3GPP TSG-RAN WG1 Meeting #112bis R1-230xxxx

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

**Agenda item:** 9.15.1

**Source:** Moderator (Qualcomm)

**Title:** Feature lead summary #2 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

For proposal 2.1, these main received comments are as follows:

* Thales:
  + Bandwidth should be 30MHz for the evaluations:
    - [Moderator comment] This needs to be separately discussed in Section 3. Right now the note just says “may”, so I kept it unchanged.
  + RAN1 should be involved in the evaluation of UP/CP latency.
    - [Moderator comment] Removed “if needed” below. I think it is the common view that the heavy lifting on this requirement should be done by RAN2, RAN1 may just need to provide some parameters.

## **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) (NOTE 1)** |
| **#2** | **Peak spectral efficiency** | **Analytical** | **§ 7.2.2** | **eMBB-s** | **Yes (modulation, #layers, etc) (NOTE 1)** |
| #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 | NOTE 2 |
| #8 | Control plane latency | Analytical and Inspection | § 7.2.7.2 | eMBB-s | NOTE 2 |
| **#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 | NOTE 2 |
| #14 | Bandwidth | Inspection | § 7.2.13 | N/A | No |
| NOTE 1: How to determine the appropriate parameters (MCS, bandwidth, etc.) may be subject to evaluations.  NOTE 2: To be evaluated by RAN2. RAN2 may need to develop assumptions for these metrics. RAN1 can provide input on aspects such as UE and gNB processing time. | | | | | |

For proposal 2.2, there were the following comments:

* Huawei: Remove directional terminals.
* Ericsson: Scenarios in FFS are out of scope of ITU, except for MTD.
* Nokia: Dislike part of the elements of the FFS
* CATT: Regenerative payload is Rel-19
* MediaTek: Would like to keep MTD

Probably we need some interactive discussion for this, but based on the comments the only scenario that does not seem to be controversial is the MTD (which is also described in M.2514). Therefore, the following modification 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 (reusing the evaluations for handheld)**

For proposal 2.3 and 2.4, the following comments were made:

* On NOTE 1 for P2.3:
  + Huawei: NR NTN can also use channels of 180kHz
  + Ericsson: Maximum BW for NB-IoT is 16 narrowbands

This issue seems to be a minor wording issue that hopefully will be easily resolved. The fact that the channel bandwidth is 30MHz does not imply that UEs need to be scheduled with 30MHz for NR. On the other hand, the maximum bandwidth for eMTC and NB-IoT are 1040 and 180kHz, respectively, hence the note. NOTE2 is added, trying to address Huawei’s comment:

## **Proposal 2.3: The following tables (Table 1 in M.2514-0 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 beams  Influence 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 (NOTE 2) | 30 MHz | 30 MHz (NOTE 1) | 30 MHz |
| 3 dB beam width | 4.41 degrees | | |
| Satellite EIRP density | 34 dBW/MHz | | |
| 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/device  or  1 message/2 hours/device  For non-full buffer system level simulation: Packet arrival follows Poisson arrival process  Full buffer system level simulation can also be applied. | Full buffer |
| UE antenna height | 1.5 m | | |
| NOTE 1: For mMTC evaluation using NTN IOT, multiple narrow channels (e.g. 180kHz for NB-IoT) may be used, using up to 30MHz of total bandwidth.  NOTE 2: In all cases, the scheduled bandwidth can be smaller than the channel bandwidth | | | |

|  |  |
| --- | --- |
| Terminal types | Handheld |
| Examples | Handset, smartphone |
| Antenna type and configuration | Omni-directional |
| Polarisation | Linear: ±45°X-pol (NOTE 1) |
| Antenna gain (dBi) | 0 |
| Antenna temperature (K) | 290 |
| Noise figure (dB) | 7 |
| Tx transmit power | 200 mW (23 dBm) |
| NOTE 1: For NTN IOT, single linearly polarized antenna is assumed. | |

For proposal 2.4, the only comment is from Nokia regarding interruptions due to mobility with FRF3. This is separately discussed in Section 6, so no change to the proposal is made.

## **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 (declared by proponent) |
| Propagation conditions | FFS: Whether 100% LOS probability is assumed or not |
| Large scale Channel model | At least for LOS conditions, large scale model of Section 6.6 in 38.811  FFS: Whether LOS probability is assumed 100%.  FFS: Whether time-correlated model for LOS/NLOS conditions is needed (if LOS probability is smaller than 100%) |
| 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 |

## Q2.1: Please provide comments on updated proposals 2.1, 2.2 and 2.3

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | For regenerative satellite in Proposal 2.2, I would like to clarify that we are not proposing to evaluate regenerative satellite. I agree with comments from Ericsson that evaluating with regenerative payload wouldn’t make a difference for most requirements. The evaluation for transparent payload can actually represent the lower-bound performance of regenerative satellite. So if RAN can confirm regenerative satellite can already be supported with Rel-17, regenerative satellite can be added in the ITU submission without additional evaluation.  For Proposal 2.3. Thanks moderator for adding note 2 to address our concern. Note 2 is rather straightforward as scheduling is anyway not necessarily to occupy the whole bandwidth. Our concern is mainly the applicability of Note 1. In our view, the applicability of Note 1 should also include NR. If one looks at 37.910 evaluation for connection density, for full buffer case, all technologies (NR, NB-IoT and eMTC) use 180 KHz to fulfill ITU requirement. The evaluation for NR NTN should also take similar approach as that in 37.910. this is also related to our discussion here in Proposal 5.6 |
| Nokia, Nokia Shanghai Bell | Proposal 2.1: OK  Proposal 2.2: OK  Proposal 2.3: OK  Proposal 2.4: OK |

On fast fading and LOS probability:

* Panasonic, Huawei, CATT: Assume 100% LOS
* Ericsson: Open to simplifications in the channel model.
* Nokia: If we go for less than 100% LOS, we need a model for time-correlation of LOS/NLOS.
* Reuse the frequency selective channel in 38.821 (Table 6.1.1.1-7): Panasonic, Huawei, CATT
* MediaTek still needs to check.

