | FDD/ TDD Table 11.2.12-3  Conf. A |
| Uplink | 0.15 | 0.228-0.273/ 0.213-0.274 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 | 0.162-0.174/ 0.159-0.171 | 🗹 Yes  No | FDD/ TDD Table 11.2.12-5  Conf. A |
| Uplink | 0.045 | 0.248-0.617/ 0.193-0.334 | 🗹 Yes  No |
| **5.2.4.3.5** Average spectral efficiency (bit/s/Hz/ TRxP) *(4.5)* | eMBB | Indoor Hotspot – eMBB | Downlink | 9 | 9.812-10.750/ 10.109-11.095 | 🗹 Yes  No | FDD/ TDD Table 11.2.12-1  Conf. A |
| Uplink | 6.75 | 7.947/  8.812 | 🗹 Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 | 11.200-11.270/ 13.271-14.371 | 🗹 Yes  No | FDD/ TDD Table 11.2.12-3  Conf. A |
| Uplink | 5.4 | 6.087-6.512/ 6.099-6.462 | 🗹 Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 | 11.600/ 9.609 | 🗹 Yes  No | FDD/ TDD Table 11.2.12-5  Conf. A |
| 6.152/ 7.490 | 🗹 Yes  No |
| Uplink | 1.6 | 4.349/ 3.626 | 🗹 Yes  No |
| 6.951/ 5.872 | 🗹 Yes  No |
| **5.2.4.3.6** Area traffic capacity (Mbit/s/m2) *(4.6)* | eMBB | Indoor-Hotspot – eMBB | Downlink | 10 | With 400 MHz for FDD  With 360 MHz for TDD | 🗹 Yes  No | § 11.2.8 |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 | 4 | 🗹 Yes  No | § 11.1.9.1.2.1 and Annex 2 |
| 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 | FDD[[5]](#footnote-5)  TDD[[6]](#footnote-6) | 🗹 Yes  No | § 11.1.9.2.2.1 and Annex 3 |
| URLLC | Not applicable | Not applicable | 20 | 🗹 Yes  No |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | 1 458 509 –  1 518 832 | 🗹 Yes  No | § 11.2.13 of CEG report. |
| **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 | § 11.2.2 of CEG report. |
| **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 | > 99.999% | 🗹 Yes  No | § 11.2.14 of CEG report |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian |  | 🗹 Yes  No | § 11.2.15 of CEG report |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) |  | 🗹 Yes  No | § 11.2.15 of CEG report |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular |  | 🗹 Yes  No | § 11.2.15 of CEG report |
| **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) | LoS: 2.1-2.292/ 1.82-2.103  NLoS: 1.63-1.985/ 1.38-1.978 | 🗹 Yes  No | FDD/ TDD  Conf. A  Table 11.2.15-1 |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) | LoS: 2.210-2.260/ 2.060-2.210  NLoS: 1.907-1.950/ 1.790-2.146 | 🗹 Yes  No | FDD/ TDD  Conf. A  Table 11.2.15-3 |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) | LoS: 2.570-2.660/ 2.180-2.308  NLoS: 2.130-2.545/ 1.920-2.191 | 🗹 Yes  No | FDD/ TDD  Conf. A  Table 11.2.15-5 |
| 0.45 (500 km/h) |  | 🗹 Yes  No |  |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 | 0 | 🗹 Yes  No | § 11.2.10 of CEG report |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz | FR1: 800-1600 MHz  FR2 : 6400 MHz | 🗹 Yes  No | Table 11.2.1.2-1 of CEG report |
| Up to 1 GHz | FR1:  800-1600 MHz  FR2: 6400 MHz | 🗹 Yes  No | Table 11.2.1.2-1 of CEG report |
| Support of multiple different bandwidth values(4) | Yes | 🗹 Yes  No | Table 11.2.1.2-2 of CEG report |
| (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. | | | | | | | |

## 10.3 Compliance templates for TSDSI RIT

The CEG decided not to include a separate compliance template for this candidate RIT in Document IMT-2020/19rev1, since the proponent confirmed, at the 33rd WP 5D meeting (December 2019), that they had “de-activated” certain features such as power boosting and pulse shaping, instead making them part of their “additional material” submitted to the ITU.

In the CEG’s opinion, with such de-activation, the candidate RIT became sufficiently similar to the 3GPP RIT that it did not warrant a separate evaluation. Therefore the same evaluation as for the 3GPP RIT applies in this case.

## 10.4 Compliance templates for Nufront RIT

### 10.4.1 Services

#### Compliance template for services

|  |  |  |
| --- | --- | --- |
|  | 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) | Conclusion: The CEG is unable to state with any degree of certainty whether the services requirements are met as per the submission received in Document [IMT-2020/18](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018), though this is probably the case.  The main reason is the sparse information provided by the proponent – both in the characteristics template (§ 5.2.3.2.23.1) and the self-evaluation (§ 5.2.4.1.1). |
| (1) Refer to the process requirements in IMT-2020/2. | | |

### 10.4.2 Spectrum

Compliance template for spectrum

|  |  |
| --- | --- |
|  | 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.  Note that EUHT RIT supports a TDD duplex mode scheme only and can be deployed in different bands ranging from 450-470 MHz all the way to 4800-4990 MHz. |
| **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.  EUHT RIT can be deployed in the bands 24.25-27.5, 27.5-28.35, 26.5-29.5 and 37-40 GHz. |
| **Observation from the CEG** | One important element that is missing is a channel numbering scheme and a frequency raster that would cover all the claimed frequency ranges. It is therefore difficult for the CEG to unequivocally conclude that the spectrum requirements are met. |

### 10.4.3 Technical Performance

The CEG was not able to proceed with an evaluation of the parameters to be evaluated by simulation. After trying extremely hard, it became clear that there were too many “functional blocks” which would be missing from the simulator (the same which was used to evaluate the 3GPP RIT and 3GPP SRIT), due to assumptions that were missing from the submission in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) or not consistent between the technology description template, the self-evaluation and the detailed specifications. Therefore, a number of the parameters here have not been evaluated.

| 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 | 20.48 bit/s/Hz | 🗹 Yes  No | Min: 80 MHz channel; 16 aggregated |
| Uplink | 10 | 10.24 bit/s/Hz | 🗹 Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 | 31.95-44.38 bit/s/Hz | 🗹 Yes  No | Normal-short CP; rates go up for short |
| Uplink | 15 | 32.04-44.50 bit/s/Hz | 🗹 Yes  No |
| **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 |  |
| 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 |  |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 |  | Yes  No |  |
| URLLC | Not applicable | Uplink and Downlink | 1 |  | Yes  No |  |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | Not applicable | Not applicable | 20 |  | Yes  No |  |
| URLLC | Not applicable | Not applicable | 20 |  | Yes  No |  |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 |  | Yes  No |  |
| **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 | Network side: Sleep ratio of 99.5%  UE side:  Sleep ratio from 80%-99.9%  Sleep duration: 10-1000 ms. | 🗹 Yes  No | UE side: CEG considered 1 and 2 ms frame lengths |
| **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  No |  |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian |  | Yes  No |  |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) |  | Yes  No |  |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular |  | Yes  No |  |
| **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) |  | Yes  No |  |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) |  | Yes  No |  |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) |  | Yes  No |  |
| 0.45 (500 km/h) |  | Yes  No |  |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 |  | Yes  No |  |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz | Up to 1.6 GHz | 🗹 Yes  No | The CEG is concerned by the guard-bands built into the carrier frequencies e.g. for 400 MHz, a 50 MHz guard-band is in-built; so 350 MHz is used. |
| Up to 1 GHz | Up to 6.4 GHz | 🗹 Yes  No |
| Support of multiple different bandwidth values(4) | 450-6000 MHz: (5,10, 15, …, 100 MHz)  Above 24.25 GHz : (50, 100, 200, 400 MHz) | 🗹 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. | | | | | | | |

## 10.5 Compliance templates for ETSI/DECT (DECT-2020 “NR” component RIT only)

### 10.5.1 Services

#### Compliance template for services

|  |  |  |
| --- | --- | --- |
|  | 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) | DECT component RIT:  The CEG evaluated the criterion of Reliability and found that it is supported. Therefore, the UMa-urLLC test environment is satisfied.  The CEG was unable to evaluate the criterion of Connection Density due to the many missing assumptions in the candidate submission. Therefore the CEG could not apply the evaluation procedure detailed in ITU-R [M.2412](https://www.itu.int/pub/R-REP-M.2412) and is unable to conclude that this component can support the UMa-mMTC test environment.  This component does not support the eMBB usage scenario.  Overall, the CEG cannot unequivocally state the two test environment condition is fulfilled by the DECT component RIT. |
| (1) Refer to the process requirements in IMT-2020/2. | | |

### 10.5.2 Spectrum

#### Compliance template for spectrum

|  |  |
| --- | --- |
|  | 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 the DECT component RIT:  1880-1900 MHz as well as 1900-1980 MHz and 2010-2025 MHz.  The CEG verified that scalability is possible by using different sub-carrier spacings (SCS) – from 27 to 432 kHz, different FFT sizes from 64 to 1024, leading to different bandwidth sizes from 1.728 to 442.368 MHz. |
| **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 the DECT component RIT:  It is claimed that frequencies above 24.25 GHz are supported. In any case, the SRIT does support bands over 24.25 GHz. |

### 10.5.3 Technical Performance

#### Compliance template for technical performance

Note that the CEG only evaluated the DECT component RIT by Inspection and Simulation (no Analysis). The proponent had confirmed in Document IMT-2020/17(Rev.1) that this component could only be applied to the UMa-mMTC and UMa-urLLC test environments, so only the *connection density* and *reliability* technical performance requirements (TPRs) were evaluated by the CEG.

| 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 |  | Yes  No |  |
| Uplink | 10 |  | Yes  No |
| **5.2.4.3.2** Peak spectral efficiency (bit/s/Hz) *(4.2)* | eMBB | Not applicable | Downlink | 30 |  | Yes  No |  |
| Uplink | 15 |  | Yes  No |
| **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 |  |
| 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 |  |
| **5.2.4.3.7** User plane latency (ms) *(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 |  | Yes  No |  |
| URLLC | Not applicable | Uplink and Downlink | 1 |  | Yes  No |  |
| **5.2.4.3.8** Control plane latency (ms) *(4.7.2)* | eMBB | Not applicable | Not applicable | 20 |  | Yes  No |  |
| URLLC | Not applicable | Not applicable | 20 |  | Yes  No |  |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | Unable to evaluate – too many assumptions required. | Yes  No | Mesh- and cellular-network layouts have to be synchronized somehow. No procedure in ITU-R [M.2412](https://www.itu.int/pub/R-REP-M.2412) |
| **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 applicable | Yes  No | DECT component RIT – only valid for mMTC & urLLC |
| **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 | DL: > 99.999%  UL: > 99.999% | 🗹 Yes  No | DECT component RIT only. |
| **5.2.4.3.12** Mobility classes *(4.11)* | eMBB | Indoor Hotspot – eMBB | Uplink | Stationary, Pedestrian |  | Yes  No |  |
| eMBB | Dense Urban – eMBB | Uplink | Stationary, Pedestrian,  Vehicular (up to 30 km/h) |  | Yes  No |  |
| eMBB | Rural – eMBB | Uplink | Pedestrian, Vehicular, High speed vehicular |  | Yes  No |  |
| **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) |  | Yes  No |  |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) |  | Yes  No |  |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) |  | Yes  No |  |
| 0.45 (500 km/h) |  | Yes  No |  |
| **5.2.4.3.14** Mobility interruption time (ms)  *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 |  | Yes  No |  |
| **5.2.4.3.15** Bandwidth and Scalability *(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz | SCSs: 27-432 kHz. FFT sizes: 64-1024. Single carrier sizes: 1.728-442.368 MHz. | 🗹 Yes  No | DECT component RIT only |
| Up to 1 GHz | Aggregating 3 single carriers provides > 1 GHz. | 🗹 Yes  No |
| Support of multiple different bandwidth values(4) | 1.728, 3.456, etc. upto 442.368 MHz | 🗹 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. | | | | | | | |

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

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

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

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

# 11 Candidate technologies and the portions thereof evaluated

The CEG evaluated the technologies described in Table 6.2.1. A more detailed table with the CEG’s intention to evaluate a candidate technology (or not), with the parameters evaluated, is presented in Table 7.1.

In the five major sub-sections that follow (11.1 through 11.5), there are further sub-sections which have been developed on the basis of the logic that the technical performance requirements were evaluated (for each of the candidate submissions) via:

– Inspection

– Analysis

– Simulation.

As evaluation via simulation requires the creation of a software platform and this, in turn, requires detailed assumptions, the reader is directed to Annex 4 to understand these details. An attempt has been made to show the differences in the assumptions between the different candidates – in the form of a comparative table in the latter part of Annex 4.

## 11.1 3GPP SRIT

Parameters evaluated via Inspection

It should be noted that the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) contains two component RITs:

– NR

– E-UTRA/LTE

In the following sub-sections, these will be referred to as the “NR component RIT” and “LTE component RIT” respectively.

### 11.1.1 Bandwidth

11.1.1.1 Conclusion: The CEG concluded that bandwidth and scalability requirements are met by the NR and LTE component RITs in the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.1.2 Verification: Based on the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), the CEG considered the following two component RITs for inspection: NR and LTE.

##### 11.1.1.2.1 NR component RIT bandwidth requirement capabilities

The capability of bandwidth and bandwidth scalability for NR:

There are two frequency ranges which are supported – FR1 (410-7125 MHz) and FR2 (24.25‑52.6 GHz). Within each of these ranges, different sub-carrier spacings (SCS) or “numerologies” exist – these are shown in Table 11.1.1.2.1-1. Corresponding to each SCS/numerology, the maximum bandwidth for a single component carrier is also shown in the same table. It is possible to aggregate up to 16 component carriers leading to the maximum bandwidths shown in the last column of the table.

Table 11.1.1.2.1-1

NR capability on bandwidth

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SCS [kHz] | Maximum bandwidth for one component carrier (MHz) | Maximum number of component carriers for carrier aggregation | Maximum aggregated bandwidth  (MHz) |
| FR1  (410 MHz – 7 125 MHz) | 15 | 50 | 16 | 800 |
| 30 | 100 | 16 | 1 600 |
| 60 | 100 | 16 | 1600 |
| FR2  (24 250 MHz – 52 600 MHz) | 60 | 200 | 16 | 3 200 |
| 120 | 400 | 16 | 6 400 |

And then the following transmission bandwidth configurations i.e. number of (physical) resource blocks per transmission bandwidth which are supported for each case (see Tables 11.1.1.2.1-2 and 11.1.1.2.1-3).

Table 11.1.1.2.1-2

Transmission bandwidth configuration NRB for FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5  MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 70 MHz | 80 MHz | 90 MHz | 100 MHz |
| NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB |
| 15 | 25 | 52 | 79 | 106 | 133 | 160 | 216 | 270 | N.A | N.A | N.A | N.A | N.A |
| 30 | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 189 | 217 | 245 | 273 |
| 60 | N.A | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 93 | 107 | 121 | 135 |

Table 11.1.1.2.1-3

Transmission bandwidth configuration NRB for FR2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS (kHz) | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| NRB | NRB | NRB | NRB |
| 60 | 66 | 132 | 264 | N.A |
| 120 | 32 | 66 | 132 | 264 |

In terms of scalability, the minimum and maximum channel bandwidths and the maximum scalability per component carrier are illustrated in Table 11.1.1.2.1-4.

Table 11.1.1.2.1-4

Bandwidth scalability of NR

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SCS [kHz] | Minimum component carrier bandwidth (MHz) | Maximum component carrier bandwidth (MHz) | Maximum Number of supported bandwidths for a component carrier |
| FR1 | 15 | 5 | 50 | 8 |
| 30 | 5 | 100 | 13 |
| 60 | 10 | 100 | 12 |
| FR2 | 60 | 50 | 200 | 3 |
| 120 | 50 | 400 | 4 |

It is observed that up to 13 different bandwidths are supported for FR1, and up to 4 for FR2. **Therefore, bandwidth scalability is fulfilled by NR component RIT.**

##### 11.1.1.2.2 LTE component RIT bandwidth requirement capabilities

According to § 8.1.2 of the self-evaluation report in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), the maximum bandwidth of a component carrier is 20 MHz for LTE. Besides, according to the same section of this self-evaluation report, carrier aggregation of up to thirty-two component carriers is supported by LTE component RIT.

**Consequently, LTE component RIT can attain a maximum aggregated system bandwidth of 640 MHz, which exceeds the requirement set by the ITU (of at least 100 MHz).**

Table 11.1.1.2.2-1

Transmission bandwidth configuration NRB in LTE

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Channel bandwidth BWChannel [MHz] | 1.4 | 3 | 5 | 10 | 15 | 20 |
| Transmission bandwidth configuration NRB | 6 | 15 | 25 | 50 | 75 | 100 |

It is observed in Table 11.1.1.2.2-1 above that up to 6 different bandwidths are supported for FR1 by LTE component RIT. **Therefore, bandwidth scalability is fulfilled by LTE component RIT.**

### 11.1.2 Energy efficiency

11.1.2.1 Conclusion:The CEG concluded that energy efficiency requirements are met by the NR and LTE component RITs in the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.2.2 Verification: Based on the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), for this evaluation by inspection, the following two component RITs were considered: NR and LTE.

