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| **Radiocommunication Study Groups** |  |
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|  | **Document 5D/708-E** |
| **3 June 2021** |
| **English only****TECHNOLOGY ASPECTS** |
| Director, Radiocommunication Bureau[[1]](#footnote-1) |
| Evaluation of EUHT rit by TTA spg33 |
|  |

# 1 Introduction

At the 36th meeting of ITU-R Working Party 5D (WP 5D), re-evaluation of two candidate
IMT-2020 radio interface technologies, DECT-2020 NR and EUHT was agreed – a.k.a. Option-2. Re-engagements of IEGs were also requested and TTA SPG33 as an IEG indicated its intention of the re-evaluation in November 2020.

# 2 Proposal

At the 38th meeting of Working Party 5D, TTA SPG33 would like to submit its evaluation report on IMT-2020 candidate technology (EUHT) in Document IMT-2020/18(Rev.1).

**Attachment**: 1

Attachment

evaluation report on EUHT RIT in document IMT-2020/18(Rev.1)

Part I

Administrative aspects of the Independent Evaluation Group

# I.1 Name of the independent evaluation group

Telecommunications Technology Association Special Project Group 33 (TTA SPG33).

# I.2 Background of the TTA SPG33

To promote the development and early deployment of 5G technology, a special technical committee (STC3) was formed under the Telecommunications Technology Association (TTA) in July 2017. STC3 consists of five special project groups and one of them (TTA SPG33) is responsible for the evaluation of IMT-2020 candidate technology submitted in ITU-R WP 5D. TTA SPG33 was registered as an independent evaluation group right after its establishment.

Like other technical committee and project groups in TTA, TTA SPG33 consists of individual members representing mobile industry, academia, and research institute.

# I.3 Method of Work

Since the establishment of TTA SPG33 in July 2017, our meetings have been held on a regular basis – four-to-five times a year. Agenda for the meeting include, information sharing on the ITU-R WP 5D activity focused on the candidate technology submission and evaluation, review of liaison statements from ITU-R WP 5D, discussion of evaluation report development and so on. We also held open workshops in October 2017 and 2018 to share our progress and get some feedback from the audience.

We have actively participated in the evaluation discussion in ITU-R WP 5D and CJK (China-Japan-Korea) IMT Evaluation Special Interest Group. Our activity updates have been presented as contributions in both meetings.

Regarding the re-evaluation of the two candidate technologies, TTA SPG33 has indicated its intention of the re-evaluation in November 2020.

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Part II

Technical aspects of the work of the Independent Evaluation Group

# II.1 Evaluated candidate IMT-2020 RIT/SRIT

This contribution is the evaluation report on the submissions in Doc. [IMT-2020/1](https://www.itu.int/md/R15-IMT.2020-C-0018/en)8(Rev.1), “EUHT RIT”.

# II.2 Utilization of ITU-R documents

TTA SPG33 confirms that the evaluation report in this contribution is conducted according to the evaluation guideline described in Report ITU‑R M.2412 [3] and the results are compared against the minimum technical requirements described in Report ITU‑R M.2410 [1].

# II.3 Documentation of any additional evaluation methodologies

None.

# II.4 Verification

TTA SPG33 checks that the technology submissions in Documents [IMT-2020/1](https://www.itu.int/md/R15-IMT.2020-C-0018/en)8(Rev.1), “EUHT RIT” include complete compliance templates for service, spectrum and technical performance as specified in Chapter 4.2.4 of Report ITU-R M.2411 [2].

# II.5 Assessment

This section summarizes the evaluation by TTA SPG33. Detailed evaluation results can be found in Annex 1.

## II.5.1 Compliance template for service

|  |  |  |
| --- | --- | --- |
|  | Service capability requirements | TTA SPG33’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 / NOSpecify which usage scenarios (eMBB, URLLC, and mMTC) the candidate RIT or candidate SRIT can support.(1) | EUHT RIT supports all three usage scenarios.  |
| (1) Refer to the process requirements in IMT-2020/2. |

## II.5.2 Compliance template for spectrum

|  |  |  |
| --- | --- | --- |
|  | Spectrum capability requirements | TTA SPG33’s comments |
| **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 / NOSpecify in which band(s) the candidate RIT or candidate SRIT can be deployed. | EUHT utilizes frequency band identified for IMT in the ITU Radio Regulations. |
| **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 / NOSpecify 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 utilizes frequency band above 24.25 GHz. |

