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| **Radiocommunication Study Groups** |  |
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|  |  |
| Subject: [Question ITU-R 229-5/5](https://www.itu.int/pub/R-QUE-SG05.229) | **Document 5D/738-E** |
| **16 August 2021** |
| **English only**  **TECHNOLOGY ASPECTS** |
| Director, Radiocommunication Bureau[[1]](#footnote-1)\* | |
| CEG Report on the re-evaluation of the “ETSI (TC DECT) and DECT Forum Proponent” and of the “Nufront Proponent” candidate technology submissions | |
|  | |

Part I

Administrative aspects of the Independent Evaluation Group

These details were provided in the previous report filed by the CEG ([IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030)) and are not repeated here since there are no changes.

This Report provides updates to the re-evaluation Report submitted by the CEG in Document [5D/624](https://www.itu.int/md/R19-WP5D-C-0624).

Part II

Technical aspects of the work of the Independent Evaluation Group

The CEG notes that in document [IMT.2020/54](https://www.itu.int/md/R15-IMT.2020-C-0054/en), the ITU has provided somewhat elaborate guidance to independent evaluation groups (IEG) in how to structure their reports. The CEG would like to respectfully point out that the guidance appears to be provided from the point-of-view of documents that are internal to the ITU and so has followed the same format for this report as the one recommended previously by the ITU.

But rather than revise its previous report ([IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030)), which would require enabling the “track changes” feature, then using the asterisk mark (‘\*’) to differentiate the old results from the new, the CEG is providing a new report in which it believes that the results are presented with sufficient clarity that the ITU will not experience any major difficulty in taking them into account. In this new report, the CEG maintains the numbering scheme followed in the original one – for sections, sub-sections, etc. – in order to ensure some degree of consistency.

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

# 7 Technologies re-evaluated by the CEG

The candidate technologies, or portions thereof, that the CEG will re-evaluate are as follows (extracted from Document [5D/545](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R19-WP5D-C-0545), Chapter 7, Attachment 7.4: “Liaison Statement to Independent Evaluation Groups and "ETSI (TC DECT) and DECT Forum Proponent" and "Nufront Proponent" engaged In Option 2”):

1 ETSI (TC DECT) and DECT Forum Candidate Technology Submission (called “DECT-2020” hereafter, noting that it refers to one RIT component of the SRIT submitted)

a Connection density: for UMa-mMTC test environment

2 Nufront Candidate Technology Submission (called “EUHT” hereafter)

a 5th percentile and average Spectral Efficiencies: for DU-eMBB test environment

b Mobility: for DU-eMBB test environment

c Reliability: for UMa-urLLC test environment

d Connection density: for UMa-mMTC test environment.

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

# 8 Evaluation Guidelines

While the CEG confirms it has utilized not just the ITU-R evaluation guidelines in Report ITU-R [M.2412](https://www.itu.int/pub/R-REP-M.2412), but the re-evaluation guidelines in document [IMT.2020/54](https://www.itu.int/md/R15-IMT.2020-C-0054/en) as well, it draws the attention of the ITU to the fact that these guidelines were established from the view-point of RITs (Radio Interface Technologies) or SRITs (Sets of RITs) that are fundamentally *cellular* in nature i.e. possess a network structure with a base-station site (usually with three sectors/cells) that communicates with user-equipment in those sectors.

The CEG notes that the DECT-2020 RIT component appears to have a hybrid nature in that it combines a cellular lay-out with mesh network capabilities, while the EUHT RIT also appears to have a hybrid RLAN/cellular structure.

Consequently, these candidate submissions require more guidelines than are presented 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

The CEG, along with other IEGs, has a separate contribution to the 38th meeting of WP 5D entitled “Observations of 5GIF, CEG, and WWRF regarding the administrative and timing circumstances of the technology evaluations for Option 2” in Document [5D/607](https://www.itu.int/md/R19-WP5D-C-0607/en)**,** which identifies areas requiring clarifications. It has chosen not to reproduce that text here in order not to create two documents with identical content (with accompanying loss in clarity if one document is updated, but not the other).

## 9.1 DECT-2020

The CEG had to tackle multiple issues to produce the desired DECT evaluation metric. Full specifications required to set up the simulator were not entirely confirmed until after the 37th WP 5D meeting (cf. section 12 for details). Besides, given the final setup adopted by the CEG based on the proponent’s feedback received by 8th April 2021 and translating into exhaustive consideration a priori of all potential D2D channels between the user equipment (UE)/devices and all potential multi-hop relaying paths (up to 255 in number), the amount of data required to be generated – for around 77,000 UE/devices per sector/cell to reflect the criterion of 1 million users per km2 – was enormous. Just a single drop to carry out a simulation could take days for one base-station (BS) site (one site comprising three cells/sectors) and, as a consequent extension, *many weeks* for the full layout of nineteen BS sites. The CEG’s academic member, despite having powerful computing servers of its own, had to rely on [Compute Canada resources](https://ccdb.computecanada.ca/security/login) to cope with the daunting demands in number crunching required by the evaluation of the connection density criterion of this submission. Simply obtaining the required memory allocations from Compute Canada could take a few days before simulations are allowed to run, since access is granted via a queue.

