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| **Radiocommunication Study Groups** |  |
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| Received: 6 June 2022  Source: Wireless World Research Forum | **Document 5D/1283-E** |
| **7 June 2022** |
| **English only**  **TECHNOLOGY ASPECTS** |
| Wireless World Research Forum | |
| Interim Evaluation Report For The Candidate IMT-2020 RIT “EUHT-5G” Submitted by Nufront For M.2150  “Revision After Year 2021” | |
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This contribution contains the interim evaluation report from the Independent Evaluation Group Wireless World Research Forum (WWRF) for the candidate IMT-2020 radio interface(s) ‘EUHT-5G’ submitted by Proponent ‘Nufront’ in WP5D #40 as part of the M.2150 “Revision after Year 2021”.

The evaluation which is based on the new EUHT-5G specifications, follows the characteristics defined in ITU-R Reports M.2410-0, M.2411-0 and M.2412-0 [1] – [3] using a methodology described in Report ITU-R M.2412-0 [3].

The interim evaluation report reflects the structure of the final report which is planned to be submitted to WP 5D #42 meeting (October 2022).

• Part I: Administrative Aspects of the WWRF

• Part II: Technical Aspects of the work of WWRF

• Part III: Conclusions

**Attachment**: 1

Part I  
  
Administrative aspects of the Independent Evaluation Group

# I-1 Name of the Independent Evaluation Group (IEG)

Wireless World Research Forum (WWRF).

# I-2 Introduction and background of the Independent Evaluation Group

WWRF’s goal is to encourage research that will achieve unbounded communications to address key societal challenges for the future. The term “Wireless World” is used in this broad sense to address the support of innovation and business, the social inclusion, and the infrastructural challenges. This will be achieved by creating a range of new technological capabilities from wide-area networks to short-range communications, machine-to-machine communications, sensor networks, wireless broadband access technologies and optical networking, along with increasing intelligence and virtualization in networks. This will support a dependable future Internet of people, knowledge and things and the development of a service universe. WWRF is the unique forum where the wireless community can tackle the key research challenges. By searching out the issues, flagging them up to opinion leaders, and then working with liaison partners to deal with them, WWRF drives the development of the Wireless World. WWRF organizes two major events each year combining inputs from industry and academic experts, the exchange of ideas and the evolution of the research agenda and technology roadmaps. WWRF’s has a strong publication programme, working with partners such as IEEE and Wiley, makes the key messages and results available to the wireless research sector. To ease standardization, WWRF disseminates and harmonizes views, and together with our major liaison partners, we initiate collaborative research, and develop the global vision.

Over the last ten years, WWRF has championed several activities focused on the wireless evolution to and beyond 5G, including workshops and special sessions, presentations, white papers and journal special issues. WWRF has been very supportive of the ITU’s evaluation process for IMT-2020 and participates as an independent evaluation group (IEG).

For the last three years, beginning 2019, the IEG has been fully engaged in the WP5D IMT-2020 process for evaluation of IMT-2020 candidate technologies. The group has participated in the evaluation of 3 candidate radio interface technologies (RITs) as of today. These activities were performed:

• initially in the context of Step 4 which was open for all submitted RITs and

• subsequently in the re-engagement of the evaluation (Option 2) for two specific RITs that did not receive a complete evaluation.

The evaluated technologies are listed below:

• TSDSI (IMT-2020/19)

• NUFRONT (IMT-2020/18 and IMT-2020/18(Rev1))

• ETSI (TC DECT) and DECT Forum (IMT-2020/17 and IMT-2020/17(Rev1))

The contributed material to the respective WP 5D meetings is summarized in the following Table:

