3GPP TSG-RAN WG1 Meeting #112bis R1-2304008

e-Meeting, April 17th – April 26th, 2023

**Agenda item:** 9.15.1

**Source:** Moderator (Qualcomm)

**Title:** Feature lead summary #1 on evaluation methodology for IMT-2020 Satellite

**Document for:** Discussion and Decision

# Introduction

In [2], a new SID was approved on IMT-2020 satellite radio interface evaluation. RAN1 is tasked with providing evaluations for different performance requirements as follows:

Detailed objectives of this study item include:

1. Complete all required submission templates as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc]
2. Provide self-evaluation results against technical performance requirements for eMBB-s as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2], including
	* Peak data rate
	* Peak spectral efficiency
	* User experienced data rate
	* 5th percentile user spectral efficiency
	* Average spectral efficiency
	* Area traffic capacity
	* Latency, including user plane latency and control plane latency
	* Energy efficiency, including both network and device
	* Mobility
	* Mobility interruption time

1. Provide self-evaluation results against technical performance requirements for mMTC-s as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2], including
	* Connection density
2. Provide self-evaluation results against technical performance requirements for HRC-s as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2], including
	* Reliability
3. Provide self-evaluation results for other requirements (including bandwidth) as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2, RAN4]

IoT NTN will at least target self-evaluation against bullets c) and e) technical requirements, and NR NTN will target self-evaluation against all technical requirements (in bullets b) to e)).

This study shall start with evaluating features that are supported by Rel-17 NTN (NR NTN + IoT NTN), as relevant for the above aspects.

This contribution will serve as a basis for discussion regarding evaluation assumptions for IMT-2020 submission.

# General considerations and parameters

Several companies provided views on the different characteristics for evaluation, and which of the characteristics need evaluation assumptions. In the following table we summarize the set of characteristics and which ones need defined assumptions. Note that some characteristics (e.g. #3 or #6) are derived from other characteristics, and therefore don’t need a separate set of evaluation assumptions:

**Proposal 2.1: The following table is the starting point for defining evaluation assumptions:**

| **Reference number** | **Characteristic for evaluation** | **High-level assessment method** | **Requirement description in ITU-R M.2514** | **Usage Scenario** | **Needed assumptions** |
| --- | --- | --- | --- | --- | --- |
| **#1** | **Peak data rate** | **Analytical**  | **§ 7.2.1** | **eMBB-s** | **Yes (modulation, #layers, etc)** |
| **#2** | **Peak spectral efficiency** | **Analytical** | **§ 7.2.2** | **eMBB-s** | **Yes (modulation, #layers, etc)** |
| #3 | User experienced data rate | Simulation and Analytical | § 7.2.3 | eMBB-s | Derived from #4 |
| **#4** | **5th percentile spectral efficiency** | **Simulation** | **§ 7.2.4** | **eMBB-s** | **Yes** |
| **#5** | **Average spectral efficiency** | **Simulation** | **§ 7.2.5** | **eMBB-s** | **Yes** |
| #6 | Area traffic capacity | Simulation and Analytical | § 7.2.6 | eMBB-s | Derived from #5 (May need discussion on how to compute the area) |
| #7 | User plane latency | Analytical and Inspection | § 7.2.7.1 | eMBB-s | No |
| #8 | Control plane latency | Analytical and Inspection | § 7.2.7.2 | eMBB-s | No |
| **#9** | **Connection density** | **Simulation** | **§ 7.2.8** | **mMTC-s** | **Yes** |
| #10 | Energy efficiency | Inspection | § 7.2.9 | eMBB-s | No |
| **#11** | **Reliability** | **Simulation** | **§ 7.2.10** | **HRC-s** | **Yes** |
| **#12** | **Mobility** | **Simulation** | **§ 7.2.11** | **eMBB-s** | **Yes** |
| #13 | Mobility interruption time | Analytical | § 7.2.12 | eMBB-s | No |
| #14 | Bandwidth | Inspection | § 7.2.13 | N/A | No |

Regarding general scenarios (orbit / frequency / types of receiver), the following points summarize the input from companies:

* Focus on transparent payload only without ISL as baseline (HW, NK)
* Focus on S-band LEO-600 (Pana, QC, Th, MTK)
* S-band, LEO-600 & GEO (ZTE)
* For peak data rate, evaluate VSAT + Ka band (ZTE)
* Include Ka band and S band, GEO and LEO (CATT, CAICT)
* Handheld terminal (NK, ZTE, Pana, QC)
* MTD and directional terminals (CATT, CAICT)

Based on the input above and the guidelines for [1] (where only evaluations for handheld terminal are mandatory), the following proposal is made:

**Proposal 2.2: The evaluation performed by RAN1 will consider at least the following scenario:**

* **Transparent payload without ISL**
* **S-band (2GHz)**
* **LEO-600**
* **Handheld UEs**