## II.5.3 Compliance template for technical performance

| Minimum technical performance requirements item (5.2.4.3.x), units, and ReportITU-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 | 🗹 Yes No |  |
| Uplink | 10 | >10 | 🗹 Yes No |
| **5.2.4.3.2**Peak spectral efficiency (bit/s/Hz)*(4.2)* | eMBB | Not applicable | Downlink | 30 | >30 | 🗹 Yes No |  |
| Uplink | 15 | >15 | 🗹 Yes No |
| **5.2.4.3.3**User experienced data rate (Mbit/s)*(4.3)* |  | Not evaluated |
| **5.2.4.3.4**5th percentile user spectral efficiency (bit/s/Hz)*(4.4)* |  | Not evaluated |
| **5.2.4.3.5**Average spectral efficiency (bit/s/Hz/ TRxP)*(4.5)* |  | Not evaluated |
| **5.2.4.3.6**Area traffic capacity (Mbit/s/m2)*(4.6)* |  | Not evaluated |
| **5.2.4.3.7**User plane latency(ms)*(4.7.1)* | eMBB | Not applicable | Uplink and Downlink | 4 | < 4 | 🗹 Yes No |  |
| URLLC | Not applicable | Uplink and Downlink | 1 | < 1 | 🗹 Yes No |  |
| **5.2.4.3.8**Control plane latency (ms)*(4.7.2)* | eMBB | Not applicable | Not applicable  | 20 | < 20 | 🗹 Yes No |  |
| URLLC | Not applicable | Not applicable | 20 | < 20 | 🗹 Yes No |  |
| **5.2.4.3.9**Connection density (devices/km2)*(4.8)* |  | Not evaluated |
| **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 | Have the capability | 🗹 Yes No |  |
| **5.2.4.3.11**Reliability*(4.10)* |  | Not evaluated |
| **5.2.4.3.12**Mobility classes*(4.11)* |  | Not evaluated |
| **5.2.4.3.13**MobilityTraffic channel link data rates (bit/s/Hz)*(4.11)* |  | Not evaluated |
| **5.2.4.3.14**Mobility interruption time (ms) *(4.12)* | eMBB and URLLC | Not applicable | Not applicable | 0 | 0 ms can be achieved | 🗹 Yes No |  |
| **5.2.4.3.15**Bandwidth and Scalability*(4.13)* | Not applicable | Not applicable | Not applicable | At least 100 MHz | > 100 MHz is supported | 🗹 Yes No |  |
| Up to 1 GHz | > 1GHz supported using 16 CA | 🗹 Yes No |  |
| Support of multiple different bandwidth values(4) | Scalable | 🗹 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. |

# II.6 Questions and Feedback to WP 5D and/or the proponents or other Independent Evaluation Groups

TTA SPG33 will keep exchanging evaluation related information with proponents and other IEGs.

# II.7 Next Step

None

PartIII

Conclusion

Annex 1
Details of evaluation report

## A-1 Results of Peak Data Rate

EUHT DL peak data rate for IMT bands

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Per CC BW (MHz)1 | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 16 CCs (Gbit/s) | Required DL bandwidth to meet the requirement (MHz)2 | Req.(Gbit/s) |
| 0.5 | 80 | 2.05 | 32.77 | 781 | 20 |
| 100 | 2.56 | 40.96 | 781 |
| 0.8 | 80 | 3.35 | 52.66 | 477 |
| 100 | 4.19 | 67.07 | 477 |

EUHT DL peak data rate for higher frequency bands

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Per CC BW (MHz) | Peak data rate per CC (Gbit/s)1 | Aggregated peak data rate over 16 CCs (Gbit/s)1 | Required DL bandwidth to meet the requirement (GHz)2 | Req.(Gbit/s) |
| 0.5 | 400 | 6.82 | 109.24 | 1.173 | 20 |
| 0.8 | 400 | 11.07 | 177.15 | 0.722 |

EUHT UL peak data rate for IMT bands

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Per CC BW (MHz) | Peak data rate per CC (Gbit/s) | Aggregated peak data rate over 16 CCs (Gbit/s) | Required UL bandwidth to meet the requirement (MHz)1 | Req.(Gbit/s) |
| 0.2 | 80 | 0.80 | 12.72 | 1006 | 10 |
| 100 | 0.99 | 15.91 | 1006 |
| 0.5 | 80 | 2.10 | 33.66 | 380 |
| 100 | 2.63 | 42.08 | 380 |