| Meeting | Document | Remarks |
| --- | --- | --- |
| WP5D #34  (02-2020) | 5D/120-E | Final evaluation report for RIT submissions From TSDSI (IMT‑2020/19) and NUFRONT (IMT-2020/18) |
| WP5D #37  (02-2021) | 5D/476 | Interim evaluation report on the Candidate Technology Submission for FOR IMT-2020 “ETSI (TC DECT) and DECT Forum Proponent” As Part of the Re-engagement in Step 4 Evaluation (Report with Provisional Results). |
| WP5D #37  (FEB-2021) | 5D/475 | Interim evaluation report on the Candidate Technology Submission for IMT-2020 “EUHT” as part of the re-engagement in Step 4 Evaluation. |
| WP5D #38  (06-2021) | 5D/658 | Evaluation report on the Candidate Technology Submission for IMT-2020 “ETSI (TC DECT) and DECT Forum Proponent” as part of the re-engagement in Step 4 evaluation. |
| WP5D #38  (JUNE-2021) | 5D/659 | Evaluation report on the Candidate Technology Submission for IMT-2020 “EUHT” as part of the re-engagement in Step 4 Evaluation |
| WG Technology Aspects Interim Meeting  (08-2021) | 5D/736 | Updated final evaluation report on the Candidate Technology Submission for IMT-2020 “ETSI (TC DECT) and DECT Forum Proponent” as part of the re-engagement in step 4 evaluation. |
| WG Technology Aspects Interim Meeting  (AUG-2021) | 5D/743 | Interim report based on further evaluations on the Candidate Technology Submission for IMT-2020 “EUHT technology” as part of the re-engagement in step 4 evaluation. (Final results were included subject to minor clarification from the Nufront proponent) |
| WP5D #39  (OCT-2021) | 5D/760 | Final report including re-evaluation of the final results for the Candidate Technology Submission for IMT-2020 “EUHT technology” as part of the re-engagement in step 4 evaluation. |

# I-3 Method of work

## I-3-1 Background

ITU-R announced in June 2021, with Circular Letter [6], the initiation of the update cycle for the revision ‘after year 2021’ of Recommendation ITU-R M.2150 for those radio interface technologies that would currently be included in the published Recommendation having the status of “in force” as of approximately March 2022. In addition, it invited the submission of new proposals for candidate radio interface technologies (RITs) or a set of RITs (SRITs) for the terrestrial components of IMT 2020. The letter also initiated, for any new candidate technology submissions, the process to evaluate the candidate RITs or SRITs for IMT‑2020 and invited the formation of Independent Evaluation Groups (IEGs) and the subsequent submission of evaluation reports on these new candidate RITs or SRITs according to the established detailed timeline. With the amendment 1 of the Circular Letter in March 2022 [7], ITU-R announced the acknowledgement of candidate submission from Nufront under Step 3 of the IMT-2020 process in WP 5D #40. The candidate IMT-2020 radio interface(s) submitted by Proponent ‘Nufront’ included an RIT. The submitted proposal is referenced in Document IMT-2020/75 [8]. WWRF IEG informed by April 2022 ITU-R WP5D about its intention to participate in the evaluation of the new EUHT-5G technology submission.

## I-3-2 Organizational Issues

The work was organized using the following channels:

1. Regular online meetings of the steering board (SB)
2. Nufront’s Workshop for their new Technical Specifications for EUHT-5G
3. Weekly meetings of the technical teams
4. File sharing through secure shared space
5. Workshops/Seminars organised by the WWRF
6. Monitoring of the ITU Discussion Forum

# I-4 Administrative contact details

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Part II  
  
 Technical aspects of the work of the Independent Evaluation Group

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

The WWRF IEG will evaluate a portion of the candidate RIT, based on the following submitted material:

|  |  |  |
| --- | --- | --- |
| Meeting number | Input contributions | Remarks |
| WP 5D #40 | 5D/[979](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0979!!MSW-E.docx)  (Attachment Part 1: 5D/[979!P1](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0979!P01!ZIP-E.zip);  Attachment Part 2: 5D/[979!P2](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0979!P02!ZIP-E.zip);  Attachment Part 3: 5D/[979!P3](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0979!P03!ZIP-E.zip);  Attachment Part 4: 5D/[979!P4](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0979!P04!ZIP-E.zip);  Attachment Part 5: 5D/[979!P5](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0979!P05!ZIP-E.zip)) | Final submission  • Characteristics template  • Compliance template  • Link budget template  • Self-evaluation report  • EUHT-5G specification |

The technical performance requirements listed in the table below will be assessed (Ref: Report ITU-R M.2412-0). In this Table we list for each addressed characteristic the assessment method used (based on ITU evaluation methodology), references to the requirements and exact methodology steps from corresponding ITU documents M.2410-0 and M.2412-0.