For both component RITs the “no data” scenarios were analyzed, since the “loaded” scenario is quantified by spectrum efficiency. In other words, neither the BS nor the UE are exchanging user-plane data.

##### 11.1.2.2.1 NR component RIT energy efficiency

###### 11.1.2.2.1.1 NR component RIT network side

Based on the definition of sleep time requirement for the network (as shown in Report [ITU-R M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx)), the following sleep mode ratio equations were proposed in the submission documents:





where  indicates the ceiling of *x*,  is the numerology (as defined in the self-evaluation Report – Part 4 – Document in [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), e.g., **=0 for 15 kHz SCS, **=1 for 30 kHz SCS, **=3 for 120 kHz SCS, and **=4 for 240 kHz SCS), *L* is the number of SS/PBCH blocks in one SSB set, *P*SSB is the SSB set periodicity, *P*RMSI is the RSMI periodicity, and  is the flag variable (=1 for FR1, and =0 for FR2).

The CEG agrees with the proposed methodology and has verified that the NR network can achieve high sleep ratios in the “unloaded” case (see Tables 11.1.2.2.1.1-1 and 11.1.2.2.1.1-2).

Table 11.1.2.2.1.1-1

NR component RIT network sleep ratio at slot level

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

Table 11.1.2.2.1.1-2

NR component RIT network sleep ratio at symbol level

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

In terms of milliseconds, the following sleep times can be achieved by NR component RIT network for different SSB periodicities:

Based on the above mechanisms, evaluation results of sleep duration are provided in Table 11.1.2.2.1.1-3. It is observed that with SSB set period of 160 ms, more than 150 ms sleep duration can be obtained by NR component RIT network. Therefore, the NR component RIT network can achieve long sleep durations in the unloaded case.

The CEG concludes that NR component RIT meets the network side energy efficiency requirement.

Table 11.1.2.2.1.1-3

NR component RIT network sleep duration (ms) at slot level

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

###### 11.1.2.2.1.2 NR component RIT UE side

The sleep ratio and sleep duration for NR component RIT UE corresponding to the “unloaded” case are evaluated.

For NR, DRX is supported by the UE in the idle, inactive and connected states.

The DRX cycle for an idle/inactive UE consists of an “On Duration” state during which the UE performs SSB monitoring, paging monitoring and RRM measurement, and an “Off Duration” state during which it can skip reception of downlink channels to save energy.

During the On Duration of a DRX cycle, the UE is assumed to perform the following tasks:

– Synchronization on one SSB burst (short paging cycle).

– Paging monitoring- this can consist of multiple slots. The Paging Frame is no longer than a single SSB burst.

– RRM measurement which is based on SS/PBCH and is assumed to be 3.5 ms.

The transition time for switching ‘ON’ or ‘OFF’ the internal components of the UE is assumed to be 10 ms.

Based on these assumptions, the NR UE can be in sleep mode more than 90% of the time for any DRX cycle in the idle/inactive state (see Tables 11.1.2.2.1.2-1 and 11.1.2.2.1.2-2).

Table 11.1.2.2.1.2-1

NR component RIT UE sleep ratio at slot level (for idle/inactive mode)

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

For RRC-Connected Mode, with no data transmissions, the sleep mode is more than 84%, assuming an “ON Duration” and other similar parameters.

Table 11.1.2.2.1.2-2

NR component RIT UE sleep ratio at slot level (for connected mode)

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

##### 11.1.2.2.2 LTE component RIT energy efficiency

###### 11.1.2.2.2.1 LTE component RIT network side

For LTE component RIT network evaluation, the FeMBMS/Unicast-mixed cell and MBMS-dedicated cell are employed.

For FeMBMS/Unicast-mixed cell:

– Sub-frame 0 and 5 are always used as non-MBSFN sub-frame for synchronization and SI acquisition.

– Sub-frame 4 and 9 are assumed to be configured as MBSFN sub-frames.

– MBSFN sub-frames are assumed not to contain unicast control region.

For FeMBMS/Unicast-mixed cell, 8 sub-frames are configured to be MBSFN sub-frames, and in the remaining 2 sub-frames, only PDCCH/SSS/PSSS and PBCH are transmitted.

Therefore, the sleep ratio of FeMBMS/Unicast-mixed cell is 1-2/10 or 1-1/5, which is 80% at the sub-frame level.

For MBMS-dedicated cell, one-non-MBSFN sub-frame is transmitted every 40 ms, thus the sleep ratio at the sub-frame level is 1-1/40=97.5%. Similarly, at the symbol level, the sleep ratio can be further improved to 1-(1+6)/14/40 = 98.75%.

In conclusion, in milliseconds, the CEG found the following results (see Table 11.1.2.2.2.1-1):

Table 11.1.2.2.2.1-1

LTE component RIT network sleep duration (ms) at subframe level

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

Therefore, the LTE component RIT meets the network (side) energy efficiency requirement.

###### 11.1.2.2.2.2 LTE component RIT UE side

For LTE, DRX is supported by the UE in both idle and connected modes.

When DRX is used, the UE wakes up and receives PSS/SSS for synchronization, listens to PDCCH only on specific paging occasions, defined in terms of paging-frame and sub-frame within a period of *N*PC\_RF radio frames, which in turn, is defined by the DRX cycle (paging cycle) of the cell and performs RRM measurement. The UE can remain in sleep mode for the remainder of the DRX cycle.

With assumptions similar to the NR case and using the LTE-specific DRX cycles, the CEG found the following results for idle mode (see Tables 11.1.2.2.2.2-1) and RRC-Connected mode (e.g. without data transmission – see Table 11.1.2.2.2.2-2):

Table 11.1.2.2.2.2-1

LTE component RIT UE sleep ratio at subframe level (for idle mode)

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

Table 11.1.2.2.2.2-2

LTE component RIT UE sleep ratio at subframe level (for connected mode)

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

The CEG concludes that in both idle and connected states, the LTE component RIT UE can achieve a very high percentage of sleep ratio at the sub-frame level.

### 11.1.3 Spectrum

11.1.3.1 Conclusion: The CEG concluded that the spectrum capability requirements defined in § 5.2.4.2 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411) are met by the NR and LTE component RITs in the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.3.2 Verification:

According to Recommendation ITU-R [M.1036](https://www.itu.int/rec/R-REC-M/recommendation.asp?lang=en&parent=R-REC-M.1036), the frequency bands listed in table 11.1.3.2-1 have been identified for IMT.

Table 11.1.3.2-1

Frequency bands identified for IMT

| Band  (MHz) | Footnotes identifying the band for IMT | | |
| --- | --- | --- | --- |
| Region 1 | Region 2 | Region 3 |
| 450-470 | **5.286AA** | | |
| 470-698 | **-** | **5.295, 5.308A** | **5.296A** |
| 694/698-960 | **5.317A** | **5.317A** | **5.313A, 5.317A** |
| 1 427-1 518 | **5.341A, 5.346** | **5.341B** | **5.341C, 5.346A** |
| 1 710-2 025 | **5.384A, 5.388** | | |
| 2 110-2 200 | **5.388** | | |
| 2 300-2 400 | **5.384A** | | |
| 2 500-2 690 | **5.384A** | | |
| 3 300-3 400 | **5.429B** | **5.429D** | **5.429F** |
| 3 400-3 600 | **5.430A** | **5.431B** | **5.432A, 5.432B, 5.433A** |
| 3 600-3 700 | **-** | **5.434** | **-** |
| 4 800-4 990 | **-** | **5.441A** | **5.441B** |

Based on the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), the CEG considered the following two component RITs for inspection: NR and LTE.

As discussed in detail in sections 11.1.3.2.1 and 11.1.3.2.2 below, the NR/LTE SRIT together supports all the bands identified for IMT either entirely or partially, while the minimum requirement for compliance is support for at least one frequency band. Therefore, NR/LTE SRIT meets the spectrum capability requirements defined in § 5.2.4.2.1 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411). In addition, NR/LTE SRIT supports operation above 24.5 GHz in the frequency ranges 24.25‑27.5 GHz, 27.5-29.5 GHz and 37-40 GHz, and thereby, meets the compliance requirements of § 5.2.4.2.2 in Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411).

11.1.3.2.1 **Frequency bands supported by NR**

The NR component RIT supports different frequency bands in two different frequency ranges FR1 (410 MHz – 7 125 MHz) and FR2 (24 250 MHz – 52 600 MHz) as shown in Tables 11.1.3.2.1-1 and 11.1.3.2.1-2, respectively.

TABLE 11.1.3.2.1-1

NR operating bands in FR1

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

TABLE 11.1.3.2.1-2

NR operating bands in 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 |

By comparing Tables 11.1.3.2.1-1 and 11.1.3.2.1-1, it is observed that NR supports all frequency bands identified for IMT either in entirety or partially except for the band 450-470 MHz. Table 11.1.3.2.1-2 reveals that NR can be deployed in the following frequency ranges above 24.5 GHz: 24.25-27.5 GHz, 27.5-29.5 GHz and 37-40 GHz.

11.1.3.2.2 **Frequency bands supported by LTE**

The LTE component RIT supports different frequency bands as shown in table 11.1.3.2.2-1. It is observed that LTE supports all frequency bands identified for IMT either entirely or partially.

TABLE 11.1.3.2.2-1

LTE operating bands

| LTE Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 1 | 1920 MHz | – | 1980 MHz | 2110 MHz | – | 2170 MHz | FDD | |
| 2 | 1850 MHz | – | 1910 MHz | 1930 MHz | – | 1990 MHz | FDD | |
| 3 | 1710 MHz | – | 1785 MHz | 1805 MHz | – | 1880 MHz | FDD | |
| 4 | 1710 MHz | – | 1755 MHz | 2110 MHz | – | 2155 MHz | FDD | |
| 5 | 824 MHz | – | 849 MHz | 869 MHz | – | 894MHz | FDD | |
| 61 | 830 MHz | – | 840 MHz | 875 MHz | – | 885 MHz | FDD | |
| 7 | 2500 MHz | – | 2570 MHz | 2620 MHz | – | 2690 MHz | FDD | |
| 8 | 880 MHz | – | 915 MHz | 925 MHz | – | 960 MHz | FDD | |
| 9 | 1749.9 MHz | – | 1784.9 MHz | 1844.9 MHz | – | 1879.9 MHz | FDD | |
| 10 | 1710 MHz | – | 1770 MHz | 2110 MHz | – | 2170 MHz | FDD | |
| 11 | 1427.9 MHz | – | 1447.9 MHz | 1475.9 MHz | – | 1495.9 MHz | FDD | |
| 12 | 699 MHz | – | 716 MHz | 729 MHz | – | 746 MHz | FDD | |
| 13 | 777 MHz | – | 787 MHz | 746 MHz | – | 756 MHz | FDD | |
| 14 | 788 MHz | – | 798 MHz | 758 MHz | – | 768 MHz | FDD | |
| 15 | Reserved | | | Reserved | | | FDD | |
| 16 | Reserved | | | Reserved | | | 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 | FDD2 | |
| 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 | FDD2 | |
| 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 | TDD8 | |
| 47 | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | TDD11 | |
| 48 | 3550 MHz | – | 3700 MHz | 3550 MHz | – | 3700 MHz | TDD | |
| 49 | 3550 MHz | – | 3700 MHz | 3550 MHz | – | 3700 MHz | TDD16 | |
| 50 | 1432 MHz | - | 1517 MHz | 1432 MHz | - | 1517 MHz | TDD13 | |
| 51 | 1427 MHz | - | 1432 MHz | 1427 MHz | - | 1432 MHz | TDD13 | |
| 52 | 3300 MHz | - | 3400 MHz | 3300 MHz | - | 3400 MHz | TDD | |
| … |  |  |  |  |  |  |  | |
| 64 | Reserved | | | | | |  |
| 65 | 1920 MHz | – | 2010 MHz | 2110 MHz | – | 2200 MHz | FDD |
| 66 | 1710 MHz | – | 1780 MHz | 2110 MHz | – | 2200 MHz | FDD4 |
| 67 |  | N/A |  | 738 MHz | – | 758 MHz | FDD2 |
| 68 | 698 MHz | – | 728 MHz | 753 MHz | – | 783 MHz | FDD |
| 69 | N/A | | | 2570 MHz | – | 2620 MHz | FDD2 |
| 70 | 1695 MHz | – | 1710 MHz | 1995 MHz | – | 2020 MHz | FDD10 |
| 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 | FDD2 |
| 76 |  | N/A |  | 1427 MHz | – | 1432 MHz | FDD2 |
| 85 | 698 MHz | – | 716 MHz | 728 MHz | – | 746 MHz | FDD |
| NOTE 1: Band 6, 23 is not applicable  NOTE 2: Restricted to E-UTRA operation when carrier aggregation is configured. The downlink operating band is paired with the uplink operating band (external) of the carrier aggregation configuration that is supporting the configured Pcell.  NOTE 3: A UE that complies with the E-UTRA Band 65 minimum requirements in this specification shall also comply with the E-UTRA Band 1 minimum requirements.  NOTE 4: The range 2180-2200 MHz of the DL operating band is restricted to E-UTRA operation when carrier aggregation is configured.  NOTE 5: A UE that supports E-UTRA Band 66 shall receive in the entire DL operating band  NOTE 6: A UE that supports E-UTRA Band 66 and CA operation in any CA band shall also comply with the minimum requirements specified for the DL CA configurations CA\_66B, CA\_66C and CA\_66A-66A.  NOTE 7: A UE that complies with the E-UTRA Band 66 minimum requirements in this specification shall also comply with the E-UTRA Band 4 minimum requirements.  NOTE 8: This band is an unlicensed band restricted to licensed-assisted operation using Frame Structure Type 3  NOTE 9: In this version of the specification, restricted to E-UTRA DL operation when carrier aggregation is configured.  NOTE 10: The range 2010-2020 MHz of the DL operating band is restricted to E-UTRA operation when carrier aggregation is configured and TX-RX separation is 300 MHz The range 2005-2020 MHz of the DL operating band is restricted to E-UTRA operation when carrier aggregation is configured and TX-RX separation is 295 MHz.  NOTE 11: This band is unlicensed band used for V2X communication. There is no expected network deployment in this band so both Frame Structure Type 1 and Frame Structure Type 2 can be used.  NOTE 12: A UE that complies with the E-UTRA Band 74 minimum requirements in this specification shall also comply with the E-UTRA Band 11 and Band 21 minimum requirements.  NOTE 13: UE that complies with the E-UTRA Band 50 minimum requirements in this specification shall also comply with the E-UTRA Band 51 minimum requirements.  NOTE 14: A UE that complies with the E-UTRA Band 75 minimum requirements in this specification shall also comply with the E-UTRA Band 76 minimum requirements.  NOTE 15: Uplink transmission is not allowed at this band for UE with external vehicle-mounted antennas.  NOTE 16: This band is restricted to licensed-assisted operation using Frame Structure Type 3 | | | | | | | |

### 11.1.4 Services

11.1.4.1 Conclusion: The CEG concluded that the service capability requirements defined in § 5.2.4.1 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411) are met by the NR and LTE component RITs in the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.4.2 Verification: Based on the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), the CEG considered the following two component RITs for inspection: NR and LTE

It is observed that the NR component RIT supports a wide ranges of services in the following usage scenarios: eMBB, mMTC and URLLC. It is also observed that the LTE component RIT supports the following usage scenarios: eMBB and mMTC. And as the evaluations of the minimum technical performance requirements (such as average as well as 5% spectral efficiencies, mobility, connection density, etc.) in other sections of this document have demonstrated, for both the NR and LTE component RITs, these service requirements are satisfied. Consequently, the CEG believes that the SRIT as a whole, in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), can support a wide ranges of services.

Parameters evaluated via Analysis

### 11.1.5 Peak data rate

11.1.5.1 Conclusion:The CEG concluded that peak data rate requirements are met by the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.5.2 Verification: Both component RITs, NR and LTE, are considered in the analysis of this technical requirement:

Spectral efficiency is an essential parameter for evaluation of radio access technologies. It provides insights into expected data rates for a given amount of spectrum, and at the same time it is used to compare different radio access technologies (e.g., IMT-2000 vs. IMT-Advanced vs. IMT-2020 comparison). Early mobile technologies had a very low peak spectral efficiency (e.g. early GSM systems were providing speeds of the order of 10 kbit/s, or spectral efficiency of < 1 bit/s/Hz), while later technologies such as IMT-2020 have very high target spectral efficiency and data rates, as summarized in table 11.1.5.2-1:

Table 11.1.5.2 -1

Target peak spectral efficiency and peak data rates (as per Report [ITU-R M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx))

|  |  |  |
| --- | --- | --- |
|  | Peak Spectral Efficiency (bit/s/Hz) | Peak Data Rate (Gbit/s) |
| Downlink | 30 | 20 |
| Uplink | 15 | 10 |

Evidently, by comparing the peak spectral efficiency and peak data rate targets, required bandwidth can be calculated by dividing the two columns in the table above, which results in 667 MHz of the minimal bandwidth needed both for the DL and UL.