EUHT UL peak data rate for higher frequency bands

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Per CC BW (MHz) | Peak data rate per CC (Gbit/s)1 | Aggregated peak data rate over 16 CCs (Gbit/s)1 | Required UL bandwidth to meet the requirement (GHz)2 | Req.(Gbit/s) |
| 0.2 | 400 | 1.72 | 27.53 | 2.325 | 10 |
| 0.5 | 400 | 4.55 | 72.80 | 0.879 |

## A-2 Results of Peak Spectral Efficiency

Peak spectral efficiencies of DL and UL are determined according to the ratio of DL to UL, ****. 8-layer is supported at below 6GHz, whereas 6-layer DL and 4-layer UL are supported at mmWave band. 256 QAM and 1024 QAM assume maximum coding rate of 0.875.

EUHT DL peak spectral efficiency for IMT bands (bit/s/Hz), =0.5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length *ρ* (ms) | 1 | 2 | 4 | Req. |
| 256QAM | 33.5 | 38.4 | 40.9 | 30 |
| 1024QAM | 41.8 | 48.1 | 51.2 | 30 |

EUHT DL peak spectral efficiency for higher frequency bands (bit/s/Hz), =0.5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length ρ (ms) | 10 | 20 | 30 | Req. |
| 256QAM | 31.71 | 33.53 | 34.13 | 30 |
| 1024QAM | 39.64 | 41.91 | 42.67 | 30 |

EUHT DL peak spectral efficiency for IMT bands (bit/s/Hz), =0.8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length ρ (ms) | 1 | 2 | 4 | Req. |
| 256QAM | 37.3 | 40.4 | 41.9 | 30 |
| 1024QAM | 46.6 | 50.5 | 52.4 | 30 |

EUHT DL peak spectral efficiency for higher frequency bands (bit/s/Hz), =0.8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length ρ (ms) | 10 | 20 | 30 | Req. |
| 256QAM | 33.08 | 34.22 | 34.60 | 30 |
| 1024QAM | 41.35 | 42.77 | 43.25 | 30 |
| Frame length ρ (ms) | 1 | 2 | 4 | Req. |
| 256QAM | 30.5 | 36.5 | 39.8 | 15 |
| 1024QAM | 38.1 | 45.6 | 49.7 | 15 |

 EUHT UL peak spectral efficiency for higher frequency bands (bit/s/Hz), =0.2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length ρ (ms) | 10 | 20 | 30 | Req. |
| 256QAM | 17.49 | 20.50 | 21.50 | 15 |
| 1024QAM | 21.87 | 25.63 | 26.88 | 15 |

UL peak spectral efficiency for IMT bands (bit/s/Hz), =0.5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length ρ (ms) | 1 | 2 | 4 | Req. |
| 256QAM | 38.3 | 40.8 | 42.1 | 15 |
| 1024QAM | 47.9 | 51.0 | 52.6 | 15 |

EUHT UL peak spectral efficiency for higher frequency bands (bit/s/Hz), =0.5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frame length ρ (ms) | 10 | 20 | 30 | Req. |
| 256QAM | 21.14 | 22.34 | 22.75 | 15 |
| 1024QAM | 26.43 | 27.93 | 28.43 | 15 |

## A-7 Results of User Plane Latency

User plane latency requirements for DL and UL eMBB (4ms) are met for frame length of 1, 2 and 4 ms, and the requirements for URLLC (1ms) are also met.

DL user plane latency for EUHT (ms)
(Frame structure DL:UL=1:1, Frame length: 1/2/4 ms)

|  |  |
| --- | --- |
| DL user plane latency – EUHT | STA |
| Frame Length |
| 1 ms | 2 ms | 4 ms |
| **Resource scheduling unit** | M=4 (4OS) | p=0 | 0.6552 | 1.1521 | 2.1528 |
| p=0.1 | 0.7661 | 1.3486 | 2.5589 |
| M=7 (7OS) | p=0 | 0.6984 | 1.1953 | 2.1960 |
| p=0.1 | 0.8093 | 1.4105 | 2.5963 |
| M=14 (14OS) | p=0 | 0.7992 | 1.2961 | 2.2968 |
| p=0.1 | 0.9101 | 1.5171 | 2.7216 |

UL user plane latency for EUHT with grant free transmission (ms)
(Frame structure DL:UL=1:1 , Frame length: 1/2/4 ms)

|  |  |
| --- | --- |
| UL user plane latency – EUHT | STA |
| Frame Length |
| 1 ms | 2 ms | 4 ms |
| **Resource scheduling unit** | M=4 (4OS) | p=0 | 0.5904 | 1.0872 | 2.0880 |
| p=0.1 | 0.7042 | 1.2996 | 2.5013 |
| M=7 (7OS) | p=0 | 0.6336 | 1.1304 | 2.1312 |
| p=0.1 | 0.7474  | 1.3428  | 2.5445 |
| M=14 (14OS) | p=0 | 0.7344 | 1.2312 | 2.2320 |
| p=0.1 | 0.8482 | 1.4436 | 2.6453 |

## A-8 Results of Control Plane Latency

Control Plane latency requirement of 20 ms are met.