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristic for evaluation (test-environment) | High-level assessment method | Reference to M.2410-0 Requirements Document | Reference to M.2412-0 Evaluation Document |
| Reliability (URLLC) | Simulation | § 4.10 | § 7.1.5 |
| Connection density (mMTC) | Simulation | § 4.8 | § 7.1.3 |
| Bandwidth | Inspection | § 4.13 | § 7.3.1 |

For the simulation-based characteristics (Reliability and Connection Density) both UL and DL and Configurations A & B will be investigated.

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

The IEG is cognisant of the ITU-R evaluation guidelines and the evaluation plan is developed under the light of those guidelines.

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

## II-C-1 Performance Evaluation (Scenario: DL & UL for Urban-macro URLLC)

### II-C-1A Link Level Parameters for EUHT-PHY layer

The range of Link level simulation parameters for EUHT-PHY layer are taken from the system specifications provided by *NuFront* for EUHT and are summarised as follows. In our current link level simulation design, we are considering both, the Downlink and the Uplink.

Table 1

Range of simulation parameters for link level EUHT-PHY layer

|  |  |
| --- | --- |
| **Scenario** | Dense Urban |
| **Carrier Frequency** | 4 GHz, 700 MHz (Sub 6 GHz Bands) |
| **Bandwidth** | Configuration A; 5, 10, 15, 20, 25, 30, 40 … 100 MHz, Configuration B; 40 MHz |
| **Signalling Waveform** | CP-OFDM (SU-MIMO) |
| **Subcarrier Spacing** | 19.53 KHz, 39.0625 KHz & 78.125 KHz (Practical) |
| **FFT** | 256, 512, 768, 1024, 1280, 1536, 2048, 2560 |
| **Cyclic Prefix** | FFT/8 (Short CP) or FFT/4 (Normal CP) |
| **Guard Band** | True |
| **Propagation Channel** | Tap Delay Line |
| **Mobility** | True |
| **Errors Considered** | Block Error Rate (BLER) |
| **Channel Coding** | Low Density Parity Check (LDPC) |
| **Modulation** | BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM & 1024-QAM |
| **Channel Estimation** | Imperfect, Non-Ideal |

Table 2

Different configurations for Antennae support in EUHT-5G

|  |  |  |  |
| --- | --- | --- | --- |
| Configurations |  | Downlink | Uplink |
| **Configuration A** | Transmit Antennas | 16 | 8 |
| Receiver Antennas | 8 | 2, 4, 8, 16 |
| **Configuration B** | Transmit Antennas | 16 | 4 |
| Receiver Antennas | 4 | 2, 4, 8, 16 |

### II-C-1B Description of simulation parameters

According to Nufront’s system specifications, different bandwidths are associated with different FFT sizes for example, for a bandwidth of 20 MHz an FFT size of 1024 should be used. Cyclic prefix (CP) can be used in two different forms i.e., short and normal form. For an FFT size of 256, the CP size will be 32 and 64 for short and normal form respectively. Sub-carrier spacing **19.53 KHz, 39.0625 KHz** are optional for actual product.

There are two types of channel coding techniques that are specified in EUHT specifications, these include convolutional channel coding and low-density parity check (LDPC) channel coding. There is a vast range of different code rates that are specified, and we aim to consider them in our simulation design.

### II-C-1C Channel Modelling

The applicable channel model is based on the Channel Model Configuration A (UMa\_A) and Configuration B (UMa\_B) [5D/736], respectively, for the test environment Urban Macro-URLLC. The configuration parameters will be taken from the Annex 1 of Report ITU-R M.2412 (2017). As some parameters are defined in the terms of ranges, our aim is to model evaluations in a manner that a number of values in the range are considered as the technical performance requirement might not depend on the highest/lowest value 1.