In Annex 1, the calculations of the peak spectral efficiencies for the two different frequency ranges FR1 (410 MHz – 7 125 MHz) and FR2 (24 250 MHz – 52 600 MHz) are shown in detail; a brief explanation of the detailed calculations is presented in the following two paragraphs.

#### 11.1.5.3 NR component RIT calculations

Depending on parameters such as channel bandwidth and spacing of subcarriers, it has been shown that the DL spectral efficiency ranges between 37.66 bit/s/Hz and 46.74 bit/s/Hz in the FR1 portion of the spectrum, which is well above the target spectral efficiency of 30 bit/s/Hz. Similarly, the UL spectral efficiency varies between 20.14 bit/s/Hz and 25 bit/s/Hz, also well above the target of 15 bit/s/Hz. In any of the calculated scenarios, there is enough room for higher overheads that may be needed (compared to overheads used in theoretical calculation). In addition to spectral efficiency, peak data rates per single carrier have been calculated and it has been shown that up to 4.67 Gbit/s can be achieved using a single 100 MHz carrier. Therefore, by combining 5 carriers (500 MHz), it is possible to achieve target of 20 Gbit/s.

For the FR2 range, spectral efficiencies are also above the ITU-R targets, even though there is less room for overhead increase when 64QAM is considered (as opposed to 256 QAM). In terms of peak data rates, even with 64QAM, a peak data rate of 10.85 Gbit/s is achievable with a single 400 MHz carrier. Therefore, only 2 carriers are needed to achieve the ITU-R target of 20 Gbit/s.

A more realistic use case is to combine FR1 and FR2 frequencies via carrier aggregation, but since the proponent’s specifications allow up to 16 carriers to be aggregated, target peak data rates of 20 Gbit/s on the DL and 10 Gbit/s on the UL should be easily achieved.

#### 11.1.5.4 LTE component RIT calculations

Using the transport block sizes specified in the self-evaluation section of Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en), a peak spectral efficiency of around 50 bit/s/Hz is calculated for LTE and a peak data rate of 1 Gbit/s per single 20 MHz channel. Given that LTE allows up to 32 component carriers in carrier aggregation, the peak DL data rate can be as high as 32 Gbit/s assuming 20 MHz channels.

**In conclusion, the peak data rate values computed in Annex 1 and explained in this section, for both NR and LTE component RITs, fulfil the ITU targets for these technical performance requirements.**

### 11.1.6 Peak spectral efficiency

11.1.6.1 Conclusion:The CEG concluded that peak spectral efficiency requirements are met by the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.6.2 Verification: Both component RITs, NR and LTE, are considered in the analysis of this technical requirement, which is carried out in § 11.1.5 above, with full details in Annex 1.

**In conclusion, the peak spectral efficiency values computed in Annex 1 and explained in the previous section (11.1.5), for both NR and LTE component RITs, fulfil the ITU target for this technical performance requirement.**

### 11.1.7 User experienced data rate (single band, single layer)

**11.1.7.1 Conclusion:** The CEG concluded that the SRIT user experienced data rate requirement is met by the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

**11.1.7.2 Verification**: For the NR component RIT, the verification is provided in § 11.2.7. For the LTE component RIT, the verification is provided below:

User experienced data rate is one of the most important performance indicators for eMBB use case as it relates to the expected user experience under certain network conditions (e.g., channel bandwidth, morphology, etc.). As such, it is part of minimal technical performance requirements, specified in Report [ITU-R M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx).

For the purpose of evaluation, *user experienced data rate* is defined as the 5% point of the cumulative distribution function of the user throughput, with the targets specified for the Dense Urban eMBB environment:

* Downlink user experienced data rate is Mbit/sec
* Uplink user experience data rate is Mbit/sec

Evaluation criteria set out in Report [ITU-R M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx) allow for one or more frequency bands and for one or more layers for transmission reception points (TRxP) provided that user spectral efficiency per band is derived from the 5th percentile. In this evaluation, the CEG assumed a single band, single layer, and, given the target user data rates for the downlink and uplink, calculated the needed bandwidth, which is not part of the requirement.

Evaluation results (LTE)

Simulation results for the configuration A (4 GHz) for dense urban eMBB use case have been considered for this evaluation. Summary results obtained by the academic partner INRS, for FDD mode only, are summarized in Table 11.1.7.2-1:

Table 11.1.7.2-1

5th percentile spectral efficiency values for DU-eMBB obtained via simulation

|  |  |  |
| --- | --- | --- |
| Spectral efficiency, | | INRS |
| FDD | DL (bit/sec/Hz) | 0.307 |
| UL (bit/sec/Hz) | 0.288 |

Given the values above, the range for the required bandwidth to meet the target data rates are calculated as:.

Table 11.1.7.2-2

Required bandwidths to meet the target data rates (100 Mbit/s DL and 50 Mbits/s UL)

|  |  |  |
| --- | --- | --- |
| Bandwidth, | | INRS |
| FDD | Downlink (MHz) | 326 |
| Uplink (MHz) | 174 |

The FDD configuration was assumed in Table 11.1.7.2-2 for the operation, which means that both downlink and uplink fractions of time are unity, that is, and .

### 11.1.8 Area traffic capacity (InH, eMBB)

**11.1.8.1 Conclusion:** The CEG concluded that the SRIT area traffic capacity requirement is met by the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

**11.1.8.2 Verification**: The requirement is defined for the purpose of evaluation in the Indoor Hotspot (InH) eMBB test environment, where the target value for the area traffic capacity on the downlink is 10 Mbit/s/m2.

The Indoor Hotspot-eMBB test environment consists of one floor of a building. The height of the ceiling is 3 m. The floor has a surface area of 120 m × 50 m and 12 BSs/site. The BSs are placed at 20 m spacing as shown in Figure 11.1.8.2-1, with a LOS probability as defined by channel model in Annex 1, Table A1-9 of Report [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412). In the figure, internal walls are not explicitly shown but are modelled via the stochastic LOS probability model.

The type of site deployed (e.g. 1 TRxP per site or 3 TRxPs per site) is not defined and should be reported by the proponent.

Figure 11.1.8.2-1

Indoor Hotspot sites layout



If 12 TRxPs are assumed in the above scenario, then can be computed as follows:

= 12 / (120 m X 50 m) = 0.002 TRxP/m2

For FDD with DL, 32 x 4 MU-MIMO Type II Codebook and SCS = 15 KHz, the average spectrum efficiency can be derived as:

Channel Model A: = 13.24 for 40 MHz carrier bandwidth.

Channel Model B: = 13.54 for 40 MHz carrier bandwidth.

For this FDD configuration, using a 400 MHz aggregation bandwidth:

Channel Model A

= 0.002 X 400 MHz X 13.24 = 10.59 Mbit/s/Hz

Channel Model B

= 0.002 X 400 MHz X 13.54 = 10.83 Mbit/s/Hz

Observation 1: For an FDD configuration, the SRIT area traffic capacity requirement can be met with a minimum aggregated channel bandwidth of 400 MHz.

For TDD with DL, 32 x 4 MU-MIMO Type II Codebook reciprocity based, 4T SRS SCS = 15 KHz and DDDSU frame structure, the average spectrum efficiency is derived as:

Channel Model A: = 14.65 for 40 MHz carrier bandwidth.

Channel Model B: = 14.64 for 40 MHz carrier bandwidth.

So, for an aggregated bandwidth of 360 MHz:

Channel Model A

= 0.002 X 360 MHz X 14.65 = 10.54 Mbit/s/Hz

Channel Model B

= 0.002 X 360 MHz X 14.64 = 10.54 Mbit/s/Hz

Observation 2: For a TDD configuration, the SRIT area traffic capacity can be met with a minimum aggregated channel bandwidth of 360MHz.

### 11.1.9 Latency (user-plane and control-plane)

### 11.1.9.1 User-plane latency

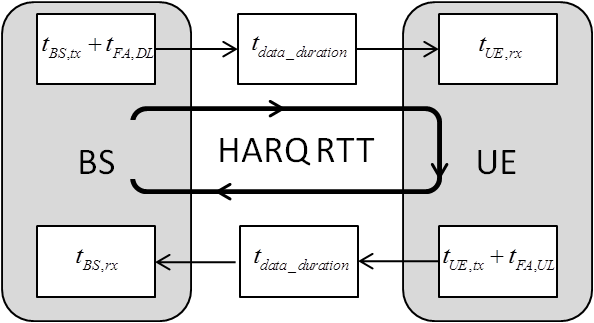
**11.1.9.1.1 Conclusion:** The NR component RIT is capable of meeting the user-plane latency requirements of 4 ms for eMBB as well as the 1 ms for URLLC in both FDD and TDD duplex modes. In the case of the LTE component RIT, the CEG could not perform an independent analysis of all the details provided by the proponent; instead it noted that this component could fulfil the 4 ms eMBB requirement in both FDD and TDD modes, whereas the 1 ms URLLC requirement would need the FDD mode configured with the appropriate sub-carrier spacings (SCSs) and transmission time intervals (TTIs).

Overall, the CEG concluded that the SRIT fulfils all the user-plane latency criteria.

**11.1.9.1.2 Verification**: of user-plane latency for the NR and LTE components is explained in the following sections, but is based on the overall procedure in figure 11.1.9.1.2-1.

Figure 11.1.9.1.2-1

Procedure to evaluate user-plane latency



**11.1.9.1.2.1** NR component RIT user-plane latency

Annex 2 provides a detailed analysis of the assumptions and results, so the CEG’s findings are simply summarized here:

1. In FDD mode on the DL, the NR component can meet the 4 ms eMBB user-plane latency requirement with a sub-carrier spacing (SCS) of 15 kHz.
2. In FDD mode on the UL, the NR component can meet the 1 ms URLLC user-plane latency requirement with 15 kHz SCS, mini-slots and configured UL grants.
3. In TDD duplex mode on the DL, the NR component can meet the 4 ms eMBB user-plane latency requirement with 15 kHz SCS, mini-slots and configured UL grants.
4. In TDD mode on the UL, the NR component can meet the 1 ms URLLC user-plane latency requirement with 120 kHz SCS, mini-slots and configured UL grants.

**11.1.9.1.2.2** LTE component RIT user-plane latency

In the case of the LTE component RIT, Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) points to contribution 5D/1216, in which the last column of the *corresponding* table 4 (note there are three such “Table 4s”) claims that the user-plane latency requirement is met by this candidate. The CEG could not locate substantial user-plane discussions in “Part 1: RP-191525: Characteristics Template – SRIT” and proceeded to the self-evaluation instead (“Part 4: RP-191521: TR 37.910 Study on self-evaluation towards IMT-2020 submission”), where, in § 5.7.1.2, the detailed assumptions to calculate the user-plane latency are provided (broken down into roughly ten steps). Table 11.1.9.1.2.2-1 illustrates this for the DL:

Table 11.1.9.1.2.2 -1

Procedure to calculate DL user-plane latency for LTE component RIT

|  |  |  |  |
| --- | --- | --- | --- |
| ID | Component | Notations | Value |
| 1 | DL data transfer | *T*1 = (*t*BS,tx + *t*FA,DL) + *t*DL\_duration + *t*UE,rx |  |
| 1.1 | BS processing delay | *t*BS,tx  The time interval between the data is arrived, and packet is generated. | 1.5 TTI |
| 1.2 | DL Frame alignment (transmission alignment) | *t*FA,DL  It includes frame alignment time, and the waiting time for next available DL slot | *T*FA + *T*wait,  *T*FA is the frame alignment time within the current DL slot;  *T*wait is the waiting time for next available DL slot if the current slot is not DL slot. |
| 1.3 | TTI for DL data packet transmission | *t*DL\_duration | 1 TTI |
| 1.4 | UE processing delay | *t*UE,rx  The time interval between the PDSCH is received and the data is decoded; | 1.5 TTI |
| 2 | HARQ retransmission | *T*HARQ = *T*1 + *T*2  *T*2 = (*t*UE,tx + *t*FA,UL)+ *t*UL\_duration + *t*BS,rx (For Steps 2.1 to 2.4) |  |
| 2.1 | UE processing delay | *t*UE,tx  The time interval between the data is decoded, and ACK/NACK packet is generated. | 1.5 TTI |
| 2.2 | UL frame alignment (transmission alignment) | *t*FA,UL  It includes frame alignment time, and the waiting time for the next available UL slot | *T*FA + *T*wait,  *T*FA is the frame alignment time within the current UL slot;  *T*wait is the waiting time for next available UL slot if the current slot is not UL slot |
| 2.3 | TTI for ACK/NACK transmission | *t*UL\_duration | 1 OFDM symbol |
| 2.4 | BS processing delay | *t*BS,rx  The time interval between the ACK is received and the ACK is decoded. | 1.5 TTI |
| 2.5 | Repeat DL data transfer from 1.1 to 1.4 | *T*1 |  |
| - | Total one way user plane latency for DL | *T*UP= *T*1 + *n*×*T*HARQ  where *n* is the number of re-transmissions (*n*≥0)  *Average T*UP*= T*1 *+* *p*×*T*HARQ  where *p* is the probability of re-transmissions | |
| NOTE: For short TTI, it is assumed that PDCCH and sPDCCH can both schedule sPDSCH such that there is no additional waiting time for PDCCH if the data arrives within the PDCCH region. In addition, sPDCCH and sPDSCH can be frequency multiplexed. | | | |

As explained in the self-evaluation, the delay associated with each step is either a function of the Time Transmission Interval (TTI) or a combination of the time taken to align the frame within the current DL/UL slot and the waiting time for the next available DL/UL slot (if the current slot is not allotted). The TTI duration varies according to the number of symbols (2, 3 or 7 or a hybrid mix of these) within the frame and the duplex mode, as shown in Tables 11.1.9.1.2.2-2 and 11.1.9.1.2.2-3:

Table 11.1.9.1.2.2-2

DL user-plane latency for LTE FDD

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

Table 11.1.9.1.2.2-3

DL user-plane latency for LTE TDD

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

From these two tables, it is clear that LTE component RIT, on the DL, can meet the 4 ms criterion for eMBB in both FDD and TDD duplex modes. For URLLC, however, the criterion of 1 ms is met only in a limited number of cases when FDD duplex mode only is used.

For the UL, Table 11.1.9.1.2.2-1 would still apply, except that “DL” would be replaced by “UL” and “BS” by “UE.” With these substitutions, the results for LTE component RIT user-plane latency on the UL are shown in Tables 11.1.9.1.2.2-4 and 11.1.9.1.2.2-5:

Table 11.1.9.1.2.2-4

UL user-plane latency for LTE FDD

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

Table 11.1.9.1.2.2-5

UL user-plane latency for LTE TDD with semi-persistent scheduling (SPS)

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

The CEG could not examine the minute details of each of the steps in this figure for both DL and UL and for each mode (FDD and TDD) and so has noted the results: the FDD and TDD modes can meet the 4 ms criterion, but only the FDD (and that, too, configured appropriately) can meet the 1 ms criterion.

### 11.1.9.2 Control-plane latency

**11.1.9.2.1 Conclusion**: The CEG concluded that the SRIT submission overall meets the requirement of 20 ms control-plane latency, with each component RIT individually satisfying this criterion in both FDD and TDD duplex modes.

**11.1.9.2.2 Verification**

11.1.9.2.2.1 NR component RIT control-plane latency

Annex 3 provides a detailed analysis of the assumptions and results, so the CEG’s findings are simply summarized here:

1. In FDD mode (DL and UL), the NR component, when using a 14-symbol TTI has a delay of

a) 15 ms for a 15 kHz SCS

b) 7.8 ms for a 120 kHz SCS.

2. In TDD mode, the NR component, when using a pattern of UL-DL-DL-DL and a 14‑symbol TTI, has a delay of

a) 20 ms for a 15 kHz SCS

b) 8.5 ms for a 120 kHz SCS.

3. In TDD mode, the NR component, when using an alternating pattern of UL-DL and a 14-symbol TTI, has a delay of

a) 18 ms for a 15 kHz SCS

b) 9.3 ms for a 120 kHz SCS.

11.1.9.2.2.2 LTE component RIT control-plane latency

In the case of the LTE component RIT, Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) points to contribution Document 5D/1216, in which the last column of table 4 (the “second” table 4) claims, via a footnote, that the control-plane latency requirement is met by this candidate component RIT. Further search of the documents enclosed in the contribution – specifically of “Part 1: RP-191525: Characteristics Template – SRIT” led to § 5.2.3.2.26.10, which in turn, pointed to the self-evaluation contained in “Part 4: RP-191521: TR 37.910 Study on self-evaluation towards IMT-2020 submission.” As explained in the self-evaluation and illustrated in Figure 11.1.9.2.2.2-1:

Figure 11.1.9.2.2.2-1

Procedure to evaluate control-plane latency of the LTE component RIT



There are 10 steps involved in the control-plane flow to transit from IDLE to CONNECTED states. It is then a question of computing the delays associated with each step and Tables 5.7.2.2-1 (LTE FDD), 5.7.2.2-2 (LTE TDD on DL) and 5.7.2.2-3 (LTE TDD on UL) in the self-evaluation demonstrate that the criterion of 20 ms is fulfilled. The CEG has noted these results.

### 11.1.10 Mobility interruption time

11.1.10.1 Conclusion: The CEG concluded that the SRIT submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) is compliant with the ITU requirement of 0 ms as specified by Report [ITU‑R M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx).