After the 38th meeting of WP 5D in June 2021, during which the DECT-2020 proponent provided the necessary clarifications, significant progress was made to successfully develop and integrate in the CEG’s system-level simulator several processing-acceleration schemes that ultimately overcame the overwhelming a) computational complexity and b) memory consumption required by the DECT submission.

## 9.2 EUHT

As far as EUHT is concerned, similar issues had to be faced. Full specifications were confirmed after the 37th WP 5D meeting (cf. section 12 for details). Once the CEG adopted the final setup based on Nufront’s feedback received by 21st April 2021, the time left to configure the simulator has proved to be insufficient. Indeed, previously developed programming blocks to simulate other candidates have been rendered inadequate, if not obsolete, as this submission is more akin to an RLAN-based technology than a cellular one. Further, the persistent recommendation of a complex receiver structure such as MMSE-IRC has resulted in rendering the reconfiguration of our simulator an extremely time-consuming task and, hence, an impossible one to be completed in the remaining time.

## 9.3 Recommendation to Working Party 5D

The CEG recommends to WP 5D that more time be spent on ensuring that proponents provide all the tools required before-hand, i.e., before the evaluation groups begin their activity. For example, the proponent or WP 5D should have provided adequate details of how to simulate a joint mesh-cellular network, or how to implement a complex receiver structure such as the MMSE-IRC, noting that Report ITU-R M.2412 was only conceived for cellular networks employing fairly simple receiver structures.

# 10 Compliance templates

## 10.4 Compliance templates for Nufront RIT

### 10.4.1 Services

Compliance template for services

This is available in document [IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030).

### 10.4.2 Spectrum

Compliance template for spectrum

This is available in document [IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030).

### 10.4.3 Technical Performance

Only the minimum technical performance requirements that were the subject of re-evaluation are presented in the table that follows:

TABLE 10.4.3-1

| 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 |  |  |  |  |
| **5.2.4.3.4** 5th percentile user spectral efficiency (bit/s/Hz) *(4.4)* | eMBB | Indoor Hotspot – eMBB | Downlink | 0.3 |  | Yes  No | Cf. Section 9.2 |
| Uplink | 0.21 |  | Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 0.225 |  | Yes  No | Cf. Section 9.2 |
| Uplink | 0.15 |  | Yes  No |
| eMBB | Rural – eMBB | Downlink | 0.12 |  | Yes  No | Cf. Section 9.2 |
| 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 | Cf. Section 9. |
| Uplink | 6.75 |  | Yes  No |
| eMBB | Dense Urban – eMBB | Downlink | 7.8 |  | Yes  No | Cf. Section 9.2 |
| Uplink | 5.4 |  | Yes  No |
| eMBB | Rural – eMBB | Downlink | 3.3 |  | Yes  No | Cf. Section 9.2 |
|  | Yes  No | Cf. Section 9.2 |
| Uplink | 1.6 |  | Yes  No | Cf. Section 9.2 |
|  | Yes  No | Cf. Section 9.2 |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 |  | Yes  No | Cf. Section 9.2 |
| **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 |  | Yes  No | Cf. Section 9.2 |
| **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 | Cf. Section 9.2 |
| eMBB | Dense Urban – eMBB | Uplink | 1.12 (30 km/h) |  | Yes  No | Cf. Section 9.2 |
| eMBB | Rural – eMBB | Uplink | 0.8 (120 km/h) |  | Yes  No | Cf. Section 9.2 |
| 0.45 (500 km/h) |  | Yes  No | Cf. Section 9.2 |
| (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

This is available in document [IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030).

### 10.5.2 Spectrum

Compliance template for spectrum

This is available in document [IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030).

### 10.5.3 Technical Performance

Compliance template for technical performance

Evaluation results for the minimum technical performance requirements of *5th percentile user spectral efficiency*, *average spectral efficiency*, *reliability*, and *mobility* are available in document [IMT.2020/30Rev1](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R15-IMT.2020-C-0030). Only the minimum technical performance requirement of *connection density*, that was the subject of re-evaluation, is presented in the table that follows:

TABLE 11.5.13-1

Urban Macro-mMTC (700 MHz, ISD=500 m, 19 BS (19 sites))

| 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 |
| **5.2.4.3.9** Connection density (devices/km2) *(4.8)* | mMTC | Urban Macro – mMTC | Uplink | 1 000 000 | 1 000 000 | 🗹 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 re-evaluated

As explained in sub-section 7 of section A, Part II, the CEG re-evaluated the following:

1 ETSI (TC DECT) and DECT Forum Candidate Technology Submission

a Connection density: for UMa-mMTC test environment

2 Nufront Candidate Technology Submission

a 5th percentile and average Spectral Efficiencies: for DU-eMBB test environment

b Mobility: for DU-eMBB test environment

c Reliability: for UMa-urLLC test environment

d Connection density: for UMa-mMTC test environment

## 11.4 Nufront EUHT RIT

Parameters re-evaluated via Simulation

### 11.4.12 5% user spectral efficiency and Average spectral efficiency (per test environment)

#### 11.4.12.1 Conclusion: Cf. Section 9.2.

#### 11.4.12.2 Verification: Cf. Section 9.2.

### 11.4.14 Reliability

#### 11.4.14.1 Conclusion: Cf. Section 9.2.

#### 11.4.14.2 Verification: Cf. Section 9.2.

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

#### 11.4.15.1 Conclusion: Cf. Section 9.2.

#### 11.4.15.2 Verification: Cf. Section 9.2.

## 11.5 ETSI/DECT Forum SRIT

Parameters re-evaluated via simulation

### 11.5.13 Connection density

#### 11.5.13.1 Conclusion: The CEG concluded that connection density requirements are met by the DECT-2020 component RIT submission.

#### 11.5.13.2 Verification:

The CEG conducted simulations for the non-full-buffer traffic model of the DECT component – the results of which are shown in Tables 10.5.3-1 and 11.5.13-1.

Table 11.5.13-1

Urban Macro-mMTC (700 MHz, ISD=500 m, 19 BS (19 sites))

|  |  |  |  |
| --- | --- | --- | --- |
| mMTC – Urban Macro | | Channel Model B - Configuration A (ISD=500m) – DECT component | |
| Metric | Link | Packet outage rate threshold | INRS |
| Packet outage rate (%) | UL | 1 | 0.214 |

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

# 12 Questions and feedback

|  |  |  |  |
| --- | --- | --- | --- |
| Submission | Document Title | Author | Link |
| 2020-12-23 | TC-DECT response to CEG questions | ETSI | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/_layouts/15/WopiFrame.aspx?sourcedoc=%7B5B3052D4-85DE-4AA0-9D64-47FAC68D5F04%7D&file=DECT(20)000369_TC-DECT_response_to_CEG__questions_.pptx) |
| 2021-01-25 | Evaluation of 5G NR Standard Candidates by System-Level Simulations: Questions regarding ETSI-DECT technology raised by the CEG | CEG/INRS | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/Question-for-DECT-01-22-2021%20revSA_VS_2020-01-25.docx) |
| 2021-02-01 | ETSI TC DECT Response to the additional questions from CEG | ETSI | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/Answers_to_Question-for-DECT-01-22-2021%20revSA_VS_2020-01-25.docx) |
| 2021-02-04 | ETSI Evaluation Group Status | ETSI | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/MSG(21)000002_Liaison_Statement_EVAL_WG_to_other_IEG.pdf) |
| 2021-03-25 | EVALUATION OF ETSI (TC DECT) & DECT FORUM CANDIDATE BY CEG – “WAY FORWARD OPTION 2”: Compilation of questions raised by CEG | CEG/INRS | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/CEG_Q&A_DECT-2020_proponent_25Mar21.pdf) |
| 2021-03-31 | ETSI TC DECT response to ‘Pending’ or ‘Open’ threads | ETSI | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/_layouts/15/WopiFrame2.aspx?sourcedoc=%7B04C19DA5-3E61-4782-B5C8-9035BBCCB568%7D&file=Response_to_CEG_QA_DECT-2020_proponent_25Mar21.docx) |
| 2021-04-08 | EVALUATION OF 5G NR STANDARD CANDIDATES BY SYSTEM-LEVEL SIMULATIONS – OPTION 2: Compilation of Questions Raised by INRS on Behalf of the CEG on EUHT Technology | CEG/INRS | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/QA-Threads-with-NuFront-Compiled-as-of-2021-04-08.pdf) |
| 2021-04-21 | EVALUATION OF IMT-2020 STANDARD CANDIDATES BY SYSTEM-LEVEL SIMULATIONS – OPTION 2: Compilation of Questions Raised by CEG on EUHT Technology | CEG/INRS | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/QA-Threads-with-NuFront-Compiled-as-of-2021-04-21.pdf) |
| 2021-04-21 | Response to CEG | Nufront | [Link with solid fill](https://extranet.itu.int/itu-r/imt2020-evalgroup/Shared%20Documents/Nufront_response_to_CEG_2021_0421.pdf) |

Part III

Conclusion

# 14 Overall conclusions

## 14.4 Nufront RIT

The CEG was not able to evaluate this RIT for the reasons explained in Section 9.2.

## 14.5 ETSI/DECT Forum SRIT

The DECT-2020 RIT component of the SRIT passed the connection density requirement.

Annex 1

Evaluation Assumptions and Configuration for ETSI (TC DECT)



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1. \* Submitted on behalf of the Canadian Evaluation Group (CEG). [↑](#footnote-ref-1)