The simulation model will consider the 4 GHz and 700 MHz carrier frequency for evaluation of Config. A and Config. B, respectively. An important aspect that impacts the evaluation is the service profile, which in our case will be the ‘full buffer best effort’. The simulation bandwidth can be up to 100 MHz for 4 GHz of carrier frequency and 40 MHz for 700 MHz carrier frequency, according to the evaluation criteria. Based on the parameters provided for EUHT-5G, a subcarrier spacing of 78.125 kHz is considered. The evaluation will be based on two channel conditions: non-line-of sight (NLoS) and line-of-sight (LoS). Making a distinction between the two cases is important as the tapped delay line (TDL) model for both cases is different. The previously submitted self-evaluation provided by Nufront considers NLoS scenario for URLLC, hence our simulation model will consider the same. The fading distribution for the TDL is Rayleigh, with the tap delays and normalised power provided in Table A1-41 [3]. The delay spread and angular spread will be taken from the Table A4-9 (UMa) in Annex 1 [3]. The path loss and shadow fading model are provided in Table A1-3 [3] for both LoS and NLoS scenarios. Finally, the baseline for the channel coefficient generation procedure will be the figure A1-2 [3] ‘Channel coefficient generation main procedure’, starting from assigning the general parameters, then moving towards small scale parameters, which results in channel coefficient generation.

Figure 1

Channel coefficient generation procedure

Diagram

Description automatically generated

## II-C-2 Implementation Plan

A stepwise implementation plan is provided as follows.

### II-C-2A Link Level Simulations

The simulation design for evaluation of Reliability for EUHT-5G consists of two major steps including link level simulations, followed by system level simulations. Figure 2 explains the two steps that will be followed for the evaluation of EUHT-5G.

Figure 2

Breakdown of the EUHT-5G Simulation tool

## II-C-3 Connection Density Evaluation for Urban Macro mMTC

The performance analysis will determine if ‘EUHT-5G’ can support a certain total number of devices per unit area (km2) with a specific quality of service, specified in Report ITU-R M.2410-0 § 4.8, for mMTC test environment.

Α two-level simulation methodology is used specified in Report ITU-R M.2412-§ 7.1.3. This includes system-level simulation combined with link-level simulations. Hence, both a system-level and a link-level simulator, along with proper interfacing mechanisms should be developed for assessing the achievable connection density in Urban Macro-mMTC regarding UL and DL.

During this period, we have performed the following activities:

– Reviewed the updated EUHT technology submission.

– Defined the structure of the link- and system-level software simulation platform.

The system level simulator will be configured according to the two Configurations for Urban Macro-mMTC described in the Report ITU-R M.2412-0. The selection of parameters will be made according to the parameter set of the EUHT submission that best fits the configurations without violating any constraint.

The event-based simulator that will be used for the evaluation of the Connection Density configurations is implemented in MATLAB utilizing the link-level simulator results that can be used for reliability evaluation. The connection density evaluation methodology is implemented in the following steps:

*Step 1*: A frequency reuse scheme is defined based on the available number of channels. Depending on the configuration defined by the ITU-R guidelines and assuming the minimum supporting bandwidth, frequency reuse factors may be 1/1, 1/3 and 1/7. Given the fact that OFDMA is also supported, subchannels may remain unused depending on the scheduling policy, even when 1/1 reuse is assumed.

*Step2*: System Level simulation using the Configuration A and the Configuration B parameters is implemented in a network layout similar with the one described for the evaluation of “reliability”. The frequency reuse factor is set to the one specified in Step 1 and a full-buffer traffic model is considered in order to create a simulation scenario where all available resources may be occupied (depending on the selected scheduling). As a result, the SINR Cumulative Density Function (CDF) distribution is extracted. Since, for the Connection Density evaluations, high congestion of users is expected, the CDF can be used in order to statistically generate the SINR for each user, when performing mMTC system-level simulations.

*Step 3*: Link Level simulation will be performed for the specified PHY configuration using the channel model setups described in Table 3 for a wide- range of SINRs. The packet error rate curves are calculated.

*Step 4*: The following investigation focuses on the procedures that take place in one site hosting three TRxPs. A large number of users is dropped into the cell. More specifically, for Configuration A, 120,000 users are uniformly generated for each sector. (Note: In order to fulfil the connection density requirement for Configuration A, complete transmission by approximately 70,000 users is required. However, due to the stochastic generation of traffic, some users may attempt more than one transmission in the time period of interest, while other users remain silent. Through test and trial, it can be found that for 120,000 generated users, the probability that at least 72,000 will attempt transmission approaches the unity. It is noted that the connection density requirement for Configuration A per sector is 73,000. In case of Configuration B, the connection density requirement per sector is 866,000. In this case 1.1M users were uniformly dropped for each sector.