**FFS: If additionally RAN1 evaluates MTD UEs, GEO, directional terminals, and Ka band.**

## Q2.1: Please provide comments on proposals 2.1 and 2.2

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. Regarding the GEO in proposal 2.2, maybe we can only focus on the IoT part since it’s more promising deployment scenarios.We are open to consider the VSAT if there is sufficient time (e.g., for peak data rate analysis). |
| MediaTek | Agree. In our paper (R1-2303346) we propose to cover both Handheld UEs and MTD UEs for the Connection Density requirement. However, we apply common UE parameters for both (see Table A3) which we think is a reasonable assumption, and therefore the additional simulation effort would be zero. |
| Panasonic | Fine with proposals 2.1 and 2.2.  |
| Samsung | Generally fine with the two proposals. For proposal 2.1, we have one clarification question on the meaning of “needed assumption”. For example, for evaluating user plane latency, 37.910 showed assumptions of procedures such as BS processing delay and UE processing delay. Thus, we may need to discuss assumption for satellite processing delay since we are assuming transparent payload as a baseline. That’s why we think that proper assumptions are necessary for user/control plane latency.  |
| Huawei/HiSilicon | **For Proposal 2.1**For peak data rate and peak spectrum efficiency, we agree that assumptions are needed. But it may not be limited to modulation and number of layers. M.2514 stated that “Peak data rate is the maximum achievable data rate under ideal conditions,” and “Peak spectral efficiency is the maximum data rate under ideal conditions normalized by the assigned bandwidth (in bit/s/Hz),”. What does ideal condition mean requires some discussion and common understanding in e.g. channel model used to calculate SNR. If SNR calculation and SNR-to-MCS mapping are needed, we are not sure whether it is just analytical or it also includes some simulation (e.g. link-to-system curve). Suggested change #1: Yes (modulation, #layers, etc) => Yes (modulation, #layers, channel model, etc); suggested change #2: Analytical => Analytical and may include simulation.Some companies propose RAN2 to evaluate user plane latency, control plane latency, energy efficiency and mobility interruption time. If it is agreed that RAN2 will evaluate them, it may not be so suitable that RAN1 concludes there is no assumption needed before RAN2 looking into it. We suggest we just leave these to RAN2, by changing the needed assumption column from “no” to “to be decided by RAN2” or keep it blank. **For Proposal 2.2**For transparent payload vs regenerative, we are OK to start evaluation of transparent payload. In parallel, we suggest TSG RAN to check and possibly confirm regenerative payload can be supported by Rel-17 specifications. If regenerative payload is confirmed to be supported, regenerative payload can also be included in the ITU submission to show competitiveness of 3GPP NTN technology. It is clear that Ka band with VSAT device is not supported in Rel-17, then there is no need to have FFS on it. Suggest to remove “directional terminals and Ka band” from the FFS. OK to keep MDT and GEO for IoT evaluation. |

For the general evaluation assumptions, the following tables (Table 1 in 8.2.3 and Table in 8.2.1.5 from [1]) are taken as a baseline:

**Proposal 2.3: The following tables (Table 1 in M.2510-0 without MTD terminal type, and Table in 8.2.1.5) are taken as baseline for the RAN1 evaluations:**

|  |  |
| --- | --- |
| Parameters | Values/Types/Configurations |
| Rural-eMBB-s | Rural-mMTC-s | Rural-HRC-s |
| Terminal type (see § 8.2.1.5) | Handheld | Handheld | Handheld |
| Satellite orbit configuration | LEO, 600 km altitude |
| Spot beam pattern  | Hexagonal pattern, at least 19 spot beamsInfluence of adjacent beam interference on the results should be accounted for, e.g. by collecting statistics only from the inner spot beams |
| Service link frequency (1) | 2 GHz  |
| Channel bandwidth | 30 MHz | 30 MHz  | 30 MHz |
| 3 dB beam width | 4.41 degrees |
| Satellite antenna gain | 30 dBi |
| Satellite G/T | 1.1 dB/K |
| Device deployment | 100% outdoor, randomly and uniformly distributed over the area |
| UE density | 10 UEs per spot beam | At least 500 per km2 | 10 UEs per spot beam |
| UE mobility model | For mobility evaluations: Fixed and identical speed of 250 km/h of all UEs, randomly and uniformly distributed direction.For all other evaluations: Stationary | Stationary | Fixed and identical speed of 30 km/h of all UEs, randomly and uniformly distributed direction |
| Traffic model | Full buffer  | With layer 2 PDU (Protocol Data Unit) message size of 32 bytes:1 message/day/deviceor1 message/2 hours/devicePacket arrival follows Poisson arrival process for non-full buffer system-level simulation | Full buffer |
| UE antenna height | 1.5 m |

|  |  |
| --- | --- |
| Terminal types | Handheld |
| Examples | Handset, smartphone |
| Antenna type and configuration | Omni-directional |
| Polarisation | Linear: ±45°X-pol |
| Antenna gain (dBi) | 0 |
| Antenna temperature (K) | 290 |
| Noise figure (dB) | 7 |
| Tx transmit power | 200 mW (23 dBm) |

Regarding other deployment parameters (SLS) not included in M.2510, the following table summarizes the input from multiple companies, mostly reusing the values in 38.811:

|  |  |
| --- | --- |
| Parameter | Input |
| Satellite antenna pattern | * HW: Section 6.4.1 in TR 38.811
* QC, ZTE: Bessel function in 38.811
 |
| Satellite antenna polarization configuration | * HW, ZTE, QC: Circular
 |
| Central beam elevation | * HW: 90 degrees
 |
| Beam layout definition and wrap-around | * ZTE: Hexagonal pattern, 19 inner beams,
	+ Total beams: 61 beams for FRF=1,
	+ 127 beams for FRF=3.
* HW: 6.1.1.1 of TR 38.821
* QC: Table 6.1.1.1-4 of 38.821
 |
| Frequency re-use factor | * HW, ZTE, QC: 1 or 3
 |
| Propagation conditions | * QC: Clear Sky, Line of Sight
* Nk: RAN1 to discuss if we can assume 100% LOS
 |
| Channel model | * QC (for SLS), Pana: Large scale model of 38.811
* ZTE (for LLS): NTN-CDL-C or NTN-CDL-D
 |
| Handover margin | * ZTE, Pana: 0dB
 |
| UE attachment | * ZTE, QC, Pana: RSRP
 |
| Receiver type (for SLS) | * ZTE: MMSE-IRC
 |
| Channel Estimation (for SLS) | * ZTE: Realistic
 |
| Satellite antenna configuration | * ZTE: 1Tx/Rx
* QC: 1Tx/Rx per beam
 |
| Polarization reuse | * Pana: Disabled
 |