Table 1

 Control plane latency [ms]

|  |  |  |
| --- | --- | --- |
| Mode | Frame length | ITU Requirement |
| 1ms | 2ms |
| Basic Mode | 6.5 | 13 | 20 |
| Fast recovery Mode | 4 | 8 |  |

## A-14 Results of Mobility Interruption Time

Mobility Interruption Time of 0ms can be achieved by the following procedure.

1. The mode of multiple access is OFDMA in EUHT, thus can realize the carrier aggregation (CA) function, and STA could connect with source CAP and target CAP.
2. RACH – less is used in EUHT, interaction between source CAP and target CAP could save the time when RACH process occurs.

Figure 5.10-1 shows the 0ms interrupt time procedure in EUHT.

Figure 5.10-1

The 0ms interrupt time procedure in EUHT

**

Important notes as follows:

1. the message ‘handover Request & Rach - less Request’ is send from Source CAP to target CAP, which carry the information with sub-band scheduling, time domain scheduling about the resources of the STA;
2. After the source CAP received feedback back news ‘Handover Response’ from Target CAP, the both CAP will schedule the frequency and time domain resource accordance with the contract. At this time, STA will communicate with two CAP at the same time.
3. the Target CAP establish connection with STA and transfer the effective data, then inform the source CAP would release STA. The Target CAP will schedule time and frequency resource to STA by itself.

## A-15 Results of Bandwidth and Scalability

From the table below, at least 10 MHz bandwidth is supported at below 6GHz carrier frequency and larger than 1GHz bandwidth is also supported above 6GHz carrier frequency. Scalable bandwidth support can also be checked.

Table 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) |
| IMT bands(Below 6 GHz) | 19.53125 | 50 | 16 | 800 |
| 39.0625 | 100 | 16 | 1600 |
| 78.125 | 100 | 16 | 1600 |
| higher frequency bands (Above 24 GHz) | 390.625 | 400 | 16 | 6400 |

Table Transmission bandwidth configuration NSD in EUHT

1. for IMT bands

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5MHz | 10MHz | 15MHz | 20MHz | 25MHz | 30MHz | 40MHz | 50MHz | 60MHz | 80 MHz | 100 MHz |
| NSD | NSD | NSD | NSD | NSD | NSD | NSD | NSD | NSD | NSD | NSD |
| 19.53125 | 224 | 448 | 672 | 896 | 1120 | 1344 | 1792 | 2240 | N/A | N/A | N/A |
| 39.0625 | 112 | 224 | 336 | 448 | 560 | 672 | 896 | 1120 | 1344 | 1792 | 2240 |
| 78.125 | 56 | 112 | 168 | 224 | 280 | 336 | 448 | 560 | 672 | 896 | 1120 |

(b) for higher frequency bands

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

Table 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 |
| IMT bands | 19.53125 | 5 | 50 | 8 |
| 39.0625 | 5 | 100 | 11 |
| 78.125 | 10 | 100 | 11 |
| higher frequency bands | 390.625 | 50 | 400 | 4 |

# References

[1] Report [ITU-R M.2410](https://www.itu.int/en/publications/ITU-R/pages/publications.aspx?parent=R-REP-M.2410), “Minimum requirements related to technical performance for IMT-2020 radio interface(s)”, 2017.

[2] Report [ITU-R M.2411](https://www.itu.int/en/publications/ITU-R/pages/publications.aspx?parent=R-REP-M.2411), “Requirements, evaluation criteria and submission template for the development of IMT-2020”, 2017.

[3] Report [ITU-R M.2412](https://www.itu.int/en/publications/ITU-R/pages/publications.aspx?parent=R-REP-M.2412), “Guidelines for evaluation of radio interface technologies for IMT-2020”, 2017.

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1. Submitted on behalf of TTA SPG33. [↑](#footnote-ref-1)