*Step 5*: Through the Poisson point process, the packets are generated for all users. More specifically, 32 bytes for each are considered, and the output of the process is the time when the packet is available at the UT for transmission. In the following analysis, the smaller EUHT-5G slot/frame is considered (0.5ms) as the sampling period/time granular for the simulator. Thus, new events are taken into account at a slot-by-slot basis. The transmission times are “translated” to slot indexes, that indicate when each UT is ready to transmit. The traffic generation process is described in Figure 3 (upper left flow diagram).

*Step 6:* A simple but efficient scheduler is defined. A FIFO queue is implemented at the scheduler. When a UT has data available for transmission, it requests the first available uplink slot (the UT enters the queue). All packets have the same priority. A specific number of slots is defined available for uplink transmission in a TDD duplex mode. Actually, the minimum necessary slots are allocated for downlink, that carry the reference signals (e.g., DL-preamble, DL-DRS, CCH, DL-TCH), as well as the required scheduling information, and acknowledgments.

*Step 7*: Based on the defined setup and with the PHY and multiplexing parameterization, we define the minimum block of resources that can be allocated to a user (consisting of 16 consecutive OFDM subcarriers during the time slot) and, then specify a block that can be used to carry the 32 bytes of message per modulation and coding scheme. The scheduler can monitor simultaneously the complete cluster of neighboring TRxPs in order to be able to perform interference mitigation and control. All UTs are assumed to have 2 antennas using codebook precoders or Maximal Ratio Transmission towards the associated TRxP. Assuming block fading, beamforming is performed exploiting channel reciprocity in TDD.

*Step 8*: For all UTs, the SINR for the TRxP link is generated from the SINR CDF that was extracted in Step 2 of this process.

*Step 9*: Evaluation is performed with increasing complexity. If the requirement is not met, then we move to a more complicated setup, that can possibly deal with the imposed challenges.

– TRxPs are initially assumed with 2 antennas. If evaluation is not successful, then 4 antennas in rectangular panel formation are considered. In case of another failure, 8 antennas are assumed (as one panel of 8 elements, or two panels of 4 elements), and so on. The search for an antenna configuration that produces satisfactory performance continues until the number of 64 antenna elements (maximum defined in the scenario configurations) is reached.

– Transmission in the uplink is assumed with QPSK and convolutional ½ coding. In order to increase bandwidth efficiency, adaptivity in modulation and coding will be introduced in case there is a failure in satisfying the requirements (using radio channel quality as decision metrics).

*Step 10*: At this point, the main loop of the simulation engine can be executed. The logical flow is presented in Figure 3. The loop simulates the time succession of slots and frames during the time period of interest. More specifically,

– At the beginning of each frame all new UTs that have available data for transmission are inserted into the FIFO queue.

– The scheduler assigns sequentially the available resources to the UTs. Allocation is performed in a first-come-first served basis. Information for the Channel State Information is utilized in case of prior channel knowledge targeting resources with estimated 8dB SINR.

– At each slot, the allocated UT attempts transmission.

• If this is the first attempted transmission, the number of transmissions is zeroed.

• For the given SINR, the probability of Packet Error is calculated by the link-level simulation curves, and with the use of a random variable, it is decided whether the transmission is successful or not.

• If the maximum number of re-transmissions is reached, then the transmission failure is recorded.

• If the transmission is successful, the latency from the packet generation instance is calculated and if it is under 10 seconds, the transmission has succeeded. Otherwise, it is considered a failure.

• In case of re-transmission, the scheduler re-evaluates the resource allocation based on the channel quality feedback received from the previous attempt.

• The loop completes after simulating a timeline of 2h or 24h according to the specifications, or when a TRxP is able to serve more than 80,000 UTs (the requirement is approximately 70,000 UTs).

– The simulation is executed several times in order to ensure that requirement satisfaction is not just a random stochastic event.