11.1.10.2 Verification: Details of the analysis. The following scenarios were considered based on the submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

NR mobility scenarios:

– Beam mobility

– CA (Carrier Aggregation) mobility

LTE mobility scenarios:

– PCell (Primary Cell) mobility

– DC (Dual Connectivity) mobility

**11.1.10.2.1 NR component RIT Beam mobility**

One of the new features of NR is the specification of beam management. While moving into a “new” cell, the transmit-receive beam of a user terminal may need to be changed.

The UE can be configured to perform beam measurements and reporting based on a set of specific RS resources. The device can report physical layer measurements for the strongest beam and for the rest of the remaining beams, just their differences from the best beam.

NR supports beam indication. This implies in informing the UE that certain PDSCH and/or PDCCH transmissions uses the same transmission beam as a configured RS. This means that a certain PDSCH and/or PDCCH is transmitted using the same spatial filter as the configured RS. So beam indication is based on the configuration and downlink signalling of so-called Transmission Configuration Indication (TCI) states.

A UE can be configured by RRC with up to 64 TCI states, and by means of MAC signalling, the network can indicate a specific TCI state.

In some situations, the PDSCH beam indication can be performed using two different procedures due to the flexible offset scheduling timing. If this is larger than N symbols, DCI scheduling (on PDCCH) can indicate the TCI state. If it is smaller than N, the UE may assume quasi-co-located transmissions with the PDCCH.

Observation 1: The above described mechanism is sufficiently flexible and allows the g-Node B (gNB) to schedule DL data on multiple beams on different slots.

A similar procedure is available for the UL, where PUSCH is sent using an SRS resource indicator (SRI) configured by the gNB. Thus, the gNB-side beam is selected for UL data reception accordingly.

Observation 2: gNB may select different beams at different slots depending on the UE mobility. Therefore, UL data packet transmission is kept during beam-pair-switching at different slots.

**Beam Mobility analysis conclusion:** the UE can always exchange user-plane packets with the gNB during mobility transitions. Therefore, 0 ms mobility interruption time can be achieved by NR component RIT for this scenario*.*

**11.1.10.2.2 NR component RIT Carrier Aggregation mobility**

When moving within the same PCell and CA enabled, the set of configured Secondary Cells (SCells) of the UE may change. The SCell addition procedure and SCell release procedures can occur.

During these procedures, the UE can always exchange user-plane packets with the gNB during transitions, because the data transmission between the UE and the PCell is kept. Therefore, 0 ms mobility interruption time is achieved by NR in this case.

**NR component RIT CA mobility analysis conclusion:** 0 ms mobility interruption time can be achieved by NR for CA mobility.

**11.1.10.2.3 LTE component RIT Primary Cell mobility**

One of the features in the LTE component RIT (Release 15) is the Make-Before-Break handover in which the connection with the source e-node B (eNB) is not released until DL synchronization is achieved with the target eNB. For intra-frequency handover a dual-receiver-capable-UE can receive data from the source eNBs and track the RS from the target cell at the same time as synchronizing with the target eNB. However, the UE must release the serving cell while performing RACH procedure with the target cell.

If the source and the target cells are synchronized, the UE may obtain the timing advance (TA) information without an explicit TA command, so a RACH-less handover is possible. So, avoiding RACH related delay sometimes is possible.

**Pcell Mobility analysis conclusion:** Combining the Make-Before-Break and RACH-less handovers for a dual-receiver-capable-UE in a scenario where TA is negligible between the source and target cells, a 0ms mobility interruption time can be achieved by LTE for Pcell mobility scenario.

**11.1.10.2.4 LTE component RIT Dual Connectivity mobility**

Dual connectivity (DC) is a feature that allows a UE to connect and exchange data with two eNBs namely MeNB (Master Node) and a SeNB (Slave Node).

When moving within the same MeNB with DC enabled, the SeNB may change. The SeNB addition/release procedures from Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) (specifically TS36.300) are shown as an example below in figure 11.1.10.2.4-1:

Figure 11.1.10.2.4-1

Procedure to add an SeNB

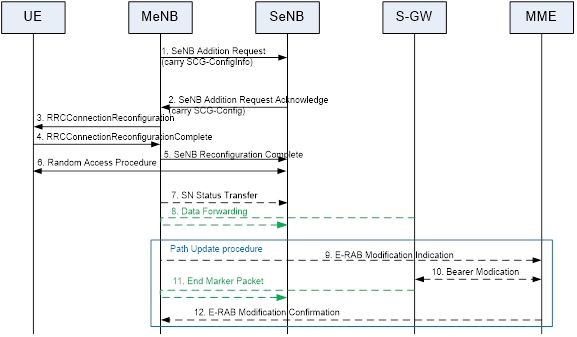


Figure 11.1.10.2.4-2

Procedure to release an SeNB – initiated by the MeNB

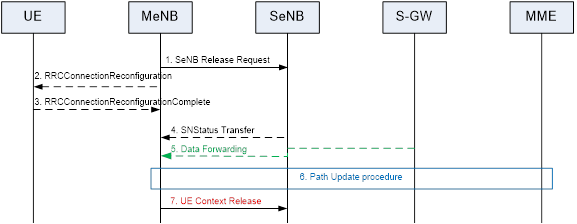
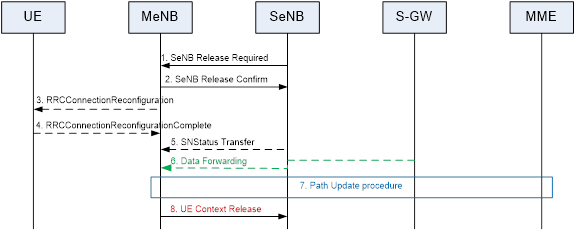


Figure 11.1.10.2.4-3

Procedure to release an SeNB – initiated by the SeNB



**Dual Connectivity (DC) Mobility analysis conclusion:** It is observed that during these procedures, the UE can always exchange user plane packets with the MeNB during transitions. Therefore, 0  ms mobility interruption time is achieved by LTE for the DC mobility scenario.

### 11.1.11 Link Budget Analysis

Link budget calculation is an important network planning tool that efficiently provides a first order approximation of cell coverage for a given level of service (and vice versa) and enables comparing the performance of different frequency bands during the network planning phase. As part of the CEG study, the calculations provided by the proponent in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) have been verified to determine whether the IMT-2020 targets would be met by their technology submission.

Inspection of the link-budget tables provided by the Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) proponent clearly shows that they are well prepared, cover the considered deployment scenarios and are appropriate for link-budget evaluation. Further, it has been verified that all setup parameters for the deployment scenarios under consideration are within the ranges suggested by the ITU in Reports [ITU-R M.2411](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2411-2017-PDF-E.pdf) and [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412-2017).

Focus of the verification efforts was centred on deriving the shadow fading margins, penetration margins and data-rate to signal-to-interference ratio (SINR) mapping as these values have been used in the tables without providing sufficient details. For both considered channel models (A and B), the theoretical derivation and numerical calculations confirm that the shadowing margins, coverage areas and receiver sensitivity points all either match or are sufficiently close in value to what has been provided by the Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en) proponent. Furthermore, in the instances where a small difference was observed, the proponent was found to have utilized more conservative values.

Shadow fading margin (SFM) derivation methodology

For each of the deployment scenarios under consideration, the cell area coverage for a single omnidirectional site has been considered to substantially reduce the complexity of the problem.

Starting with the following cell area coverage probability integral:

= (1)

where the probability of coverage at a distance *r* from the site with the pathloss can be expressed as:

(2)

After substituting and resolving the integral, the cell coverage probability becomes:

(3)

where the ***Q-function*** is the tail distribution function of the standard normal distribution and:

In all eMBB and URLLC deployment scenarios, cell coverage probabilities of 90% and 95% were considered for data and control channels, respectively.

For the mMTC deployment scenarios, 99% cell area coverage was considered for both data and control channels.

Using the above cell coverage probability functional points along with the pathloss equations for channel models A and B, the SFM was derived as a function of the pathloss exponent.

Shadow Fading Standard Deviation considerations:

The eMBB and URLLC deployment scenarios were considered to be the most challenging cases, particularly the NLOS, NLOS-Outdoor-Indoor and NLOS In-Car scenarios, with = 5, and the outdoor σ having a different value.

Since there is only a single σ value that can be inserted into the calculation equation, scenarios with two independent standard deviations combined them using the following rule:

*σ* = (4)

For the NLOS cases of eMBB and URLLC:

*a =*

*b =*

and for the NLOS O-I cases:

*a =*

*b =*

For channel model A, where an explicit value is not defined, the is derived and approximated using a generic uniform distribution of a variable into an interval (a, b), U (a, b), with the following characteristics:

The median u is defined as follows:

*u = (a + b)/2* (5)

while the standard deviation σ is derived as follows:

= (6)

The pathloss exponent is determined by the applicable pathloss equations found in Report [ITU‑R M.2412](https://www.itu.int/pub/R-REP-M.2412-2017) along with the rest of the shadow fading margins σ used for each specific scenario.

The summary of the results for SFM values is presented in the following tables for each channel model. They all fall well within the values of the self-evaluation template in Document [IMT‑2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en). Note that for the sake of brevity, the proponent is referred to as “3GPP” in the following tables.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM eMBB – Channel Model A | | | | | | | | | |
| Scenario | InH (4 GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Control Channel SFM (95%) | 2.80 | 2.84 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 8.07 | 6.95 | 8.12 | 6.97 | 10.45 | 8.45 | 10.01 | 8.24 |
| Data Channel SFM (90%) | O.91 | 0.94 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 4.85 | 4.03 | 4.89 | 4.04 | 6.61 | 5.13 | 6.24 | 4.86 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM eMBB – Channel Model B | | | | | | | | | |
| Scenario | InH (4 GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Control channel SFM (95%) | 8.50 | 8.49 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 8.07 | 9.04 | 8.12 | 9.59 | 10.45 | 10 | 10.01 | 9.66 |
| Data Channel SFM (90%) | 5.20 | 5.20 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 4.85 | 5.60 | 4.89 | 5.99 | 6.61 | 6.30 | 6.24 | 5.92 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | SFM URLLC - Channel Model A | | | | | Scenario | UMa (700 MHz) | | | | | Results from: | **3GPP** | | **CEG** | | | Control Channel SFM (95%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 8.11 | 7 | 8.12 | 7.28 | | Data Channel SFM (90%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 4.89 | 4.08 | 4.89 | 4.15 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | SFM URLLC - Channel Model B | | | | | Scenario | UMa (700 MHz) | | | | | Results from: | **3GPP** | | **CEG** | | | Control Channel SFM (95%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 8.11 | 8.30 | 8.12 | 7.59 | | Data Channel SFM (90%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 4.89 | 5.10 | 4.89 | 4.50 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM mMTC – Channel Model A | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Control Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 | 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 |
| Data Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 | 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM mMTC – Channel Model B | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Control Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 | 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 |
| Data Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 | 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 |

Penetration margin derivation

The penetration margin calculations were performed using the instructions and information from Report [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412-2017) for both channel models A and B. Note that the car penetration portion utilized a study conducted on LTE mobiles mounted on various car models that verified the agreed values for NLOS eMBB scenarios.

Also, for mMTC scenarios, the high-loss equations for building penetration were used due to the 99% cell area coverage requirement which is considered to be the most conservative case.

The tables below detail and compare the derived penetration loss values for all scenarios against the values in Document [IMT-2020/13](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0003). All differences are within a 1 dB range. Again note that the proponent is referred to as “3GPP” for the sake of brevity in the following tables.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin eMBB – Channel Model A | | | | | | | | | |
| Scenario | InH (4 GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Penetration Margin | 0 | 0 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 9 | 26.25 | 9 | 26.25 | 9 | 12.5 | 9 | 12.5 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin eMBB – Channel Model B | | | | | | | | | |
| Scenario | InH (4 GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Penetration Margin | 0 | 0 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 9 | 17.98 | 9 | 17.98 | 9 | 11.90 | 9 | 11.96 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Penetration margin  URLLC - Channel Model A | | | | | Scenario | UMa (700 MHz) | | | | | Results from: | **3GPP** | | **CEG** | | | Penetration Margin | NLOS | NLOS O-I | NLOS | NLOS O-I | | 9 | 26.25 | 9 | 26.25 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Penetration margin  URLLC - Channel Model B | | | | | Scenario | UMa (700 MHz) | | | | | Results from: | **3GPP** | | **CEG** | | | Penetration Margin | NLOS | NLOS O-I | NLOS | NLOS O-I | | 9 | 14.41 | 9 | 14.46 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin mMTC – Channel Model A | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Penetration Margin | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 0 | 0 | 26.25 | 0 | 0 | 26.25 | 0 | 0 | 26.25 | 0 | 0 | 26.25 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin mMTC - Channel Model B | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Penetration Margin | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 0 | 0 | 21.92 | 0 | 0 | 22.01 | 0 | 0 | 21.92 | 0 | 0 | 22.01 |

SNR verification

SNR verification was done using link-level simulations. The methodology used was based on maintaining the same spectrum efficiency from the proponent’s self-evaluation templates and computing the equivalent channel overhead for each specified bandwidth. The number of antennas and all other RF characteristics were maintained to provide a correct verification of the proposed results.

The simulations verified that all suggested SNR values in the proponent’s link-budget templates were within 1-2 dB margin from the simulated values, which is below the receiver implementation loss of 2 dB. For this reason, it is concluded that the proposed SNR values are correct.

Parameters evaluated via Simulation

### 11.1.12 5% user spectral efficiency and Average spectral efficiency (per test environment)

11.1.12.1 Conclusion: The CEG concluded that the 5% user and average spectral efficiency requirements are met by the NR and LTE component RITs in the submission in Document [IMT‑2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.12.2 Verification: Results are presented here only for the LTE component RIT (in Tables 11.1.12.2-1 through 11.1.12.2-5). For the NR component RIT, results are presented in § 11.2.12 of this report.

Table 11.1.12.2-1

Indoor Hotspot – eMBB (Configuration A – 4 GHz/1 layer) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Indoor Hotspot (LTE comp RIT) | | Channel Model B - Configuration A (4GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.300 | 0.380/… | …/… |
| UL | 0.210 | 0.357/… | …/… |
| ASE [bit/s/Hz/TRxP] | DL | 9.000 | 9.120/… | …/… |
| UL | 6.750 | 7.538/… | …/… |

Table 11.1.12.2-2

Dense Urban – eMBB (Configuration A – 4 GHz/1 layer) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Dense Urban (LTE comp RIT) | | Channel Model B - Configuration A (4GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.225 | 0.307/… | …/… |
| UL | 0.150 | 0.288/… | …/… |
| ASE [bit/s/Hz/TRxP] | DL | 7.800 | 7.923/… | …/… |
| UL | 5.400 | 6.756/… | …/… |

Table 11.1.12.2-3

Rural – eMBB (Configuration A – 700 MHz) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural (LTE comp RIT) | | Channel Model B - Configuration A (4GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.120 | 0.201/… | …/… |
| UL | 0.045 | 0.108/… | …/… |
| ASE [bit/s/Hz/TRxP] | DL | 3.300 | 10.664/… | …/… |
| UL | 1.600 | 5.037/… | …/… |

Table 11.1.12.2-4

Rural – eMBB (Configuration B – 4 GHz) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural (LTE comp RIT) | | Channel Model B - Configuration A (4GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.120 | 0.3342/… | …/… |
| UL | 0.045 | 0.093/… | …/… |
| ASE [bit/s/Hz/TRxP] | DL | 3.300 | 12.027/… | …/… |
| UL | 1.600 | 2.041/… | …/… |

Table 11.1.12.2-5

Rural – eMBB (Configuration C – LMLC at 700 MHz) – FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural (LTE comp RIT) | | Channel Model B - Configuration C (700MHz) | | |
| Metric | Link | M.2410 | INRS | UofT |
| ASE [bit/s/Hz/TRxP] | DL | 3.300 | … | … |
| UL | 1.600 | 3.836 | … |

### 11.1.13 Connection density

**11.1.13.1 Conclusion**: The CEG concluded that the connection density requirements are met by the SRIT submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

**11.1.13.2 Verification**: The CEG conducted simulations for the full-buffer traffic model of the LTE component of the SRIT – the results of which are shown in Tables 11.1.13.2-1 and 11.1.13.2-2.

Table 11.1.13.2-1

Urban Macro-mMTC (Configuration A – 700 MHz, ISD=500 m) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model B - Configuration A (ISD=500m) – LTE component SRIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Connection density [device/km2] | UL | 1 000 000 | 34 378 000 | … |

Table 11.1.13.2-2

Urban Macro-mMTC (Configuration B – 700 MHz, ISD=1732 m) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model B - Configuration A (ISD=1732 m) – LTE component SRIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Connection density [device/km2] | UL | 1 000 000 | 1 422 700 | … |

### 11.1.14 Reliability

11.1.14.1 Conclusion: The CEG concluded that the reliability requirements are met by the SRIT submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.14.2 Verification: For the NR component RIT, results are presented in § 11.2.14 of this report. For the LTE component RIT, it is the CEG’s understanding that this technical performance requirement is not applicable and need not be evaluated.

### 11.1.15 Mobility (InH, DU, RU)

11.1.15.1 Conclusion: The CEG concluded that the mobility requirements are met by the SRIT submission in Document [IMT-2020/13](https://www.itu.int/md/R15-IMT.2020-C-0013/en).