In view of the above, the only controversial issue seems to be how to define the propagation conditions (i.e., if we can assume 100% LOS). The rest seems to be common across companies:

**Proposal 2.4: The following table is agreed as additional parameters for RAN1 evaluations.**

|  |  |
| --- | --- |
| Parameter | Input |
| Satellite antenna pattern | Bessel function as in Section 6.4.1 in TR 38.811 |
| Satellite antenna polarization configuration | Circular |
| Central beam elevation | 90 degrees |
| Beam layout definition and wrap-around | As described in 6.1.1.1 of TR 38.821 |
| Frequency re-use factor | 1 or 3 |
| Propagation conditions | FFS: Whether 100% LOS probability is assumed or not |
| Large scale Channel model | Large scale model of 38.811 |
| Small scale | TBD |
| Handover margin | 0dB |
| UE attachment | RSRP |
| Receiver type (for SLS) | MMSE-IRC |
| Channel Estimation (for SLS) | Realistic |
| Satellite antenna configuration | 1Rx / 1Tx per beam |
| Polarization reuse | Disabled |

## Q2.2: Please provide comments on proposals 2.3 and 2.4

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree 2.3 to take it as baseline.For 2.4, we are fine to take central beam evaluation as 90 degree. Regarding the channel condition, since in the link budget analysis, we only focus on the LoS case for both NR and IoT. So, it’s straightforward to take it as baseline, which is also similar/proximity to the rural case. |
| MediaTek | Most of Proposal 2.3 is fine, but we would like to clarify some points:* Channel BW: in IMT-2020 for Connection Density it was required to report the required bandwidth over which the density requirement is met, which for LTE was multiple narrow channels to create the capacity, so 30MHz would be an upper bound in that sense. So we would like to clarify that we take the same approach here for IoT NTN, as highlighted in our paper.
* Traffic model: In IMT-2020 there was a full buffer and non-full buffer for Connection Density, and an upper bound for delivery of 10ms, but the description in the table only refers to non-full buffer. It would be good to be clear that the full buffer approach (same as IMT-2020) can be applied for Connection Density here.
* Terminal Types: For IoT NTN it would be 1 Tx/Rx antenna so no polarization.

Proposal 2.4 generally fine. A few points:* FRF: Is the intention that each company selects FRF=1 or FRF=3? We would be fine to select FRF=1 as baseline.
* Propagation conditions: Regarding LOS only, while NLOS may lower the results in rural environment somewhat, we do not expect a huge difference, so LOS-only may be ok.
* Channel model: At least for IoT NTN, as narrowband and SISO, we tend to believe just “large-scale” modelling would be sufficient for SLS, and that modelling “small-scale” modelling should not be required.
 |
| Panasonic | On proposal 2.3, satellite EIRP density (or transmission power) should be added. As in TR38.821, 34 dBW/MHz for LEO-600 should be the baseline.  |
| Samsung | Fine with the proposals.  |
| Huawei/HiSilicon | **For Proposal 2.3:** OK with the proposal except that M.2510-0 may be a typo, should be M.2514-0 instead?**For Proposal 2.4:**For Large scale Channel model, we suggest to make it more clear "Large scale model in **Section 6.6** of 38.811". Once companies agree to reuse large scale model in Section 6.6 of 38.811, then there is no need to further study 100% LOS probability for system level simulation, as the LOS probability is already defined in Section 6.6.1 of 38.811. For FFS of 100% LOS probability, maybe it is still relevant for peak data rate and peak spectrum efficiency analysis. We suggest change it to “further study 100% LOS probability and other ideal conditions for peak data rate and peak spectrum efficiency analysis”For small scale: it is clearly requested in M.2514 that “General aspects such as path loss, LOS probability, shadow fading, outdoor-to-indoor building penetration loss and fast fading should be modelled”, so fast fading should be modelled to meet M.2514 requirement. Suggest to change “TBD” to “TBD between Section 6.7.1 of 38.811 and Section 6.7.2 of 38.811, or both” |

# Peak data rate and spectral efficiency (#1, #2)

**Relevant documents:**

|  |  |
| --- | --- |
| Source | Comments |
| [2384](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302384.zip) (HW) | Sections 4.1 and 4.2 |
| [2873](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302873.zip) (E/Q/Th) | Section 2 |
| [3157](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303157.zip) (SS) | Section 2 |
| [2435](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302435.zip) (NK) | Section 3 |

All the inputs for this matter are consistent in using a variant of the data rate equation in TS 38.306. The main discussion in RAN1 would be to decide on the specific parameters (e.g. number of layers, bandwidth, overhead, modulation order, etc).

Given the input to this meeting, and the general procedure in [1], the evaluation should proceed as follows:

* Calculate the peak spectral efficiency $SE\_{p}$
* Based on the peak spectral efficiency, calculate the peak data rate as $R\_{p}=BW×SE\_{p}$

A majority of companies also propose to use a single carrier to calculate the peak data rate. Therefore, the following proposal is made:

**Proposal 3.1: The peak spectral efficiency is calculated as**

$$SE\_{p}=\frac{v\_{Layers}⋅Q\_{m}⋅f⋅R\_{max}\frac{N\_{PRB}^{BW,μ}⋅12}{T\_{s}^{μ}}\left(1-OH\right)}{BW }$$

**Proposal 3.2: The peak data rate is calculated as** $R\_{p}=BW×SE\_{p}$**, assuming single carrier operation.**

RAN1 would need to agree on the specific parameters for all the parameters. Given that NR NTN reuses the modulation order / number of layers / etc of NR TN, the current specification does not restrict usage of parameters (e.g. modulation order) that may not be relevant for NTN scenarios. Based on several inputs, RAN1 should consider selecting a set of realistic parameters for the peak spectral efficiency and data rate calculations.