Table 3

Channel model parameters for Connection Density

| Parameters | Urban Macro–mMTC  (for Connection density) | Urban Macro–URLLC  (for Reliability) |
| --- | --- | --- |
| Link-level Channel model | NLOS: TDL-iii and CDL-iii  LOS: TDL-v and CDL-iii | NLOS: TDL-iii and CDL-iii  LOS: TDL-v and CDL-iii |
| Delay spread scaling parameter (s) | Log10() =lgDS in  Table A4-9 (UMa) in Annex 1 | Log10() =lgDS in  Table A4-9 (UMa) in Annex 1 |
| AoA, AoD, ZoA angular spreads scaling parameter   (degree) | Log10() =lgASA /lgASD /lgZSA in Table A4‑9 (UMa) in Annex 1 | Log10() =lgASA /lgASD /lgZSA in Table A4‑9 (UMa) in Annex 1 |
| ZoD angular spreads scaling parameter   (degree) | Log10() =lgZSD in Table A4‑10 (UMa) in Annex 1 | Log10() =lgZSD in Table A4‑10 (UMa) in Annex 1 |

Figure 3

Connection Density Simulation Methodology

Diagram

Description automatically generated with medium confidence

# II-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)

This is an interim report, and the verification of compliance templates and the self-evaluation will be conducted in the final report.

# II-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)

This is an interim report, and the final assessment on a system level scale will be conducted in the midterm and final report.

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

This IEG has referred to the previously submitted self-evaluation report (SER) provided by the Nufront and plans to use the parameters used by the EUHT-5G self-evaluation to cross verify the findings.

# II-G Proposed next steps towards the final report

## II-G-2A Results for the URLLC Link Level Simulator

The system level simulator design shown in Section II-C is work in progress and the next reports will include EUHT-5G evaluation results for Link Level simulations.

## II-G-2B System Level Simulation design

The EUHT system-level simulator will be developed according to the ITU specifications. The simulator will include a 19-cell two-tier scenario as shown in Figure 4.

Figure 4

System Level Simulation Plan: 19-Cell Scenario with Two Tiers

A close - up of a keyboard

Description automatically generated with low confidence

The system-level simulator will solely focus on evaluating the reliability of the EUHT-5G technology. ITU-R guideline on system-level simulation requirements for evaluating reliability defined in Report ITU-R M.2410-0 [1], section 4.10 [1] and Report ITU-R M.2412-0, section 7.1.5 [3]. The system-level simulation will run downlink and uplink full buffer system-level simulations of EUHT-5G using the evaluation parameters of the Urban Macro-URLLC test environment defined in Report ITU-R M.2412-0, section 8.4.1 [3] and summarised in Table 4 and collect overall statistics for downlink and uplink SINR values, and construct CDF over these values. Then use the CDF for the Urban Macro-URLLC test environment to save the respective 5th percentile downlink and uplink SINR value. The simulation will be repeated for Configuration A and Configuration B.

Table 4

System configuration

|  |  |
| --- | --- |
| Parameter | Value |
| Number of sites | 19 |
| Number of sectors per site | 3 |
| Frequency reuse factor | 3 |
| Total number of cells | 19 × 3 = 57 |
| Number of STA devices per cell | 10 |
| Total STA devices | 57 × 10 = 570 |
| STA antenna height | 1.5 m |
| CAP antenna height | 25 m |
| Inter-site distance | 500 m |

Table 5

Common System level technical assumptions & parameters (downlink and uplink)

| Parameter | Value |
| --- | --- |
| Base station noise figure | 5 dB |
| STA noise figure | 7 dB |
| CAP antenna element gain | 8 dBi |
| STA antenna element gain | 0 dBi |
| STA power class | 23 dBm |
| Thermal noise level | ‒174 dBm/Hz |
| Traffic model | Full buffer |
| Simulation bandwidth | 20 MHz |
| Percentage of high loss and low loss building type | 100% low loss |
| Mechanic tilt | 90° in GCS |
| Electronic tilt | 99° in LCS |
| STA mobility model | Fixed and identical speed |v| of all UEs, randomly and uniformly distributed direction |
| STA speeds of interest | 3 km/h |

Table 6

Configuration based System level technical assumptions & parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Configuration A | Configuration B |
| Number of antenna elements per TRxP | 16 | 16 |
| Number of STA antenna elements | 8 | 4 |
| Carrier frequency for evaluation | 4 GHz | 700 MHz |

Following details stepwise implementation plan for the system level simulator.