11.1.15.2 Verification: For the NR component RIT, results are presented in § 11.2.15 of this report. For the LTE component RIT, the results are shown in table 11.1.15.2-1 through 11.1.15.2-4.

Table 11.1.15.2-1

Indoor Hotspot – eMBB (Configuration A – 4 GHz/1 layer, 10 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Indoor Hotspot (LTE comp RIT) | | Channel Model B - Configuration A (4GHz) | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 1.500 | 2.297/… | …/… |
| NLoS | 1.500 | …/… | …/… |

Table 11.1.15.2-2

Dense Urban – eMBB (Configuration A – 4 GHz/1 layer, 30 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Dense Urban (LTE comp RIT) | | Channel Model B - Configuration A (4GHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 1.120 | 1.746/… | …/… |
| NLoS | 1.120 | 1.457/… | …/… |

Table 11.1.15.2-3

Rural – eMBB (Configuration A – 700 MHz/1 layer, 120 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural (LTE comp RIT) | | Channel Model B - Configuration A (700MHz) | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 0.800 | 2.718/… | …/… |
| NLoS | 0.800 | 2.495/… | …/… |

Table 11.1.15.2-4

Rural – eMBB (Configuration B – 4 GHz/1 layer, 120 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural (LTE comp RIT) | | Channel Model B - Configuration B (4GHz) | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 0.800 | …/… | …/… |
| NLoS | 0.800 | 1.924/… | …/… |

## 11.2 3GPP RIT

Parameters evaluated via Inspection

### 11.2.1 Bandwidth

11.2.1.1 Conclusion: The CEG concluded that bandwidth and scalability requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.1.2 Verification: Based on the submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en), the CEG evaluated the bandwidth capabilities of the NR RIT.

##### 11.2.1.2.1 NR RIT bandwidth requirements capabilities

The capability of bandwidth and bandwidth scalability for NR RIT:

There are two frequency ranges which are supported – FR1 (410-7125 MHz) and FR2 (24.25‑52.6 GHz), along with their associated SCS or numerologies. Up to 16 component carriers can be aggregated.

According to the self-evaluation report in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en), the following channel bandwidths and maximum aggregation bandwidths are supported (see Table 11.2.1.2-1):

Table 11.2.1.2-1

NR RIT capability on bandwidth

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SCS [kHz] | Maximum bandwidth for one component carrier (MHz) | Maximum number of component carriers for carrier aggregation | Maximum aggregated bandwidth (MHz) |
| FR1  (410 MHz – 7 125 MHz) | 15 | 50 | 16 | 800 |
| 30 | 100 | 16 | 1600 |
| 60 | 100 | 16 | 1600 |
| FR2  (24 250 MHz – 52 600 MHz) | 60 | 200 | 16 | 3200 |
| 120 | 400 | 16 | 6400 |

And then the following transmission bandwidths configurations are supported for each case (see Tables 11.2.1.2-2 and 11.2.1.2-3).

Table 11.2.1.2-2

Transmission bandwidth configuration NRB for FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30  MHz | 40 MHz | 50 MHz | 60 MHz | 70  MHz | 80 MHz | 90 MHz | 100 MHz |
| NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB | NRB |
| 15 | 25 | 52 | 79 | 106 | 133 | 160 | 216 | 270 | N.A | N.A | N.A | N.A | N.A |
| 30 | 11 | 24 | 38 | 51 | 65 | 78 | 106 | 133 | 162 | 189 | 217 | 245 | 273 |
| 60 | N.A | 11 | 18 | 24 | 31 | 38 | 51 | 65 | 79 | 93 | 107 | 121 | 135 |

Table 11.2.1.2-3

Transmission bandwidth configuration NRB for FR2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS (kHz) | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| NRB | NRB | NRB | NRB |
| 60 | 66 | 132 | 264 | N.A |
| 120 | 32 | 66 | 132 | 264 |

In terms of scalability, the minimum and maximum channel bandwidths and the maximum scalability per component carrier are illustrated in Table 11.2.1.2-4.

Table 11.2.1.2-4

Bandwidth scalability of NR RIT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SCS [kHz] | Minimum component carrier bandwidth (MHz) | Maximum component carrier bandwidth (MHz) | Maximum Number of supported bandwidths for a component carrier |
| FR1 | 15 | 5 | 50 | 8 |
| 30 | 5 | 100 | 13 |
| 60 | 10 | 100 | 12 |
| FR2 | 60 | 50 | 200 | 3 |
| 120 | 50 | 400 | 4 |

It is observed that up to 13 different bandwidths are supported for FR1, and up to 4 for FR2. **Therefore, bandwidth scalability capability is fulfilled by the NR RIT.**

### 11.2.2 Energy efficiency of NR RIT

11.2.2.1 Conclusion:CEG concluded that energy efficiency requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.2.2 Verification: The CEG carried out the inspection for this requirement for both the network and the UE.

##### 11.2.2.2.1 NR RIT network side

Based on the definition of network sleep time (as in the requirement Report ITU-R [M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx)), the following sleep mode ratio equations were proposed in the submission documents:





where  indicates the ceiling of *x*, *µ* is the numerology (as defined in the self-evaluation report – Part 4 – in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en), e.g., *µ* =0 for 15 kHz SCS, **=1 for 30 kHz SCS, **=3 for 120 kHz SCS, and **=4 for 240 kHz SCS), *L* is the number of SS/PBCH blocks in one SSB set, *P*SSB is the SSB set periodicity, *P*RMSI is the RSMI periodicity, and  is the flag variable (=1 for FR1, and =0 for FR2).

The CEG agrees with the proposed methodology and as a result, the NR network side can achieve a high sleep ratio in the unloaded case (see Tables 11.2.2.2.1-1 and 11.2.2.2.1-2).

Table 11.2.2.2.1-1

NR RIT network sleep ratio at slot level

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

Table 11.2.2.2.1-2

NR RIT network sleep ratio at symbol level

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

In terms of milliseconds, the sleep times that can be achieved by NR RIT network on different SSB periodicities, based on the above mechanisms, are provided in Table 11.2.2.2.1-3. It is observed that with a set period of SSB of 160 ms, more than 150 ms sleep duration can be obtained by NR RIT network. **Therefore, NR RIT network can achieve long sleep duration in the unloaded case and meets the network side energy efficiency requirement.**

Table 11.2.2.2.1-3

NR RIT network sleep duration (ms) at slot level

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

##### 11.2.2.2.2 NR RIT UE side

For NR, DRX is supported for UEs in idle, inactive and connected states.

The DRX cycle for idle state/inactive state UE consists of an “On Duration” during which the UE should perform SSB monitoring, paging monitoring and RRM measurement, and an “Off Duration” during which the UE can skip reception of downlink channels to save energy.

During the On Duration of a DRX cycle, the UE is assumed to perform the following tasks:

– Synchronization on one SSB burst (short paging cycle)

– Paging monitoring- this can consist on multiple slots. The Paging Frame is no longer than a one SSB bursts.

– RRM measurement which is based on SS/PBCH and it is assumed to be 3.5 ms.

The transition time for switching ON/OFF UE internal components is assumed to be 10 ms.

Based on these assumptions, the UE can be in sleep mode more than 90% in for any DRX cycle in idle/inactive state as shown in table 11.2.2.2.2-1:

Table 11.2.2.2.2-1

NR RIT UE sleep ratio at slot level (for idle/inactive mode)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Paging cycle *N*PC\_RF \*10 (ms) | SCS(kHz) | SSB L | SSB reception time (ms) | SSB cycle (ms) | Number of SSB burst set | RRM measurement time per DRX (ms) | Transition time (ms) | Sleep ratio |
| RRC-Idle/Inactive | 320 | 240 | 32 | 1 | - | 1 | 3.5 | 10 | 95.5% |
| 2 560 | 15 | 2 | 1 | - | 1 | 3 | 10 | 99.5% |
| 2 560 | 15 | 2 | 1 | 160 | 2 | 3 | 10 | 93.2% |

For RRC-Connected Mode, with no data transmissions, the sleep mode is more than 84%, assuming an “ON Duration” and the other similar parameters as shown in Table 11.2.2.2.2-2:

Table 11.2.2.2.2-2

NR RIT UE sleep ratio at slot level (for connected mode)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | DRX cycle *T*SC\_ms \* *M*SC (ms) | Number of SSB burst set | DRX-onDurationTimer (ms) | RRM measurement time per DRX (ms) | Transition time (ms) | Sleep ratio |
| RRC-Connected | 320 | 1 | 2 | 3.5 | 10 | 95.2% |
| 320 | 1 | 10 | 3 | 10 | 92.8% |
| 2 560 | 1 | 100 | 3 | 10 | 95.6% |
| 10 240 | 1 | 1 600 | 3 | 10 | 84.2% |

**The CEG concludes that in both idle and connected states, the NR RIT** **UE can achieve a very high percentage of sleep ratio at the slot level.**

### 11.2.3 Spectrum

11.2.3.1 Conclusion: The CEG concluded that the NR RIT submitted in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014) meets the spectrum capability requirements defined in § 5.2.4.2 in Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411).

11.2.3.2 Verification: Based on the submission in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014), the CEG considered the NR RIT for inspection. As discussed in § 11.1.3.2.1 of this report, NR supports all the frequency bands identified for IMT either entirely or partially except for the band 450-470 MHz. The minimum requirement is the support for one frequency band. Therefore, the NR RIT submission supports the requirements in § 5.2.4.2.1 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411). In addition, NR supports the following frequency ranges above 24.5 GHz: 24.25-27.5 GHz, 27.5-29.5 GHz and 37-40 GHz. Therefore, it meets the compliance requirements in § 5.2.4.2.2 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411).

### 11.2.4 Services

11.2.4.1 Conclusion: The CEG concluded that the NR RIT submitted in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014) meets service capability requirements defined in § 5.2.4.1 of Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411).

11.2.4.2 Verification: Based on the submission in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014), the CEG considered NR RIT for inspection, as explained in § 11.14.2, where it was verified that the NR RIT component supports a wide ranges of services in all three usage scenarios: eMBB, mMTC and URLLC. The same verification applies here as well.

Parameters evaluated via Analysis

### 11.2.5 Peak data rate

11.2.5.1 Conclusion:The CEG concluded that peak data rate requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.5.2 Verification: This analysis has already been provided in § 11.1.5 of the current report.

**In conclusion, the peak data rate values computed and explained in § 11.1.5 apply to NR RIT, which is considered to have fulfilled the ITU technical performance requirements.**

### 11.2.6 Peak spectral efficiency

11.2.6.1 Conclusion:The CEG concluded that peak spectral efficiency requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.6.2 Verification: This analysis has already been provided in § 11.1.6 of the current report.

**In conclusion, the peak spectral efficiency values computed and explained in § 11.1.6 apply to NR RIT, which is considered to have fulfilled the ITU technical performance requirements.**

### 11.2.7 User experienced data rate (single band, single layer)

11.2.7.1 Conclusion: The CEG concluded that the user experienced data rate requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.7.2 Verification: User experienced data rate is one of the most important performance indicators for eMBB use case as it relates to the expected user experience under certain network conditions (e.g., channel bandwidth, morphology, etc.). As such, it is part of minimal technical performance requirements, specified in Report ITU-R [M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx).

For the purpose of evaluation, *user experienced data rate* is defined as the 5% point of the cumulative distribution function of the user throughput, with the targets specified for the Dense Urban eMBB environment:

* Downlink user experienced data rate is Mbit/s
* Uplink user experience data rate is Mbit/s

Evaluation criteria set out in Report [M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx) allow for one or more frequency bands and for one or more layers for transmission reception points (TRxP) provided that user spectral efficiency per band is derived from the 5th percentile. In this evaluation, the CEG assumed a single band, single layer, and, given the target user data rates for the downlink and uplink, calculated the needed bandwidth, which is not part of the requirement.

**Evaluation results (NR)**

Simulation results for the configuration A (4 GHz) for dense urban eMBB use case have been considered for this evaluation. Summary results obtained by the University of Toronto (U of T) and INRS are summarized in table 11.2.7.2-1:

Table 11.2.7.2-1

5th percentile spectral efficiency values for DU-eMBB obtained via simulation

|  |  |  |  |
| --- | --- | --- | --- |
| Spectral efficiency, | | U of T | INRS |
| FDD | DL (bit/s/Hz) | 0.38 | 0.248 |
| UL (bit/s/Hz) | 0.228 | 0.273 |
| TDD | DL (bit/s/Hz) | 0.43 | 0.328 |
| UL (bit/s/Hz) | 0.213 | 0.274 |

Given the values above, the range for the required bandwidth to meet the target data rates are calculated as:.

Table 11.2.7.2-2

Required bandwidths to meet the target data rates (100 Mbit/s DL and 50 Mbit/s UL)

|  |  |  |  |
| --- | --- | --- | --- |
| Bandwidth, | | U of T | INRS |
| FDD | Downlink (MHz) | 263 | 403 |
| Uplink (MHz) | 219 | 183 |
| TDD | Downlink (MHz) | 304 | 399 |
| Uplink (MHz) | 1174 | 912 |

The DDDSU configuration was assumed in table 11.2.7.2-2 for the TDD mode of operation, with and representing the downlink and uplink fractions of the time, respectively.

### 11.2.8 Area traffic capacity (InH, eMBB)

11.2.8.1: Conclusion: TheCEG concluded that the area traffic capacity requirement is met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.8.2: Verification: The requirement is defined for the purpose of evaluation in the Indoor Hotspot (InH) eMBB test environment, where the target value for the area traffic capacity on the downlink is 10 Mbit/s/m2.

The Indoor Hotspot-eMBB test environment consists of one floor of a building. The height of the ceiling is 3 m. The floor has a surface of 120 m × 50 m and 12 BSs/sites which are placed in 20 meters spacing as shown in figure 11.2.6.2-1, with a LOS probability as defined by channel model in Annex 1, Table A1-9 of Report [ITU-R M.2412](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2412-2017-MSW-E.docx). In the figure, internal walls are not explicitly shown but are modeled via the stochastic LOS probability model.

The type of site deployed (e.g. 1 TRxP per site or 3 TRxPs per site) is not defined and should be reported by the proponent.

Figure 11.2.8.2-1

Indoor Hotspot sites layout



If 12 TRxP are assumed in the above scenario, then can be computed as follows:

= 12 / (120m X 50m) = 0.002 TRxP/m2

For FDD with DL with 32x4 MU-MIMO Type II Codebook, and SCS = 15 KHz the average spectrum efficiency may be derived as:

Channel Model A: = 13.24 for 40 MHz carrier bandwidth.

Channel Model B: = 13.54 for 40 MHz carrier bandwidth.

For this FDD configuration, using a 400 MHz aggregation bandwidth:

Channel Model A

= 0.002 X 400 MHz X 13.24 = 10.59 Mbit/s/Hz

Channel Model B

= 0.002 X 400 MHz X 13.54 = 10.83 Mbit/s/Hz

Observation 1: For an FDD configuration, the RIT area traffic capacity requirement can be met with a minimum aggregated channel bandwidth of 400 MHz.

For TDD with DL with 32x4 MU-MIMO Type II Codebook reciprocity based, 4T SRS, SCS = 15 KHz and DDDSU frame structure, the average spectrum efficiency may be derived as:

Channel Model A: = 14.65 for 40 MHz carrier bandwidth.

Channel Model B: = 14.64 for 40 MHz carrier bandwidth.

So, for the above TDD configuration with 360MHz aggregated bandwidth the following area traffic capacities are found:

Channel Model A

= 0.002 X 360 MHz X 14.65 = 10.54 Mbit/s/Hz

Channel Model B

= 0.002 X 360 MHz X 14.64 = 10.54 Mbit/s/Hz

Observation 2: For TDD configuration, the RIT area traffic capacity requirement can be met with a minimum aggregated channel bandwidth of 360 MHz.

### 11.2.9 Latency (user-plane and control-plane)

**11.2.9.1 User-plane latency**

**11.2.9.1.1 Conclusion**: The CEG concluded that the RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) is capable of satisfying the technical performance requirement of 4 ms for the eMBB usage scenario and 1 ms for the URLLC usage scenario.

**11.2.9.1.2 Verification**: This is explained in detail in § 11.1.9.1.2.1, with the corresponding details in Annex 2.

**11.2.9.2 Control-plane latency**

**11.2.9.1.1 Conclusion**: The CEG concluded that the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) is capable of satisfying the technical performance requirement of 20 ms.

**11.2.9.1.2 Verification**: This is explained in detail in § 11.1.9.2.2.1, with the corresponding details in Annex 3.

### 11.2.10 Mobility interruption time

**11.2.10.1 Conclusion:** The CEG concluded that the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) is compliant with the mobility interruption time requirement of 0 ms as specified by Report [ITU‑R M.2410](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-MSW-E.docx).

#### 11.2.10.2 Verification

Details of the analysis

The following scenarios were considered based on the submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

NR mobility scenarios:

– Beam mobility

– CA (Carrier Aggregation) mobility

##### 11.2.10.2.1 NR RIT Beam mobility

One of the new features of NR RIT is the specification of beam management. While moving into a cell, the transmit-receive beam of a user terminal may need to be changed.