**Proposal 3.3: When selecting the parameters for peak spectral efficiency and peak data rate, RAN1 to consider realistic values based on NTN deployment characteristics (e.g. link budget).**

## Q3.1: Please provide comments on proposals 3.1, 3.2 and 3.3

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. |
| Panasonic | Fine with proposals 3.1, 3.2 and 3.3.  |
| Samsung | Fine with the proposals. |
| Huawei/HiSilicon | Agree with Proposal 3.1 and 3.2**For Proposal 3.3**Companies should agree on ideal conditions for link budget calculation. Suggested change: **When selecting the parameters for peak spectral efficiency and peak data rate, RAN1 to consider realistic values for** *Rmax* **and *Qm* based on NTN deployment characteristics (e.g. link budget). Ideal conditions for e.g. LOS probability, shadow fading and Scintillation are assumed for link budget analysis when analysing peak spectrum efficiency and peak data rate.** |

Two tdocs provided input on the specific values to be used for the peak data rate evaluation, which are reproduced below

Table 3.1 – Input from contributions 2873 and 3157

|  |  |  |
| --- | --- | --- |
|  | **DL** | **UL** |
| Parameters | [2873](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302873.zip) **(E/Q/Th)** | [**3157**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303157.zip) **(SS)** | [2873](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302873.zip) **(E/Q/Th)** | [**3157**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303157.zip) **(SS)** |
| Max. number of layers | 1 | 1 | 1 | 1 |
| Highest modulation order | 8 | 6 | 8 | 6 |
| Scaling factor of modulation  | 1 | 1 | 1 | 1 |
| Max. coding rate*Rmax* | 948/1024 = 0.9258 | 948/1024 = 0.9258 | 948/1024 = 0.9258 | 948/1024 = 0.9258 |
|  | 0 | 0 | 0 | 0 |
|  | Based on ITU-R report M.2514, 30 MHz channel BW should be considered. Hence, 160 PRBs are assumed for the purpose of the evaluations | 160 | Based on ITU-R report M.2514 30 MHz channel BW should be considered. Hence, 160 PRBs are assumed for the purpose of the evaluations | 8 |
| $$BW$$ | 30MHz | 30MHz | 30MHz | 1.44MHz |
| Overhead assumptions | * PDCCH: CORESET of 24 PRBs (4 CCE; AL 4) in every slot

🡪 12 RE/PRB/slot* TRS burst of 2 slots with periodicity of 80 ms and occupies 52 PRBs🡪 12 RE/PRB/80 ms
* DMRS: Type 1, Mapping A

🡪 12 RE/PRB/slot * CSI-RS: 1 CSI-RS ports with periodicity of 20 ms🡪 1 RE/PRB/20 ms
* 1 SS/PBCH blocks (SSB) per 20 ms; one SSB occupies 960 REs = 4 OFDM symbols × 20 PRB × 12 REs/PRB

NOTE: If the channel bandwidth is less than TRS bandwidth, the TRS bandwidth is assumed to be equal to the channel bandwidth. | 0.14 | * PUCCH: short PUCCH with 1 PRB and 1 symbol in every UL slot🡪 12 RE/slot
* DMRS: Type 1, one complete symbol 🡪 12 RE/PRB/slot
* SRS: 1 symbol with periodicity of 10 ms
 | 0.08 |

For discussion, companies are encouraged to provide input on the different values:

## Q3.2: Please provide comments on the parameters for peak SE in the tables below:

Table 3.2 – Peak SE parameters for downlink

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | $$v\_{Layers}$$ | $$Q\_{m}$$ | $$f$$ | $$R\_{max}$$ | $$μ$$ | $$N\_{PRB}^{BW,μ}$$ | $$OH$$ | $$BW$$ |
| Huawei/HiSilicon | 1 | Based on link budget analysis  | 1 | Based on link budget analysis | 0 | 160 | * PDCCH: CORESET of 24 PRBs (4 CCE) in every slot
	+ - 12 REs/PRB/slot
* TRS burst of 2 slots with periodicity of 20ms and occupies 52 PRBs
	+ - 12 REs/PRB/20 ms
* DMRS: Type 1, 6 REs/PRB/slot for 1 layer
* CSI-RS: 1 CSI-RS port with periodicity of 20ms
	+ - 1 RE/PRB/20 ms

1 SS/PBCH blocks (SSB) per 20ms; one SSB occupies 960REs = 4 OFDM symbols × 20 PRBs × 12 REs/PRB  | 30 MHz |

Table 3.3 – Peak SE parameters for uplink

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | $$v\_{Layers}$$ | $$Q\_{m}$$ | $$f$$ | $$R\_{max}$$ | $$μ$$ | $$N\_{PRB}^{BW,μ}$$ | $$OH$$ | $$BW$$ |
| Huawei/HiSilicon | 1 | Based on link budget analysis | 1 | Based on link budget analysis | 0 | Based on link budget analysis | * PUCCH: short PUCCH with 1 PRB and 1 symbol in every UL slot;
* DMRS: Type1, 6 REs/PRB/slot for 1 layer

SRS: 1 symbol per slot with periodicity of 10ms | Based on link budget analysis |

Table 3.4 – General comments

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | According to 38.821, CNRs of DL and UL for handheld are 6.6 dB and 2.8 dB, respectively, CNRs of DL and UL for VSAT are 8.5 dB and 18.4~23.1 dB, respectively. The Qm may be 4 for DL and 2 for UL for handheld and 8 for UL for VSAT. The max code rate may be 0.4785 and 0.6016 for DL for handheld and VSAT, respectively, may be 0.5879 and 0.7783 for UL for handheld and VSAT, respectively. |
| Panasonic | If we consider realistic link budget, modulation order and max coding rate for peak rate calculation should be based on link budget with the elevation angle 90 degree (i.e. Tx-Rx distance 600km) rather than 30 degree. In this case, CNR of DL and UL for handheld are 11.8dB and 7.9dB. Qm for DL and UL can be 6 and 4. On the other hand, for UL, 360kHz transmission BW is assumed for the link budget. If 360kHz BW is used for peak rate calculation, the requirement (2Mbps) can not be satisfied. What to be considered as realistic deployment would need to be discussed.  |
| Samsung | For MCS level, we are open to discuss realistic values based on link budget results. For UL BW, if majorities prefer to consider 30MHz, we are fine with that. However, we would like to understand the logic before that. As we observed in our contribution, at least MCS level 22 and 13 is necessary for DL and UL, respectively assuming that DL=30MHz, UL=1.44MHz.  |
| Huawei/HiSilicon | See comments to proposal 3.3 |