Downlink (DL) Steps:

– Step 1: Setup 57 Cells and randomly assign 10 STAs per Cell

– Step 2: Each STA, calculate receiving power from assigned Cell and noise from all other 56 Cells

– Step 3: Store calculated SINR value for all STAs

– Step 4: Repeat Step 1 to 3 for 10,000 times.

– Step 5: Using all SINR values collected in Step 3 (57 \* 10,000) calculate CDF curve

– Step 6: Use CDF curve to find 5th Percentile.

Uplink (UL) Steps:

– Step 1: Setup 57 Cells and randomly assign 10 STAs per Cell

– Step 2: Each CAP, calculate receiving power from assigned STAs and noise from all other 56 Cells

– Step 3: Store calculated SINR value for all CAPs

– Step 4: Repeat Step 1 to 3 for 10,000 times.

– Step 5: Using all SINR values collected in Step 3 (57 \* 10,000) calculate CDF curve

– Step 6: Use CDF curve to find 5th Percentile.

### II-G-2D Connection Density

In the period towards WP 5D Meeting #42 we plan to:

– Implement the link- and system-level software simulation platform

– Configure the exact evaluation scenarios according to ITU-R M.2412

– Run the simulation scenarios and acquire the performance results

### II-G-2E Bandwidth & Spectrum Analysis

Bandwidth is the maximum aggregated system bandwidth. As defined in M.2410, the bandwidth may be supported by single or multiple radio frequency (RF) carriers, with the following requirements:

– Bandwidth of at least 100 MHz should be supported.

– Bandwidth should be scalable, i.e., multiple different bandwidth values should be supported.

– Bandwidths up to 1 GHz for operation in higher frequency bands (e.g., above 6 GHz) should be also supported.

The assessment is performed through inspection as defined in M.2411 and the outcomes are reflected in the following clauses of the Evaluation Methodology:

– Compliance Template Spectrum: Higher Frequency range/band(s) (M.2411 - 5.2.4.2.2)

– Compliance Template for Technical Performance: Bandwidth & Scalability KPI (M.2411 - 5.2.4.3.15).

During this period, we have performed a thorough reviewed of the updated EUHT 5G specifications and the submission material. In the period towards WP 5D Meeting #42 we plan to complete the bandwidth and spectrum analysis study.

Part III  
  
Conclusions

In this report, we present the methodology that we plan to adopt for evaluating the EUHT-5G RIT, in terms of Reliability, Connection Density and Bandwidth characteristics. For reliability we consider the urban macro URLLC scenario. First, we highlight the implementation plan for the link-level simulations. We identify some important parameters and explain the individual modules and transmitter/receiver design involved in the implementation plan. We also provide an initial discussion on how the link-level simulations will be connected to the system level simulations, as a direction for the next report. For connection density we describe the step-by-step procedure for link- and system-level simulation as will be applied to the Urban Macro mMTC scenario. Finally, bandwidth will be assessed using inspection.

References & Additional Material

[1] ITU-R: Minimum requirements related to technical performance for IMT-2020 radio interface(s). Report ITU-R M.2410-0, (11/2017).

[2] ITU-R: Requirements, evaluation criteria and submission templates for the development of IMT-2020. Report ITU-R M.2411-0, (11/2017).

[3] ITU-R: Guidelines for evaluation of radio interface technologies for IMT-2020. Report ITU-R M.2412-0, (10/2017).

[4] 3GPP. 2018. TR 38.901. Study on channel for frequencies from 0.5 to 100 GHz. V.15.0.0. (2018-06).

[5] Menglei Zhang, Michele Polese, Marco Mezzavilla, Sundeep Rangan, Michele Zorzi. “ns-3 Implementation of the 3GPP MIMO Channel Model for Frequency Spectrum above 6 GHz”. In Proceedings of the Workshop on ns-3 (WNS3 ‘17). 2017.

[6] ITU Radiocommunication Bureau (BR), Circular Letter, 5/LCCE/94, 28 June 2021

[7] ITU Radiocommunication Bureau (BR), Addendum 1 to Circular Letter, 5/LCCE/94, 8 March 2022

[8] IMT-2020/75, ITU-R IMT.2020 Contribution 75, Submission received for proposals of candidate radio interface technologies from proponent 'Nufront' under step 3 of the IMT-2020 process, 2022-03-03, https://www.itu.int/md/R15-IMT.2020-C-0075/en

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