The UE can be configured to perform beam measurements and reporting based on a set of specific RS resources. The device can report physical layer measurements for the strongest beam and for the rest of the remaining beams, just their differences from the best beam.

NR supports beam indication. This implies in informing the UE that certain PDSCH and/or PDCCH transmissions uses the same transmission beam as a configured reference signal (RS). That means that a certain PDSCH and/or PDCCH is transmitted using the same spatial filter as the configured RS. So, beam indication is based on the configuration and downlink signaling of so-called Transmission Configuration Indication (TCI) states.

A UE can be configured by RRC with up to 64 TCI states, and by means of MAC signaling, the network can indicate a specific TCI state.

In some situations, the PDSCH beam indication can be performed using 2 different procedures due to the flexible offset scheduling timing. If this is larger than N symbols, DCI scheduling (on PDCCH) can indicate the TCI state. If it is smaller than N, the UE may assume quasi-collocated transmissions with the PDCCH.

Observation 1: The above described mechanism is sufficiently flexible and allows the gNB to schedule DL data on multiple beams on different slots.

A similar procedure is available for the UL, where PUSCH is sent using an SRS resource indicator (SRI) configured by the gNB. Thus, the gNB-side beam is selected for UL data reception accordingly.

Observation 2: gNB may select different beams at different slots depending on the UE mobility. Therefore, UL data packet transmission is kept during beam-pair-switching at different slots.

**Beam Mobility analysis conclusion: the UE can always exchange user plane packets with the gNB during mobility transitions. Therefore, 0** **ms mobility interruption time can be achieved by NR RIT for this scenario.**

##### 11.2.10.2.2 NR Carrier Aggregation mobility

When moving within the same PCell with CA enabled, the set of configured SCells of the UE may change. The SCell addition procedure and SCell release procedures can occur.

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

**NR RIT CA mobility analysis conclusion: 0 ms mobility interruption time can be achieved by NR for CA mobility.**

### 11.2.11 Link Budget Analysis

Link budget calculation is an important network planning tool that efficiently provides a first order approximation of cell coverage for a given level of service (and vice versa) and enables comparing the performance of different frequency bands during the network planning phase. As part of the CEG study, the calculations provided by the proponent in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) have been verified to determine whether the IMT-2020 targets would be met by their technology submission.

Inspection of the link budget template tables provided by the Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) proponent clearly shows that they are well prepared, cover the considered deployment scenarios and are appropriate for link-budget evaluation. Further, it has been verified that all setup parameters for the deployment scenarios under consideration are within the ranges suggested by the ITU in Reports [ITU-R M.2411](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2411-2017-PDF-E.pdf) and [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412-2017).

Focus of the verification efforts was centred on deriving the shadow fading margins, penetration margins and data-rate to signal-to-interference (SINR) mapping as these values have been used in the tables without providing sufficient details. For both considered channel models (A and B), the theoretical derivation and numerical calculations, confirm that the shadowing margins, coverage areas and receiver sensitivity points all either match or are sufficiently close in value to what has been provided by the Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en). Furthermore, in the instances where a small difference was observed, the proponent was found to have utilized more conservative values.

Shadow fading margin (SFM) derivation methodology

For each of the deployment scenarios under consideration, the cell area coverage for a single omnidirectional site has been considered to substantially reduce the complexity of the problem.

Starting with the following cell area coverage probability integral:

= (1)

where the probability of coverage at a distance *r* from the site with the pathloss can be expressed as:

(2)

After substituting and resolving the integral, the cell coverage probability becomes:

(3)

where the ***Q-function*** is the tail distribution function of the standard normal distribution and:

In all eMBB and URLLC deployment scenarios, the cell coverage probabilities of 90% and 95% were considered for data and control channels, respectively.

For the mMTC deployment scenarios, 99% cell area coverage was considered for both data and control channels.

Using the above cell coverage probability functional points along with the pathloss equations for channel models A and B, the SFM was derived as a function of the pathloss exponent.

Shadow Fading Standard Deviation considerations:

The eMBB and URLLC deployment scenarios were considered to be the most challenging cases, particularly the NLOS, NLOS-Outdoor-Indoor and NLOS In-Car scenarios, with = 5, and the outdoor *σ* having a different value.

Since there is only a single σ value that can be inserted into the calculation equation, scenarios with two independent standard deviations combined them using the following rule:

*σ* = (4)

For NLOS cases of eMBB and URLLC:

*a =*

*b =*

and for NLOS-O-I cases:

*a =*

*b =*

For channel model A, where an explicit value is not defined, the is derived and approximated using a generic uniform distribution of a variable into an interval (a, b), U (a, b), with the following characteristics:

The median u is defined as follows:

*u = (a + b)/2* (5)

while the standard deviation σ is derived as follows:

= (6)

The pathloss exponent is determined by the applicable pathloss equations found in Report [ITU‑R M.2412](https://www.itu.int/pub/R-REP-M.2412-2017) along with the rest of the shadow fading margins σ used for each specific scenario.

The summary of the results for SFM values are presented in the following tables for each channel model. They all fall well within the values of the self-evaluation template in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en). Note that for the sake of brevity, the proponent is referred to as “3GPP” in the following tables.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM eMBB - Channel Model A | | | | | | | | | |
| Scenario | InH (4 GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Control Channel SFM (95%) | 2.80 | 2.84 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 8.07 | 6.95 | 8.12 | 6.97 | 10.45 | 8.45 | 10.01 | 8.24 |
| Data Channel SFM (90%) | O.91 | 0.94 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 4.85 | 4.03 | 4.89 | 4.04 | 6.61 | 5.13 | 6.24 | 4.86 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM eMBB - Channel Model B | | | | | | | | | |
| Scenario | InH (4 GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Control Channel SFM (95%) | 8.50 | 8.49 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 8.07 | 9.04 | 8.12 | 9.59 | 10.45 | 10 | 10.01 | 9.66 |
| Data Channel SFM (90%) | 5.20 | 5.20 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 4.85 | 5.60 | 4.89 | 5.99 | 6.61 | 6.30 | 6.24 | 5.92 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | SFM URLLC – Channel Model A | | | | | Scenario | UMa (700 MHz) | | | | | Results origin | **3GPP** | | **CEG** | | | Control Channel SFM (95%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 8.11 | 7 | 8.12 | 7.28 | | Data Channel SFM (90%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 4.89 | 4.08 | 4.89 | 4.15 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | SFM URLLC – Channel Model B | | | | | Scenario | UMa (700 MHz) | | | | | Results origin | **3GPP** | | **CEG** | | | Control Channel SFM (95%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 8.11 | 8.30 | 8.12 | 7.59 | | Data Channel SFM (90%) | NLOS | NLOS O-I | NLOS | NLOS O-I | | 4.89 | 5.10 | 4.89 | 4.50 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM mMTC - zChannel Model A | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Control Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 | 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 |
| Data Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 | 6.30 | 10.26 | 12.22 | 6.24 | 10.26 | 12.32 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SFM mMTC - Channel Model B | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Control Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 | 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 |
| Data Channel SFM (99%) | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 | 6.3 | 10.26 | 17 | 6.24 | 10.26 | 16.18 |

Penetration Margin derivation

The penetration margin calculations were performed using the instructions and information from Report [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412-2017) for both channel models A and B. Note that the car penetration portion utilized a study conducted on LTE mobiles mounted on various car models that verified the agreed values for NLOS eMBB scenarios.

Also, for mMTC scenarios the high-loss equations for building penetration were used due to the 99% cell area coverage requirement which is considered to be the most conservative case.

The tables below detail and compare the derived penetration loss values for all scenarios against the values in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en). All differences are within a 1 dB range. Again note that the proponent is referred to as “3GPP” for the sake of brevity in the following tables.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin eMBB - Channel Model A | | | | | | | | | |
| Scenario | InH (4GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Penetration Margin | 0 | 0 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 9 | 26.25 | 9 | 26.25 | 9 | 12.5 | 9 | 12.5 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin eMBB - Channel Model B | | | | | | | | | |
| Scenario | InH (4GHz) | | DU (4 GHz) | | | | Rural (700 MHz) | | | |
| Results from: | **3GPP** | **CEG** | **3GPP** | | **CEG** | | **3GPP** | | **CEG** | |
| Penetration Margin | 0 | 0 | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I | NLOS | NLOS O-I |
| 9 | 17.98 | 9 | 17.98 | 9 | 11.90 | 9 | 11.96 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Penetration margin  URLLC - Channel Model A | | | | | Scenario | UMa (700 MHz) | | | | | Results from: | **3GPP** | | **CEG** | | | Penetration Margin | NLOS | NLOS O-I | NLOS | NLOS O-I | | 9 | 26.25 | 9 | 26.25 | | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Penetration margin  URLLC - Channel Model B | | | | | Scenario | UMa (700 MHz) | | | | | Results from: | **3GPP** | | **CEG** | | | Penetration Margin | NLOS | NLOS O-I | NLOS | NLOS O-I | | 9 | 14.41 | 9 | 14.46 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin mMTC - Channel Model A | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Penetration Margin | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 0 | 0 | 26.25 | 0 | 0 | 26.25 | 0 | 0 | 26.25 | 0 | 0 | 26.25 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Penetration margin mMTC - Channel Model B | | | | | | | | | | | |
| Scenario | UMa NB-IoT (700 MHz) | | | | | | UMa eMTC (700 MHz) | | | | | |
| Results from: | **3GPP** | | | **CEG** | | | **3GPP** | | | **CEG** | | |
| Penetration Margin | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I | LOS | NLOS | NLOS O-I |
| 0 | 0 | 21.92 | 0 | 0 | 22.01 | 0 | 0 | 21.92 | 0 | 0 | 22.01 |

SNR verification

SNR verification was done using link-level simulations. The methodology used was based on maintaining the same spectrum efficiency from the proponent’s self-evaluation templates and computing the equivalent channel overhead for each specified bandwidth. The number of antennas and all other RF characteristics was maintained to provide a correct verification of the proposed results.

The simulations verified that all suggested SNR values in the proponent’s link-budget templates were within 1-2 dB margin from the simulated values, which is below the receiver implementation loss of 2 dB. For this reason, it is concluded that the proposed SNR values are correct.

Parameters evaluated via Simulation

### 11.2.12 5% user spectral efficiency and Average spectral efficiency (per test environment)

11.2.12.1 Conclusion: The CEG concluded that the 5% user and average spectral efficiency requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.12.2 Verification: The results of the verification are presented in tables 11.2.12.2-1 through 11.2.12.2-7 below.

Table 11.2.12.2-1

Indoor Hotspot – eMBB (Configuration A – 4 GHz) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Indoor hotspot | | Channel Model B - Configuration A (4 GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.300 | 0.331/0.416 | 0.359/0.381 |
| UL | 0.210 | 0.581/0.308 | …/… |
| ASE [bit/s/Hz/TRxP] | DL | 9.000 | 10.750/11.095 | 9.812/10.109 |
| UL | 6.750 | 7.947/8.812 | …/… |

Table 11.2.12.2-2

Indoor Hotspot – eMBB (Configuration B – 30 GHz) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Indoor hotspot | | Channel Model B - Configuration B (30GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.300 | 0.426/0.610 | 0.324/… |
| UL | 0.210 | 0.303/0.357 | …/… |
| ASE [bit/s/Hz/TRxP] | DL | 9.000 | 12.512/17.811 | 10.851/… |
| UL | 6.750 | 9.072/9.437 | …/… |

Table 11.2.12.2-3

Dense Urban – eMBB (Configuration A – 4 GHz/1 layer) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Dense Urban | | Channel Model B - Configuration A (4 GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.225 | 0.248/0.328 | 0.380/0.430 |
| UL | 0.150 | 0.273/0.274 | 0.228/0.213 |
| ASE [bit/s/Hz/TRxP] | DL | 7.800 | 11.200/14.371 | 11.270/13.371 |
| UL | 5.400 | 6.087/6.099 | 6.512/6.462 |

Table 11.2.12.2-4

Dense Urban – eMBB (Configuration B – 30 GHz/1 layer) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Dense Urban | | Channel Model B - Configuration B (30 GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.225 | 0.490/0.494 | 0.350/0.370 |
| UL | 0.150 | 0.244/0.245 | 0.264/0.291 |
| ASE [bit/s/Hz/TRxP] | DL | 7.800 | 13.752/13.521 | 11.360/13.144 |
| UL | 5.400 | 6.087/5.994 | 6.397/7.752 |

Table 11.2.12.2-5

Rural – eMBB (Configuration A – 700 MHz) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural | | Channel Model B - Configuration A (700 MHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.120 | 0.174/0.171 | 0.162/0.159 |
| UL | 0.045 | 0.617/0.334 | 0.248/0.193 |
| ASE [bit/s/Hz/TRxP] | DL | 3.300 | 11.600/9.609 | 6.152/7.490 |
| UL | 1.600 | 4.349/3.626 | 6.951/5.872 |

Table 11.2.12.2-6

Rural – eMBB (Configuration B – 4 GHz) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural | | Channel Model B - Configuration B (4 GHz) | | |
| Metric | Link | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| 5% USE [bit/s/Hz] | DL | 0.120 | 0.278/0.349 | 0.187/0.370 |
| UL | 0.045 | 0.145/0.195 | 0.189/0.132 |
| ASE [bit/s/Hz/TRxP] | DL | 3.300 | 13.892/10.384 | 6.480/13.144 |
| UL | 1.600 | 4.102/2.907 | 7.125/3.361 |

Table 11.2.12.2-7

Rural – eMBB (Configuration C – LMLC at 700 MHz) – FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural | | Channel Model B - Configuration C (700 MHz) | | |
| Metric | Link | M.2410 | INRS | UofT |
| ASE [bit/s/Hz/TRxP] | DL | 3.300 | 10.521 | … |
| UL | 1.600 | 3.500 | … |

Note: No evaluation configuration for 5% SE in the case of LMLC at 700 MHz

### 11.2.13 Connection density

11.2.13.1 Conclusion: The CEG concluded that the connection density requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.13.2 Verification: The results of the verification are presented in table 11.2.13.2-1 below.

Table 11.2.13.2-1

Urban Macro-mMTC (Configuration A – 700 MHz, ISD = 1 732m) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model B - Configuration A (700MHz, ISD = 1 732m) – NR RIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Connection density [device/km2] | UL | 1 000 000 | 1 458 509 | 1 518 832 |

### 11.2.14 Reliability

11.2.14.1 Conclusion: The CEG concluded that the reliability requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.3.14.2 Verification: The results of the verification are presented in tables 11.2.14.2-1 through 11.2.14.2-3 below.

Table 11.2.14.2-1

Urban Macro-URLLC (Configuration A – Channel Model A) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model A - Configuration A (4 GHz) – NR RIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Reliability [%] | DL | 99.999% | >99.999% | 99.9999% |
| Reliability [%] | UL | 99.999% | >99.999% | 99.9997% |

Table 11.2.14.2-2

Urban Macro-URLLC (Configuration A – Channel Model B) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model B - Configuration A (4 GHz) – NR RIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Reliability [%] | DL | 99.999% | … | 99.99997% |
| Reliability [%] | UL | 99.999% | … | 99.9993% |

Table 11.2.14.2-3

Urban Macro-URLLC (Configuration B) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model A - Configuration B (700 MHz) – NR RIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Reliability [%] | DL | 99.999% | >99.999% | 99.9997% |
| Reliability [%] | UL | 99.999% | >99.999% | 99.9999% |

### 11.2.15 Mobility (InH, DU, RU)

11.2.15.1 Conclusion: The CEG concluded that the reliability requirements are met by the NR RIT submission in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en).

11.2.15.2 Verification: The results of the verification are presented in tables 11.2.15.2-1 through 11.2.15.2-6 below.

Table 11.2.15.2-1

Indoor Hotspot – eMBB (Configuration A – 4 GHz, 10 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Indoor Hotspot | | Channel Model A - Configuration A (4 GHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 1.500 | 2.292/2.103 | 2.1/1.82 |
| NLoS | 1.500 | 1.985/1.978 | 1.63/1.38 |

Table 11.2.15.2-2

Indoor Hotspot – eMBB (Configuration B – 30 GHz, 10 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Indoor Hotspot | | Channel Model A - Configuration B (30 GHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
|
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 1.500 | …/2.324 | …/… |
| NLoS | 1.500 | 2.545/1.984 | 2.71/… |

Table 11.2.15.2-3

Dense Urban – eMBB (Configuration A – 4 GHz/1 layer, 30 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Dense Urban | | Channel Model B - Configuration A (4 GHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 1.120 | 2.260/2.210 | 2.210/2.060 |
| NLoS | 1.120 | 1.907/2.146 | 1.950/1.790 |

Table 11.2.15.2-4

Dense Urban – eMBB (Configuration B – 30 GHz/1 layer, 30 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Dense Urban | | Channel Model B - Configuration B (30 GHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 1.120 | 2.242/1.751 | …/… |
| NLoS | 1.120 | 1.890/1.662 | 1.180/… |

Table 11.2.15.2-5

Rural – eMBB (Configuration A – 700 MHz, 120 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural | | Channel Model B - Configuration A (700 MHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 0.800 | 2.660/2.308 | 2.570/2.180 |
| NLoS | 0.800 | 2.545/2.191 | 2.130/1.920 |

Table 11.2.15.2-6

Rural – eMBB (Configuration B – 4 GHz, 120 km/h) – FDD and TDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eMBB – Rural | | Channel Model B - Configuration B (4 GHz) – NR RIT | | |
| Metric | LoS/NLoS | M.2410 | INRS (FDD/TDD) | UofT (FDD/TDD) |
| Normalized traffic channel link data rate [bit/s/Hz] | LoS | 0.800 | 2.537/2.451 | 2.620/2.140 |
| NLoS | 0.800 | 2.376/1.935 | 2.150/1.940 |

## 11.3 TSDSI RIT

Subsequent to the exchange of e-mails/views with the proponent and the discussions at the 33rd meeting of the concerned working party of ITU-R in December 2020, the CEG’s opinion developed to the point where it deemed the contents of the submission in Document [IMT-2020/19Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0019) were very similar to those of Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en) and that a complete evaluation of the TSDSI RIT was not really necessary. This was further enhanced by two related events – the first being the determination by the concerned working party that the revised submission from TSDSI was “complete,” but rendering this decision only at its December 2019 meeting, and the second being that the final report to the ITU had to be delivered by 12th February 2020, leaving very little time in-between for overall evaluation of *all* submitted technologies.