# Spectral efficiency – eMBB-s additional assumptions (#3, #4, #5, #6)

For eMBB evaluations, there are additional parameters that would need to be agreed before performing the evaluations. The table below captures a summary of the proposed parameters from several companies.

|  |  |
| --- | --- |
| CSI feedback | * ZTE: Release 15 + RTT
* QC: TBD
 |
| Frequency offset | * ZTE: 0.1ppm
 |
| Frequency drift | * ZTE: [Doppler rate values provided in Table 6.1.1.1-8 in [4]]
 |
| UE speed | * ZTE: 3 km/h, 0 km/s (stationary)
 |
| UE antenna configuration | * ZTE: (1,1,2) with omni
* HW: Up to 4 Tx/Rx
* QC: 2Rx / 1Tx
 |
| DL CSI measurement | * QC: One layer/ 1-port CSI-RS
* OPPO: Non-precoded/precoded according to CSI measurement (with codebook selection) and interference measurement
* OPPO: SU-CQI
* OPPO: For slot/non-slot: PMI, CQI: every [5] slot; RI: every [5] slot, CRI: every [5] slot
	+ Subband based
 |
| PRB bundling | * QC: Wideband
* OPPO: 4 PRB or wideband
 |
| Codeword (CW) | * QC: single CW
* OPPO: for 1-4 layers, CW1, for 5 layers or more, 2CW
 |
| Transmission scheme | * QC: One layer/ No MIMO
* OPPO: Closed loop SU-MIMO adaptation
 |
| Scheduler | * QC: PF
* Pana: To be reported by companies
 |
| Number of HARQ processes | * Pana: Up to 32
 |
| HARQ-ACK delay | * QC: [no HARQ, N+4]
* OPPO: Enabled or disabled
 |
| Retransmission delay | * QC: [no HARQ, N+4/N+8 + RTT]
* OPPO: Companies to report
 |
| Antenna gain | * Nk: -5.5dBi
* Others: use the value in M.2510 (0dBi)
 |
| Frame structure | * Oppo: FDD
 |
| PDCCH resource sharing | * OPPO: Consider in overhead calculation
 |
| Overhead | * OPPO: SS/PBCH block
	+ ([1 SS/PBCH block in every 20ms])
	+ CSI-RS, DMRS and TRS, CSI-IM (if used)
	+ PDCCH
* QC: PDCCH / SSB / CSI-RS for CM / DMRS / TRS/ PUCCH / DMRS / SRS
 |

**Proposal 4.1: RAN1 to discuss additional parameters for eMBB-s SLS taking the table above as starting point.**

## Q4.1: Please provide comments on proposal 4.1

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. |
| Panasonic | Agree. The assumptions should basically be based on TR38.821. It is not clear if parameters not defined in TR38.821 need to be agreed. To be reported by companies would be ok.  |
| Samsung | Fine with the proposals.  |
| Huawei/HiSilicon | AgreeOK to have RAN1 to further discuss and decide additional parameters for eMBB-s SLS taking the table above table and company inputs as starting point. |

# Connection density – mMTC-s (#9)

For the evaluation on connection density, the input from contributions (as well as documented in [2]) is to support both full buffer and non-full buffer evaluations. One issue brought up is how to compute the area for the connection density, since not all the beams in the evaluation have the same size:

**Proposal 5.1: For connection density evaluation, non-full buffer and full-buffer evaluations (as described in M.2412) are allowed.**

**Proposal 5.2: For computing the area for connection density, RAN1 to discuss whether to consider:**

* **Only the central beam**
* **All the beams**

**Proposal 5.3: For SLS to LLS metric, use “pre-processing SNR” as described in TR 37.910.**

## Q5.1: Please provide comments on proposals 5.1, 5.2 and 5.3

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. To compute the area of the central beam is preferred. |
| MediaTek | 5.1: Agree, but whether we apply the same 10 second packet delivery restriction as for IMT-2020 should be clarified. 5.2: The requirement says 500 UEs/km2. So does this mean we would only evaluate the connection density for central beam and then calculate the per km2 density from that? Would we then only drop UEs into the central beam?5.3: Looking at 37.901, pre-processing SINR includes assumptions on the small-scale modelling. We suggest to put this on hold and come back to it once we have agreed on the channel modelling aspects.  |
| Huawei/HiSilicon | Proposal 5.1: agreeProposal 5.2: for computing the area for connection density, RAN1 to consider all beams with necessary approximation (not including wrap-around beams). Proposal 5.3: agree |

For the LLS evaluations, RAN1 would need to agree on the parameters for eMTC, NB-IoT and NR (since all 3 technologies are to be evaluated for this KPI)