However, further to evaluating the link-budget tables submitted by this proponent, the CEG also debated the “additional information” provided:

– The pi/2 BPSK modulation scheme (which, the proponent says, is different from a similar modulation scheme in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en)).

– The 26 dB transmit power capability of the UE (3 dB higher than the power class elaborated in Report M.2412).

The bandwidth of 60 MHz at a frequency of 3.5 GHz and an inter-site distance of 12 km.

These were interesting, but as WP 5D of the ITU-R concluded in Document [IMT-2020/28(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0028)[[7]](#footnote-7), could not be taken into account in the evaluation process, since the parameters in the last two bullets are outside the evaluation configurations specified in Report [M.2412](https://www.itu.int/pub/R-REP-M.2412).

## 11.4 Nufront EUHT RIT

Parameters evaluated via Inspection

### 11.4.1 Bandwidth

11.4.1.1 Conclusion: The CEG is of the opinion that the EUHT RIT candidate submitted by Nufront is *probably* able to meet the bandwidth and scalability requirements established by the ITU, as per the submission received in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018).

11.4.1.2 Verification: The CEG inspected §5.2.3.2.8 (and its sub-sections 1-8) of the “characteristics template for EUHT RIT” document as well as § 8.1 (‘Bandwidth and scalability’) of the “Self-Evaluation Report – EUHT RIT” document, both of which can be found in [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018).

As per the characteristics template: one component carrier can support a scalable bandwidth of 5, 10, 15, etc., upto 100 MHz in a frequency range of 450-6000 MHz. Above 24.25 GHz, one component carrier can support bandwidths of 50, 100, 200 or 400 MHz. The supported bandwidths are shown in § 5.2.3.2.8.3, where the upper bound is 40 GHz.

From the self-evaluation report: apparently, the maximum number of component carriers that can be aggregated is 16, as explained in Table 8.1-1 reproduced in Table 11.4.1.2-1:

Table 11.4.1.2-1

EUHT capability on bandwidth

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **SCS [kHz]** | **Maximum bandwidth for one component carrier (MHz)** | **Maximum number of component carriers for carrier aggregation** | **Maximum aggregated bandwidth (MHz)** |
| Sub-6GHz bands  (Below 6 GHz) | 19.53125 | 50 | 16 | 800 |
| 39.0625 | 100 | 16 | 1600 |
| 78.125 | 100 | 16 | 1600 |
| mmWave bands  (Above 24 GHz) | 390.625 | 400 | 16 | 6400 |

Clearly, the minimum bandwidth of 100 MHz can be met as can the requirement of at least 1 GHz in higher bands (e.g. 24.25 GHz or above).

However, Tables 8.1-2(b) and 8.1-3 of the self-evaluation, as reproduced below in Tables 11.4.1.2-2 and 11.4.1.2-3, would appear to sow some confusion in the mind of the reader, as the last column in Table 11.4.1.2-3 indicates a “maximum number of supported bandwidths for a component carrier” :

Table 11.4.1.2-2

Transmission bandwidth configuration NSD in EUHT for mmWave bands

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS [kHz] | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| NSD | NSD | NSD | NSD |
| 390.625 | 112 | 224 | 448 | 896 |

Table 11.4.1.2-3

Bandwidth scalability capability for EUHT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **SCS [kHz]** | **Minimum component carrier bandwidth (MHz)** | **Maximum component carrier bandwidth (MHz)** | **Maximum Number of supported bandwidth for a component carrier** |
| Sub-6GHz bands | 19.53125 | 5 | 50 | 8 |
| 39.0625 | 5 | 100 | 11 |
| 78.125 | 5 | 100 | 11 |
| mmWave bands | 390.625 | 50 | 400 | 4 |

Thus if one were to multiply the “maximum Number of supports bandwidth for a component carrier” by the “Maximum component carrier bandwidth” (i.e. 400 by 4),” one would arrive at a different conclusion as it would yield a bandwidth of 1.6 GHz, whereas from table 11.4.1.2-1, one should actually multiply 400 MHz by 16.

From table 11.4.1.2-2, a somewhat perplexing result is precipitated: the proponent appears to multiply the SCS of 390.625 by the number of data sub-carriers (NSD) = 896, which yields about 350 MHz (instead of 400 MHz, indicating a guard-band of 50 MHz built into the radio-frame?).This means that if two such 400 MHz carriers are aggregated, there will be a compulsory guardband of 50 MHz between them – which does not seem to constitute an efficient use of spectrum.

### 11.4.2 Energy efficiency of EUHT RIT

11.4.2.1 Conclusion: TheCEG concluded that energy efficiency requirements are met by the EUHT RIT submission in Document [IMT-2020/18(Rev.1).](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018)

11.4.2.2 Verification: The CEG carried out the inspection for this requirement for both the network side and the UE side.

11.4.2.2.1 **EUHT RIT network side**

The only channel required to be broadcast by a Central Access Point (CAP) is the Broadcast Control Frame (BCF) which is used by a station (STA, or UE) to discover the CAP/network. The BCF has a configurable periodicity that can go up to a maximum of 65 535 ms while the BCF length can be {0.5, 1, 1.6, 6, 2.5, 4} ms.

Considering a typical periodicity of 100 ms and a length of 0.5 ms for the BCF, it is possible to evaluate that 99.5% sleep mode is achievable on transmit (from the network side).

For the listening window on the CAP side, for random access, or an RA\_Pn (Random Access\_Pseudo-noise) signal, the CAP listens periodically to the Random Access (RA) channel for STA access.

11.4.2.2.2 **EUHT RIT UE side**

In sleep mode, the STA has to monitor synchronization and Data Frame Indication (DTF\_IND) signals within a specific time window called listening window. The sleep window is an integer multiple of the frame length (1 or 2 ms). During sleep mode, the STA skips reception. The listen and sleep windows are configurable.

It is possible to have different sleep/monitoring ratios.

As explained in the following tables, for each type of frame length of 1 or 2 ms it is possible have the following sleep ratios:

Table 11.4.2.2.2-1

EUHT STA sleep ratio for 1 ms frame length

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Duration of sleep (ms)** | **numbers of duration** | **sleep time (ms)** | **listen time (ms)** | **Frame length (ms)** | **Frame numbers in sleep** | **Frame numbers in listen** | **Sleep ratio** |
| 10 | 40 | 9 | 1 | 1 | 9 | 1 | 90% |
| 20 | 20 | 19 | 1 | 1 | 19 | 1 | 95% |
| 40 | 10 | 39 | 1 | 1 | 39 | 1 | 97.5% |
| … | | | | | | | |
| 1000 | 1 | 999 | 1 | 1 | 999 | 1 | 99.9% |

Table 11.4.2.2.2-2

EUHT STA sleep ratio for 2 ms frame length

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Duration of sleep (ms)** | **numbers of duration** | **sleep time (ms)** | **listen time (ms)** | **Frame length (ms)** | **Frame numbers in sleep** | **Frame numbers in listen** | **Sleep ratio** |
| 10 | 40 | 8 | 2 | 2 | 4 | 1 | 80% |
| 20 | 20 | 18 | 2 | 2 | 9 | 1 | 90% |
| 40 | 10 | 38 | 2 | 2 | 19 | 1 | 95% |
| … | | | | | | | |
| 1000 | 1 | 998 | 2 | 2 | 499 | 1 | 99.8% |

### 11.4.3 Spectrum

11.4.3.1 Conclusion: The CEG is of the opinion that the EUHT RIT candidate submitted by Nufront in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) is *probably* able to meet the spectrum requirements as outlined in Report ITU-R [M.2411](https://www.itu.int/pub/R-REP-M.2411).

11.4.3.2 Verification

EUHT RIT supports only a TDD duplexing scheme. The BCF indicates no options for full duplex mode operation.

As explained in Report M.2411, the following frequency bands have been identified for IMT in the ITU Radio Regulations (RR) by previous World Radiocommunication Conferences (WARC-92, WRC-2000, WRC-07, WRC-12 and WRC-15):

450-470 MHz (see RR No. **5.286AA**)

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

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

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

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

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

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

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

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

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

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

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

For all of the above frequency ranges, EUHT RIT has indicated uniquely TDD duplex mode operation, as shown in Table 11.4.3.2-1.

Table 11.4.3.2-1

EUHT operating bands in Sub-6GHz bands

|  |  |
| --- | --- |
| **Uplink (UL) and Downlink (DL)operating band** | **Duplex Mode** |
| 450 – 470 MHz | TDD |
| 470 – 698 MHz | TDD |
| 694/698 – 960 MHz | TDD |
| 1427 – 1518 MHz | TDD |
| 1710 – 2025 MHz | TDD |
| 2110 – 2200 MHz | TDD |
| 2300 – 2400 MHz | TDD |
| 2500 – 2690 MHz | TDD |
| 3300 - 3400 MHz | TDD |
| 3400 - 3600 MHz | TDD |
| 3600 - 3700 MHz | TDD |
| 4800 - 4990 MHz | TDD |

For frequencies above 24.25GHz, EUHT has the following table (8.2-2 from the self-evaluation report, reproduced below):

Table 11.4.3.2-2

EUHT operating bands in mmWave bands

|  |  |
| --- | --- |
| **Uplink (UL) and Downlink (DL) operating band** | **Duplex Mode** |
| 26500 MHz – 29500 MHz | TDD |
| 24250 MHz – 27500 MHz | TDD |
| 37000 MHz – 40000 MHz | TDD |
| 27500 MHz – 28350 MHz | TDD |

One important element that is missing is a channel numbering scheme and a frequency raster that would cover all the claimed frequency ranges. It is therefore difficult for the CEG to unequivocally conclude that the spectrum requirements are met, though from Table 11.4.3.2-1, the condition to support “1” band in the sub-6GHz appears to be satisfied.

### 11.4.4 Services

11.4.4.1 Conclusion: The CEG is unable to state with any degree of certainty whether the services requirements are met as per the submission received in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018), though this is probably the case.

11.4.4.2 Verification: Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) contains many parts, including a) Self Evaluation Report – EUHT RIT b) compliance template for EUHT RIT c) characteristics template for EUHT RIT d) EUHT\_Specification, and so on.

The CEG was unable to find any specific chapter, section or sub-section that was devoted to “Service” in the Self Evaluation Report.

From the compliance template, the following table (11.4.4.2-1) was extracted:

Table 11.4.4.2-1

|  |  |  |
| --- | --- | --- |
|  | 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*  Specify which usage scenarios (eMBB, URLLC, and mMTC) the candidate RIT or candidate SRIT can support.(1)  *The EUHT RIT can support eMBB, URLLC and mMTC usage scenarios.* | *The assessment of service requirement follows the evaluation method as defined in § 7.3.3 in Report ITU-R M.2412.* |
| (1) Refer to the process requirements in IMT-2020/2. | | |

This basically states a view, without providing much detail.

Finally, from the characteristics template, the following table (11.4.4.2-2) was extracted:

Table 11.4.4.2-2

|  |  |
| --- | --- |
| **5.2.3.2.23** | **Support for wide range of services** |
| 5.2.3.2.23.1 | Describe what kind of services/applications can be supported in each usage scenarios in Recommendation ITU-R M.2083 (eMBB, URLLC, and mMTC).  *According to Recommendation ITU-R M.2083, the EUHT RIT has a variety of use forms in many scenarios such as eMBB, URLLC, and mMTC.*  *According to Recommendation ITU-R M.1822, the application scope of the EUHT RIT is shown as follows:*  *- The application of the eMBB includes high-speed mobility, high data rates (including the passing back of the videos to the ground from the high-speed train and the internet access of the passengers in high-speed trains), interactive services (including multi-party video conferences),broadcast services (including television broadcasting signals), telephone communication services (including basic/rich telephone communication services), and other high data rate services. It can meet the application requirements of stationary users, pedestrian users and high-speed train/vehicle users.*  *- The application of the URLLC includes highly reliable and short-delay services such as remote medical services, smart traffic and smart power grids.*  *- The application of the mMTC includes smart cities, smart home and the communications between other machines.* |

This appears to indicate support for the usage scenarios: eMBB, mMTC, urLLC. If this data is combined with results from simulations in the five different test environments, it may be possible to conclude that the services requirement is met.

### 11.4.5 Peak data rate

11.4.5.1 Conclusion: The CEG concluded that the EUHT RIT submission in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) can fulfil the requirements of the peak data rate criterion.

11.4.5.2 Verification: As specified in Report ITU-R [M.2410](https://www.itu.int/pub/R-REP-M.2410), the minimum requirements for the peak data rates for the purpose of evaluation in the eMBB usage scenario are defined as below:

Table 11.4.5.2-1

Peak data rate requirements

|  |  |  |
| --- | --- | --- |
|  | Antenna Configuration (No. of Spatial Layers) | Peak Data Rate (Gbit/s) |
| Downlink | 8 | 20 |
| Uplink | 4 | 10 |

The peak data rate is calculated following the methodology specified in § 4.1 of Report ITU-R [M.2410](https://www.itu.int/pub/R-REP-M.2410), using peak spectral efficiency values derived for a 20 MHz channel in the peak spectral efficiency section ( § 4.2) and maximum assignable channel bandwidths. While a more accurate calculation would involve calculating the exact peak spectral efficiency for a given bandwidth, the CEG adopted an approach similar to what it did to evaluate the submission in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014) (3GPP’s candidate NR RIT and reference to TS 38.306), where overheads are considered constant for any channel bandwidth. Consequently, regardless of the channel bandwidth, the CEG only used one set of peak spectral efficiency values.

Two widest channel bandwidths, 80 MHz and 100 MHz, are considered along with the subcarrier spacing of 78.125 kHz, as shown in table 11.4.5.2-2 below. Normal cyclic prefix is considered in the calculation, and TDD mode of operation is assumed, with and representing the downlink and uplink fractions of the time, respectively.

Table 11.4.5.2-2

Peak DL data rate in Gbit/s per single carrier for 256QAM and 1024QAM, 8 spatial layers

|  |  |  |  |
| --- | --- | --- | --- |
| SCS (kHz) | Qm  bit/s/Hz | 80 MHz channel  bit/s/Hz | 100 MHz channel  bit/s/Hz |
| 78.125 | 8 | 1.28 | 2.56 |
| 78.125 | 10 | 1.60 | 3.20 |

To achieve a target data rate of 20 Gbit/s, 16 component carriers of 80 MHz channels are required if 256QAM modulation order is used, which is within the capability of the EUHT proposal which supports up to 16 component carriers. For higher modulation order (1024QAM, or Qm=10), 10 or 13 component carriers are needed, depending on the individual channel bandwidths (i.e., 100 MHz or 80 MHz, respectively).

Similarly, for the uplink peak data rate calculation, the CEG relied on the spectral efficiency values evaluated in peak spectral efficiency section (§ 11.4.6) using 80 and 100 MHz RF channel bandwidth and subcarrier spacing of 78.125 kHz, as shown in table 11.4.5.2-3 below. One difference is that for the peak data rate calculation the CEG scaled the peak spectral efficiency by a factor of 2 as ITU-R [M.2410](https://www.itu.int/pub/R-REP-M.2410) states that the target peak spectral efficiency for the UL peak was based on four spatial layers, whereas peak spectral efficiencies have been calculated based on 8 spatial layers both in the downlink and uplink.

Table 11.4.5.2-3

Peak UL data rate in Gbit/s per single carrier for 256QAM and 1024QAM, 4 spatial layers

|  |  |  |  |
| --- | --- | --- | --- |
| SCS (kHz) | Qm  bit/s/Hz | 80 MHz channel  bit/s/Hz | 100 MHz channel  bit/s/Hz |
| 78.125 | 8 | 0.64 | 0.80 |
| 78.125 | 10 | 0.80 | 1.00 |

Again, to achieve the peak data rate of 10 Gbit/s in the uplink, 16 component carriers are needed if 80 MHz channels are aggregated using 256QAM, and 13 component carriers are needed if 1024QAM is used for the same 80 MHz bandwidth. When the bandwidth is increased to 100 MHz per channel, 13 component carriers are needed for 80 MHz channels, and 10 component carriers for 100 MHz channels.