**Proposal 5.4: RAN1 to discuss the LLS parameters for NR, eMTC and NB-IoT, taking the following table as starting point.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | NB-IoT Uplink | eMTC Uplink | NR Uplink |
| Physical channel | NPUSCH | PUSCH | PUSCH |
| Simulation bandwidth | Single Tone |  |  |
| Number of users in simulation | 1 | 1 | 1 |
| Link-level Channel model | TBD |  |  |
| Antenna configuration at Satellite | 1Rx | 1Rx |  |
| Antenna configuration at UE | 1Tx | 1Tx |  |
| Transmission mode | SISO | SISO | SISO |
| Transmission rank | 1 | 1 | 1 |
| TBS | 256 | 256 | 256 |
| Modulation order | [BPSK-π/2, QPSK-π/4] |  |  |
| Number of Resource units | [2,3,4,5,6,8,10] |  |  |
| Number of repetition | [1,2,4,8,16] |  |  |
| Channel estimation | [LMMSE] |  |  |
| Channel coding scheme | Turbo code | Turbo code | LDPC |
| Doppler spread |  |  |  |

## Q5.2: Please provide comments on proposal 5.4

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. LOS channel model can be considered.  |
| MediaTek | For NB-IoT, we need to add the **Subcarrier Spacing**, e.g. 15kHz as baseline.Note that the radio configuration aspects are also covered in the SLS part, and from the original IMT-2020 parameters (we would also need to add (see R1-2303346):* **PUSCH scheduling Unit:** e.g. 1 tone for NB-IoT
* **Power control parameters**
* **UL DMRS configuration**
* **PRACH configuration:** for non-full buffer only
* **Duplex mode:** for eMTC (HD or FD)
 |
| Huawei/HiSilicon | Proposal 5.4: OK to take this table as starting point. |

# Reliability – HRC-s (#11)

For reliability evaluations, RAN1 should follow the approach in [1] which includes SLS followed by LLS. The SLS simulation assumptions should be the same as for “average spectral efficiency” and “5%-ile user spectral efficiency”, as described in [3].

**Proposal 6.1: For reliability evaluations, RAN1 to use “SLS followed by LLS”, using the same SLS simulation assumptions as in “average spectral efficiency”, and using pre-processing SINR as the SLS to LLS metric.**

**Proposal 6.2: For mobility evaluations, RAN1 to use discuss LLS parameters for NR, taking the following table as starting point:**

|  |  |  |
| --- | --- | --- |
|  | NR Uplink | NR Downlink |
| Physical channel | PUSCH | PDSCH |
| Simulation bandwidth |  |  |
| Number of users in simulation | 1 |  |
| Link-level Channel model |  |  |
| Antenna configuration at Satellite |  |  |
| Antenna configuration at UE |  |  |
| Transmission mode | SISO |  |
| Transmission rank | 1 |  |
| TBS |  |  |
| Modulation order |  |  |
| Number of Resource units |  |  |
| Number of repetition |  |  |
| Channel estimation |  |  |
| Channel coding scheme | LDPC |  |
| Doppler spread |  |  |

## Q6.1: Please provide comments on proposals 6.1 and 6.2

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. |
| Huawei/HiSilicon | Agree |

# Mobility – eMBB-s (#12)

For reliability evaluations, RAN1 should follow the same approach as in reliability (SLS to get SNR operating point, followed by LLS). For mobility, only uplink simulations are needed:

**Proposal 7.1: For mobility evaluations, RAN1 to use “SLS followed by LLS”, using the same SLS simulation assumptions as in “average spectral efficiency”, and using pre-processing SINR as the SLS to LLS metric.**

**Proposal 7.2: For mobility evaluations, RAN1 to use discuss LLS parameters for NR, taking the following table as starting point**

|  |  |
| --- | --- |
|  | NR Uplink |
| Physical channel | PUSCH |
| Simulation bandwidth |  |
| Number of users in simulation | 1 |
| Link-level Channel model |  |
| Antenna configuration at Satellite |  |
| Antenna configuration at UE |  |
| Transmission mode | SISO |
| Transmission rank | 1 |
| TBS |  |
| Modulation order |  |
| Number of Resource units |  |
| Number of repetition |  |
| Channel estimation |  |
| Channel coding scheme | LDPC |
| Doppler spread |  |

## Q7.1: Please provide comments on proposals 7.1 and 7.2

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Agree. |
| Huawei/HiSilicon | Agree |

# Annex - Contributions

|  |  |  |  |
| --- | --- | --- | --- |
| Tdoc# | Title | Company |  |
| [R1-2302384](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302384.zip) | Evaluation methodology of IMT-2020 satellite | Huawei, HiSilicon | ***Proposal 1:*** ***Satellite self-evaluation focuses on transparent payload only. If RAN can check and confirm regenerative payload be supported by Rel-17 specifications, then the evaluation results for transparent payload can be used as a reference for regenerative payload for ITU submission.******Proposal 2:*** ***The channel model in section 6 of TR 38.811 can be viewed as an adaptation for satellite evaluation on top of terrestrial evaluation and can be used for satellite self-evaluation.******Proposal 3:*** ***Reuse the wrap around mechanism in section 6.1.1.1 of TR 38.821 for satellite self-evaluation.******Proposal 4: The additional parameters listed in Table 3 are added on top of example parameters in section 8.2.3 of Report ITU-R M.2514 for Rural-eMBB-s evaluation.******Proposal 5: Companies are encouraged to provide calibration curves aligned with TR 38.821 calibration case 9 or case 10 when providing satellite self-evaluation results. Then there is no need for additional cross-company calibration.******Proposal 6: Both non-full buffer simulation and full-buffer simulation defined in section 7.1.3 of Report ITU-R M.2412 are used for satellite connection density evaluation, with the following adaptation to satellite self-evaluation:******- Traffic model for QoS calculation is defined in Table 1 in section 8.2.3 of Report ITU-R M.2514.******- Requirement for evaluation is defined in section 7.2.8 of Report ITU-R M.2514.******Proposal 7:*** ***The calculation method of pre-processing SINR from TR 37.910 is reused for system-level simulation followed by link-level simulation.******Proposal 8:*** ***Additional parameters listed in Table 5 are added on top of example parameters in section 8.2.3 of Report ITU-R M.2514 for Rural-mMTC-s evaluation.******Proposal 9: The evaluation methodology defined in section 7.1.4 of Report ITU-R*** [***M.2412***](https://www.itu.int/pub/R-REP-M.2412) ***is reused to evaluate mobility, with the same evaluation parameters and configurations selected for the evaluation of average spectral efficiency, and with speed of 250 km/h.******Proposal 10: The additional parameters listed in Table 3 are added on top of example parameters in section 8.2.3 of Report ITU-R M.2514 for Rural-HRC-s evaluation, as that for Rural-eMBB-s.******Proposal 11: For peak spectral efficiency assessment, the generic formula defined in TR 37.910 can be reused, and the highest coding rate, maximum modulation order and maximum number of layers need to take into consideration of the achievable values based on, e.g., link budget analysis of CNR.******Proposal 12: The effect of earth curvature on area calculation needs to be considered for evaluating area traffic capacity.******Proposal 13: Control plane latency, user plane latency and mobility interruption time should be discussed by RAN2.******Proposal 14: Energy efficiency should be discussed by RAN2.*** |
| [R1-2302435](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302435.zip) | Discussion on self-evaluation methodology for potential 3GPP submission of IMT-2020 Satellite Radio Interface Technology | Nokia, Nokia Shanghai Bell | **Proposal 1: The evaluation of the peak spectral efficiency considers a UE at nadir and in LOS conditions without presence of interference for the relevant satellite deployment cases.****Proposal 2: The evaluation of the peak data rate considers a UE at nadir and in LOS conditions for the relevant satellite deployment cases.****Proposal 3: The evaluation of the control and user plane latencies should focus on LEO scenarios.****Proposal 4: The evaluation of the mobility interruption time should be based on cells from the same gNB or co-located gNBs and LEO scenario assumptions.****Proposal 5: Evaluation assumptions should include the realistic UE handset antenna gain of -5.5 dB** **Proposal 6: The scenarios are limited to transparent architecture without ISL.****Proposal 7: RAN1 to decide that the eMBB-s simulations focus on LEO600, Set-1 and handheld UEs.****Proposal 8: Connection density for eMTC should focus on the maximum density, limited by the RACH capacity.****Proposal 9: The evaluation should focus on handheld UEs with the assumptions from 38.821 Table 6.1.1.1-3.** **Proposal 10: Under the evaluation it may be considered to assume a UE with full availability of UE capabilities such as e.g. support of 32 HARQ processes.****Proposal 11: RAN1 to discuss whether 100% LOS can be considered or whether a model like in [5] should be included in the evaluation.** |
| [R1-2302693](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302693.zip) | Considerations on evaluation methodology for IMT2020 Satellite RIT | CATT,CAICT | **Proposal 1: For test environment and evaluation configurations, the following should be considered in evaluation of IMT-2020 SRI.*** **A Rural test environment;**
* **The GEO and LEO orbit;**
* **The handheld, MTD (IOT) and directional terminals.**

**Proposal 2: For NR NTN evaluation, the parameters of satellites and configurations of terminals described in TR 38.821 should be taken as baseline. And for IOT NTN evaluation, the parameters described in TR 36.763 should be treated as baseline. Moreover, Rel-18 NTN features can be evaluated if necessary.** **Proposal 3: Support the assessment methods mentioned in Report ITU-R M.2514 as baseline.** |
| [R1-2302774](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302774.zip) | Discussion on self-evaluation methodology for IMT-2020 satellite radio interface | OPPO | ***Proposal 1: Rel-17 NR NTN*** ***on single-band is considered as a starting point for eMBB-s evaluation towards IMT-2020 submission.******Proposal 2: Performance requirements in Table 2 should be considered for eMBB-s evaluation towards IMT-2020 submission.******Proposal 3: Evaluation parameters in TR38.821, Table 3 and Table 4 can be considered as a starting point for eMBB-s evaluation towards IMT-2020 submission.******Proposal 4: Rel-17 IoT NTN*** ***is considered as a starting point for mMTC-s evaluation towards IMT-2020 submission.******Proposal 5: Performance requirement in Table 6 should be considered for mMTC-s evaluation towards IMT-2020 submission.******Proposal 6: The procedure and delay modeling for NB-IoT and eMTC with needed adaptions can be considered as a starting point for mMTC-s evaluation towards IMT-2020 submission.******Proposal 7: Rel-17 NR NTN*** ***on single-band is considered as a starting point for HRC-s evaluation towards IMT-2020 submission.******Proposal 8: Performance requirement in Table 8 should be considered for HRC-s evaluation towards IMT-2020 submission.******Proposal 9: The evaluation method for URLLC reliability with enhancements can be considered as a starting point for HRC-s evaluation towards IMT-2020 submission.*** |
| [R1-2302873](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302873.zip) | Assumptions for the Self-Evaluation for the Satellite Component of IMT-2020 | Ericsson, Qualcomm, Thales | 1. The evaluation assumptions in the enclosed tables are endorsed.
 |
| [R1-2303157](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303157.zip) | On evaluation methodology for IMT-2020 Satellite | Samsung | **Observation 1: The minimum requirements for peak data rate and spectral efficiency can be met when assuming proper configuration(s).** **Observation 2: The DL minimum requirements for peak data rate and spectral efficiency can be met if at least 22 MCS level can be achieved in NTN with 30MHz when assuming that the number of carriers and layers are 1.****Observation 3: The UL minimum requirements for peak data rate and spectral efficiency can be met if at least 13 MCS level can be achieved in NTN with 1.44MHz when assuming that the number of carriers and layers are 1.** |
| [R1-2303299](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303299.zip) | Discussion on the evaluation methodology of Self-Evaluation towards the 3GPP submission of a IMT-2020 Satellite | ZTE | ***Proposal 1:*** *The test environment is Rural for all usage scenarios, and channel model for Rural in sector 6.6.6 and 6.6.7.2 in [3] can be used.****Proposal 2:*** *Evaluation for handheld terminals and S-band should be considered as the baseline.****Proposal 3:*** *The assumption listed in Table 1-4 should be considered as the baseline of parameters for self-evaluation.****Proposal 4:*** *For peak data rate and peak spectral efficiency evaluation, VSAT and Ka-band with up to 400 MHz should be considered. For other characteristics, handheld and S-band with up to 30 MHz should be considered.* |
| [R1-2303346](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303346.zip) | Evaluation methodology for IMT-2020 satellite | MediaTek Inc. | **Observation 1: While many parameters seem to be reusable from past evaluations, further confirmation is needed. In particular, the “channel modelling” details need further discussion.****Proposal 1: Consider the IoT NTN Connection Density parameters for “System-level” simulation (section 2.2) and “Link-level” simulations (section 2.3) in this document as a starting point for further discussion and refinement during RAN1#112bis-e.****Proposal 2: Consider the Connection Density simulation process in this document as a starting point for IoT NTN Connection Density.** |
| [R1-2303619](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303619.zip) | eMBB Spectral Efficiency SLS parameters and assumptions | Qualcomm Incorporated, Thales | [Proposal 1 The evaluation parameters and assumptions described in sec 2.1 and 2.2 should be endorsed, as baseline for the simulation of eMBB spectral efficiency TPRs for NR-NTN IMT-2020 self-evaluation.](#_Toc131586922) |
| [R1-2303626](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303626.zip) | Discussion on simulation assumptions for self-evaluation of IMT-2020 satellite radio interface technology | Panasonic | **Proposal 1: Evaluation with handheld terminal should be prioritized.** **Proposal 2: Frequency band 2GHz and LEO 600km should be assumed for the evaluation.** **Proposal 3: Satellite parameter set 1 in Table 6.1.1.1-1 of TR38.821 should be used for the evaluation.****Proposal 4: handheld terminal characteristics defined in Table 6.1.1.1-3 of TR38.821 should be used for the evaluation.** **Proposal 5: System level simulation assumptions defined in TR38.821 should be used for the evaluation. Full buffer traffic should be considered in order to satisfy the average spectral efficiency requirement.**  |