In conclusion, both downlink and uplink target peak data rates are achievable with EUHT proposal based on the evaluation methodology specified in Report [ITU-R M.2410-0](https://www.itu.int/pub/R-REP-M.2410) report. Even higher uplink data rates are possible with 8 spatial layers, or alternatively, different values for TDD downlink/uplink splits would be possible (e.g., with and ) if higher number of spatial layers was used for the uplink.

### 11.4.6 Peak spectral efficiency

11.4.6.1 Conclusion: The CEG concluded that the EUHT RIT submission in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) can fulfil the requirements of the peak spectral efficiency criterion.

11.4.6.2 Verification: For the purposes of evaluating Nufront’s peak spectral efficiency, the CEG focused on the 20 MHz channel with 78.125 kHz subcarrier spacing, for which the overhead values are provided in the self-evaluation in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018), appendix B2. While the overhead provided in the self-evaluation seems reasonable and comparable to that of other candidate RITs, the characteristics template in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) provides a very different value in § 5.2.3.2.4.2, where the overhead on the downlink for the eMBB usage scenario amounts to 6.7% only (compared to 18.5% in the equivalent self-evaluation configuration).

Using the parameters provided by Nufront, the CEG evaluated the following scenario (shown in Table 11.4.6.2-1):

Table 11.4.6.2-1

Parameters used in the calculation of EUHT RIT peak spectral efficiency criterion

| Parameter | Value |
| --- | --- |
| BW (MHz) | 20 |
| Number of FFT points (NFFT) | 256 |
| Number of data subcarriers (NSD) | 224 |
| Cyclic prefix duration in µs | 1.6 (short CP)  3.2 (normal CP) |
| OFDM symbol period (Tlink) | 14.4 (short CP)  16 (normal CP) |
| Subcarrier spacing (kHz) | 78.125 |
| DL overhead (OHDL) | 18.49% |
| UL overhead (OHUL) | 18.26% |
| Modulation order (Qm) | 8,10 |
| Number of MIMO layers (NL) | 8 |
| Maximal code rate (Rmax) | 0.875 |

Spectral efficiency was calculated using the formula:

Substituting the values provided in table 11.4.6.2-1 above, the calculations are shown in table 11.4.6.2-2:

Table 11.4.6.2-2

Peak spectral efficiency of EUHT RIT candidate submission in [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018)

|  |  |  |
| --- | --- | --- |
| Peak spectral efficiency | Qm=8 | Qm=10 |
| DL, short CP (bit/s/Hz) | 35.50 | 44.38 |
| DL, normal CP (bit/s/Hz) | 31.95 | 39.94 |
| UL, short CP (bit/s/Hz) | 35.60 | 44.50 |
| UL, normal CP (bit/s/Hz) | 32.04 | 40.05 |

Based on these calculations, the CEG concluded that the EUHT RIT submission in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) can meet the peak spectral efficiency criterion for this particular set of parameters.

## 11.5 ETSI/DECT Forum SRIT

Parameters evaluated via Inspection

### 11.5.1 Bandwidth of ETSI/DECT Forum component RIT

11.5.1.1 Conclusion: The CEG concluded that bandwidth and scalability requirements are met by the DECT-2020 NR component RIT in the submission in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017).

11.5.1.2 Verification of DECT-2020 NR bandwidth **requirement capabilities**

Based on the submission in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017), the CEG considered the DECT-2020 NR component RIT for inspection as follows.

Bandwidth scalability of DECT-2020 NR is provided using sub-carrier spacings, FFT size and link aggregation. Table 11.5.1.2-1 lists some example bandwidth configurations for different FFT sizes and sub-carrier spacing options (standard 27 kHz and up to 16 times to 432 kHz) for a single link. Higher sub-carrier options are considered for operations in higher frequencies.

Table 11.5.1.2-1

DECT-2020 NR capability on bandwidth

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sub-carrier spacing (kHz) | Maximum bandwidth for a single link (MHz) | | | | | |
| FFT  64 | FFT  128 | FFT  256 | FFT  512 | FFT  768 | FFT  1024 |
| 27 | 1.728 | 3.456 | 6.912 | 13.824 | 20.736 | 27.648 |
| 54 | 3.456 | 6.912 | 13.824 | 27.648 | 41.472 | 55.296 |
| 108 | 6.912 | 13.824 | 27.648 | 55.296 | 82.944 | 110.592 |
| 216 | 13.824 | 27.648 | 55.296 | 110.592 | 165.888 | 221.184 |
| 432 | 27.648 | 55.296 | 110.592 | 221.184 | 331.776 | 442.368 |

It is observed that a single layer 1 link with a sub-carrier spacing of 432 kHz and an FFT size of 1024 provides a link bandwidth of 442.368 MHz. If three such layer 1 links are aggregated, a channel bandwidth in excess of 1 GHz can be achieved.

### 11.5.2 Energy Efficiency of ETSI/DECT Forum component RIT

11.5.2.1 Conclusion: The CEG concluded that there was no possibility of evaluating this technical performance requirement since, according to Report [ITU-R M.2410](https://www.itu.int/pub/R-REP-M.2410), the evaluation needs to be performed in an eMBB usage scenario, whereas the submission in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017) shows that this component RIT only applies to the mMTC and URLLC usage scenarios.

### 11.5.3 Spectrum

11.5.3.1 Conclusion: The CEG concluded that the determined spectrum bands and ranges for DECT-2020 NR component RIT, as provided in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017), fulfill the ITU-R targets.

11.5.3.2 Verification: The CEG verified the following for DECT-2020 NR component RIT:

– The frequency range of 1880 MHz to 1900 MHz which is determined by DECT‑2020‑NR to be used by candidate RIT has been identified for IMT-2020 in the ITU Radio Regulations as per Report ITU-R M.2411.

– The frequency range of 1900 MHz to 1980 MHz which is determined by DECT‑2020‑NR to be used by candidate RIT has been identified for IMT-2020 in the ITU Radio Regulations as per Report ITU-R M.2411.

– The frequency range of 2010 MHz to 2025 MHz which is determined by DECT‑2020‑NR to be used by candidate RIT has been identified for IMT-2020 in the ITU Radio Regulations as per Report ITU-R M.2411.

– Other frequency bands that may be allocated in the future (including those above 24.25 GHz) which are determined by DECT-2020-NR to be used by candidate RIT have been identified for IMT-2020 in the ITU Radio Regulations as per Report ITU‑R M.2411.

### 11.5.4 Services

**11.5.4.1 Conclusion**: The CEG concluded that the services requirements are met by DECT-2020 NR component RIT in submission [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017). It should be noted that this statement only applies to usage scenarios mMTC and urLLC, as the submission indicated that the requirements of eMBB usage scenario would be supported by 3GPP NR IMT-2020 candidate technology.

**11.5.4.2** **Verification**: The CEG’s conclusion is based on the information found in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017), which, in turn, points to the details in Documents [5D/1299](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-WP5D-C-1299) and [5D/1230](https://www.itu.int/md/R15-WP5D-C-1230/en) that explain how DECT-2020 NR component is planning to support mMTC and urLLC services by providing the following functionalities:

– Specific QoS for specific services (response to § 5.2.3.2.12.1)

– Specific modulation/code rate per service (response to § 5.2.3.2.2.2.1)

– Use of 1/2 slots for specific services (response to § 5.2.3.2.2.7.1)

– Resource allocation scheduler for emergency services (response to § 5.2.3.2.16.1)

– Support of broadcast, multicast and unicast (response to § 5.2.3.2.17.1)

– Support of multiple services per user (response to § 5.2.3.2.17.2)

– Support of scheduled and non-scheduled systems in the same service (response to § 5.2.3.2.23.1)

– A function controlling how different services with different QoS requirements are multiplexed and prioritized for transmission (response to § 5.2.3.2.13.1).

Parameters evaluated via simulation

### 11.5.13 Connection density

**11.5.13.1 Conclusion**: The CEG did its best to evaluate this technical performance requirement, but was unable to come to any definite conclusions.

**11.5.13.2 Verification**: In order to simulate the connection density requirements of the DECT component submission in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017), the CEG had to put together a number of assumptions, especially those dealing with device-to-device (D2D) communications. The CEG had to write to the proponent to ensure the validity of these assumptions and after a few exchanges of correspondence, the proponent informed the CEG that it was at liberty to make any assumptions that were missing, but necessary.

### 11.5.14 Reliability

11.5.14.1 Conclusion: The CEG concluded that the reliability requirements are met by the DECT component RIT submission in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017).

11.5.14.2 Verification: The results of the verification are presented in table 11.5.14.2-1 below.

Table 11.5.14.2-1

Urban Macro-URLLC (Configuration A – Channel Model A) - FDD

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model A - Configuration A (4 GHz) – NR RIT | | |
| Metric | Link | M.2410 | INRS | UofT |
| Reliability [%] | DL | 99.999% | >99.999% | … |
| Reliability [%] | UL | 99.999% | >99.999% | … |

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

# 12 Questions and feedback

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

# 13 Next steps towards the final report

The CEG is on track to present its final report at the 34th meeting of WP 5D (19-26 February 2020).

Part III

Conclusion

# 14 Overall conclusions

## 14.1 3GPP SRIT

The CEG believes that the submission in Document [IMT-2020/13](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0013), which is an SRIT constituted by two components, NR and LTE, satisfies all of the minimum requirements as specified in Reports [ITU-R M.2410](https://www.itu.int/pub/R-REP-M.2410), [ITU-R M.2411](https://www.itu.int/pub/R-REP-M.2411) and [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412).

## 14.2 3GPP RIT

The CEG believes that the submission in Document [IMT-2020/14](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0014), which is an RIT constituted by one component, NR, satisfies all of the minimum requirements as specified in Reports [ITU-R M.2410](https://www.itu.int/pub/R-REP-M.2410), [ITU-R M.2411](https://www.itu.int/pub/R-REP-M.2411) and [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412).

## 14.3 TSDSI RIT

In the CEG’s opinion, with:

1) The de-activation of additional features such as pulse shaping and power boosting

2) The decision by WP 5D at its 33rd meeting (December 2019) that the evaluation configuration containing bandwidths such as 60 MHz at a frequency of 3.5 GHz as well as an inter-site distance of 12 km were not directly relevant to the evaluation process.

the evaluation of this candidate submission (Document [IMT-2020/19Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0019)) became tantamount to evaluating the candidate in Document [IMT-2020/14](https://www.itu.int/md/R15-IMT.2020-C-0014/en); consequently no separate or independent activity was implemented.

In terms of the link-budget calculations, as explained in § 9 of this report, attempts were made by the CEG and the proponent (including in person at the 33rd meeting of WP 5D, December 2019) to arrive at a mutually satisfactory explanation. Unfortunately, due to the manner in which the pathloss model in M.2412 differentiates between LOS and NLOS propagation, the mathematical interpretations proved inconclusive, particularly with respect to the 12 dB gain factor. Perhaps this is an area that needs further work within WP 5D.

## 14.4 Nufront RIT

The CEG identified certain key issues related to the submission in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) – EUHT RIT candidate:

1) Scheduler: While the self-evaluation shows simulation results using a proportional fair (PF) scheduler, the detailed specifications supplied by the proponent show support for only round robin (RR) scheduler. In the specifications, a single bit setting is given to the RR scheduling mechanism, while the other bit value is “Reserved.” Since a RR scheduler would provide clearly lower spectrum efficiency values, the CEG is unable to determine if the simulation results provided by the proponent are achievable.

2) Spectrum: While the EUHT self-evaluation and compliance templates in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) mark all the IMT-designated bands in § 3.2 of Report [ITU-R M.2411](https://www.itu.int/pub/R-REP-M.2411) as supported under a TDD duplexing scheme, the CEG noticed that the detailed specifications provided by EUHT have a very rudimentary channelization scheme, using only 8 bits, meaning a maximum of 256 channels and no specified channel raster at all. The lack of flexibility in the channelization scheme and missing channel raster would render coexistence requirements for other bands very difficult. Further, there seems to be a guard-band built into each carrier frequency for which the CEG was not able to find any justification.

3) Bandwidth scalability: While EUHT provides support for multiple bandwidths and multiple sub-carrier spacings, the CEG observed a guard-band seemingly “in-built” into the carrier frequency. As explained in § 11.4.1.2 of this report, a 400 MHz carrier would effectively occupy 350 MHz of the spectrum allotted to it, leaving 25 MHz on either side (simply multiplying the sub-carrier bandwidth by the number of sub-carriers available yields this result). For a 100 MHz carrier, the bandwidth actually occupied by the sub-carriers is 87.5 MHz, which means that 12.5% (and not 10% as mentioned in the compliance templates) of the spectrum is vacant. When carriers are aggregated, this issue will lead to less efficient spectrum utilization (if two 400 MHz carriers are aggregated, a 50 MHz guard-band will inevitably exist between them).

4) Supporting handover to a legacy IMT system: While this is not a requirement (technical, service or spectrum) per se, it is unclear how a handover can be achieved from EUHT to a legacy IMT system (i.e. a user equipment context transfer between two completely different RITs). In the CEG’s view, a cell reselection from one RIT to another under an out-of-service condition might be possible.

5) Simulations: The CEG spent a considerable amount of time and effort in extracting all the specifications of EUHT RIT, in an attempt to reconfigure its simulator to evaluate this candidate (in spite of the complexity involved). However, unlike other IMT candidates, this reconfiguration step could not ultimately be completed by simple parametric modifications of common blocks. Instead, it needed the development of completely new building blocks for the simulator that would have required efforts equivalent to, if not surpassing, those spent to assess the rest of the candidates examined by the CEG. Ultimately, the CEG decided to abandon its attempts to evaluate the minimum requirements of EUHT RIT via simulation.

Based on the above observations and the fact that the submission in Document [IMT-2020/18(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0018) is self-contradictory at times (that is, the information contained in the technology description template, the compliance templates, the self-evaluation and the detailed specifications is not always consistent), the CEG cannot state, unequivocally, that the EUHT RIT satisfies all of the requirements (spectrum, services and technical) for IMT-2020, as specified in Reports [ITU-R M.2410](https://www.itu.int/pub/R-REP-M.2410), [ITU-R M.2411](https://www.itu.int/pub/R-REP-M.2411) and [ITU-R M.2412](https://www.itu.int/pub/R-REP-M.2412).

## 14.5 ETSI/DECT Forum SRIT

The CEG evaluated only the DECT component RIT of the submission in Document [IMT-2020/17(Rev.1)](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0017) and offers the following observations:

1) This component RIT applies only to UMa-URLLC and UMa-mMTC. Therefore, no evaluations applying to the eMBB usage scenario could be implemented (even to parameters to be evaluated by inspection only i.e. energy efficiency).

2) The CEG was able to show that the DECT component RIT fulfils the reliability criterion for the UMa-URLLC test environment.

3) However, with respect to the connection density criterion in the UMa-mMTC test environment, the CEG is unable to offer any conclusions. The assumptions required to simulate this test environment are very specific to the DECT component RIT and in-spite of several e-mail exchanges with the proponent, proved to be too numerous and too complicated to execute. These assumptions certainly go far beyond what is provided as a methodology in Report ITU-R M.2412 to evaluate candidate RITs. Ultimately, with the network going from cellular lay-out to mesh lay-out, and interactions required between the two, the CEG abandoned attempts to perform simulations. Some examples of the assumptions required to be made follow:

a. Device-to-device channel and interference models for shortest path selection and data relaying.

b. Criteria required to establish the number of hops and path from the user equipment via other user devices to reach the base stations.

c. RSSI sensitivity threshold to determine device-to-device connectivity.

d. Device-to-device data relaying, modulation, coding, and resource allocation schemes.

Consequently, the CEG is not able to conclude whether the DECT component RIT passes the connection density requirements, which in turn implies that it is unclear if this component meets the overall criterion of fulfilling the requirements of at least two test environments.

Annex 1

IMT-2020 Evaluation:  
Peak Data Rate and Peak Spectral Efficiency Evaluations for NR



ANNEX 2

IMT-2020: Evaluation of user-plane latency



ANNEX 3

IMT-2020: Evaluation of control-plane latency



Annex 4

IMT-2020: Initial evaluation report

This Annex to the CEG report presents the detailed assumptions used to generate the results of parameters that were meant to be evaluated via simulation. They were prepared by INRS – one of the academia partners – and are reproduced here to provide additional context to the results generated by the INRS simulator.



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1. \* Submitted on behalf of the Canadian Evaluation Group (CEG) [↑](#footnote-ref-1)
2. 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-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)
4. Simulation results for the configuration A (4 GHz) for dense urban eMBB use case have been considered for this evaluation; the summary results are presented in Section 11.2.7 of the CEG report. [↑](#footnote-ref-4)
5. The worst-case CP latency in NR Rel-15 FDD is estimated to 9TTI+6ms at 15/30kHz SCS and 14TTI+6ms at 120kHz SCS. [↑](#footnote-ref-5)
6. The worst-case CP latency in NR Rel-15 TDD with alternating UL-DL pattern is estimated to 14TTI+6ms for 15/30kHz SCS and 20TTI+6ms for 120kHz SCS. [↑](#footnote-ref-6)
7. Note: This document has a main body and several “parts;” the reference here is to the main body. [↑](#footnote-ref-7)