# Annex – Study item objectives

The contents of the “objective” section of the SID ([RP-230736](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_99/Docs/RP-230736.zip)) is pasted below for quick reference:

This study item will provide the description of the self-evaluation results towards IMT-2020 submission to ITU-R WP 4B against the technical performance requirements defined by Report ITU-R M.2514, using the evaluation criteria defined in the report, and complete the related compliance template and description templates. The candidate IMT-2020 RIT/SRIT(s) submission by 3GPP based on Rel-17 NTN (including both NR NTN and IoT NTN), will be evaluated and described as part of the study.

Detailed objectives of this study item include:

1. Complete all required submission templates as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc]
2. Provide self-evaluation results against technical performance requirements for eMBB-s as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2], including
	* Peak data rate
	* Peak spectral efficiency
	* User experienced data rate
	* 5th percentile user spectral efficiency
	* Average spectral efficiency
	* Area traffic capacity
	* Latency, including user plane latency and control plane latency
	* Energy efficiency, including both network and device
	* Mobility
	* Mobility interruption time

1. Provide self-evaluation results against technical performance requirements for mMTC-s as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2], including
	* Connection density
2. Provide self-evaluation results against technical performance requirements for HRC-s as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2], including
	* Reliability
3. Provide self-evaluation results for other requirements (including bandwidth) as defined in Report ITU-R M.2514 [RAN ITU-R Ad-Hoc, RAN1, RAN2, RAN4]

IoT NTN will at least target self-evaluation against bullets c) and e) technical requirements, and NR NTN will target self-evaluation against all technical requirements (in bullets b) to e)).

This study shall start with evaluating features that are supported by Rel-17 NTN (NR NTN + IoT NTN), as relevant for the above aspects.

The study will produce documents used for the 3GPP IMT-2020 submission to ITU-R based on the ITU-R templates, including a description of the self-evaluation results in a new TR, 37.9xx, created by this study.

This study shall have (an) appropriate RIT/SRIT(s) adoption to demonstrate that 3GPP’s candidate IMT-2020 RIT/SRIT fulfils the required condition defined in Step 2, 6, and 7 in Document IMT-2020-SAT/2. The decision to make a submission as RIT(s) or SRIT(s) is outside the scope of this study but is needed for the completion of the study. Such discussion shall be taken by TSG RAN plenary directly.

The study will be done in coordination with the RAN ITU-R Ad-Hoc group. The study can start in the working groups after RAN#99, to discuss initial self-evaluation time-plan, TR template, evaluation assumption, etc. The work in the working groups should be limited in time and using email discussion to a large extent, as possible. The work split between RAN1 and RAN2 will initially follow the split adopted for the previous 5G IMT-2020 submission. The study aims to have a final submission package ready by RAN#102, that is before ITU-R WP4B submission deadline (end of December 2023).

# Annex – References

[1] Report ITU-R M.2514 (09/2022) - Vision, requirements and evaluation guidelines for satellite radio interface(s) of IMT-2020 – [PDF](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2514-2022-PDF-E.pdf), [Word](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2514-2022-MSW-E.docx)

[2] RP-230736 - New SID: Study on Self-Evaluation towards the 3GPP submission of an IMT-2020 Satellite Radio Interface Technology, Ericsson, Qualcomm, Thales, MediaTek Inc.

[3] Report ITU-R M.2412 (10/2017) - Guidelines for evaluation of radio interface technologies for IMT-2020 – [PDF](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2412-2017-PDF-E.pdf), [Word](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2412-2017-MSW-E.docx)