Given the above, the following proposal is made (although we may need to discuss offline, especially on the small scale fading):

## **Proposal 2.5: The following is assumed in RAN1 evaluations:**

* **LOS probability of 100%**
* **Small scale fading is modelled as in 38.821 (Table 6.1.1.1-7).**

## Q2.2: Please provide comments on proposal 2.5

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | OK |
| Nokia, Nokia Shanghai Bell | OK |

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

Proposals 3.1 and 3.2 included for completeness

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

## **Proposal 3.2: The peak data rate is calculated as , assuming single carrier operation.**

Regarding how to choose these parameters, the following input is received:

* Use 90 degree elevation, no shadowing / scintillation / atmospheric losses: Panasonic, [Ericsson], Huawei
* Do not consider VSAT: Huawei, Nokia, Ericsson
* Use conservative values: Ericsson (in previous round), Huawei (plus proof that it is achievable).
* Qualcomm: Even with 0 margin, it may not be possible to meet the requirements (UL SNR with 1.04MHz and zero losses is 5.51dB)

Based on the above, the following proposal is made:

## **Proposal 3.3: For spectral efficiency and peak data rate parameters:**

* **The parameters are chosen based on “ideal conditions”**
* **Companies to provide in RAN1#113 realistic parameters, declaring the assumptions and evaluations leading to those parameters.**

## Q3.1: Please provide comments on proposal 3.3

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | OK with the proposal.  Seems there is concern whether requirement for uplink can be achieved or not. For uplink, if 8 PRB is used and polarization loss is assumed to be 0 dB (following 38.821 Table 6.1.3.3-1), one can get CNR of 7.08 dB. With this CNR, MCS = 13 is feasible. Then peak spectrum efficiency of 1.5 bps/Hz and peak data rate of 2 Mbps can be supported.   |  |  | | --- | --- | | Transmission mode | UL | | Frequency [GHz] | 2.00 | | Target elevation angle [deg] | 90 | | Distance [km] | 600 | | TX: EIRP [dBm] | 23.00 | | RX: G/T [dB/T] | 1.10 | | Bandwidth [MHz] | 1.44 | | Free space path loss [dB] | 154.03 | | Atmospheric loss [dB] | 0.00 | | Shadow fading margin [dB] | 0.00 | | Scintillation Loss [dB] | 0.00 | | Polarization loss [dB] | 0.00 | | Additional losses [dB] | 0.00 | | CNR [dB] | 7.08 | |
| Nokia, Nokia Shanghai Bell | In general OK, but the term “ideal conditions” is a bit unclear. For instance, would ideal conditions still put restrictions to the maximum MCS that can be used? Or would this allow for infinite UL tx power? |

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

Proposal 4.1 seems stable based on the inputs, the discussion should now focus on the specific parameters. Proposal 4.1 is pasted below for completeness. The table for collecting parameters is kept as in the previous version (input copy/pasted).

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

* **NOTE: The objective is to define a set of default parameters to be used by companies. If companies follow a different set from the default set, they can declare it and the results will be captured in the TR.**

|  |  |
| --- | --- |
| 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.2514 (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 |

## Q4.1: Please provide input on the default parameters

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | CSI feedback | Frequency offset | Frequency drift | UE speed | UE antenna configuration | DL CSI measurement |
| Panasonic | 20ms periodicity | 0 ppm (perfect post-compensation) or 0.1ppm | 0 (perfect pre-compensation) | 3km/h | (1,1,2) with omni | CQI only |
| Ericsson | Rel-15, as in 38.821 | 0.1 ppm, as in 38.821 | as in 38.821 | 3 km/h | (1,1,2) with omni | 1 layer / 1-port CSI-RS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | PRB bundling | Codeword (CW) | Transmission scheme | Scheduler | Number of HARQ processes | HARQ-ACK delay |
| Panasonic |  |  | No MIMO | PF | Up to 32 | N+4 |
| Ericsson | wideband | single CW | one layer | to be reported | up to 32 | N+4 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Retransmission delay | Antenna gain | Frame structure | PDCCH resource sharing | Overhead |  |
| Panasonic | Larger than RTT | 0dBi | FDD |  |  |  |
| Ericsson | to be reported | 0 dBi | FDD |  | same as for peak data rate calculations |  |
| Nokia, Nokia Shanghai Bell |  |  | **FDD** |  |  |  |

# Connection density – mMTC-s (#9)

For proposals 5.1, 5.2 and 5.3, the only comment was whether we should specify the maximum delay. It was clarified that this clarification may be needed because it is not specified in M.2514. Therefore, the 3 proposals seem stable.

## **Proposal 5.1: For connection density evaluation, non-full buffer and full-buffer evaluations (as described in M.2412) are allowed. The maximum transmission delay is 10 seconds.**

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

* **Only the central beam**
* **All the beams (excluding wrap-around beams)**

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

**NOTE: If small scale fading is not considered for evaluation, the “pre-processing SNR” equation may be modified accordingly (e.g. by setting , and )**

Regarding what beams to use for the evaluation of connection density, here are the views:

* Ericsson, Huawei: Use central 7 beams for statistic collection
* Nokia, Thales, MTK: Central beam only.
* Qualcomm: Central beam or non-wrap around beams (no preference).

Huawei also brought up the issue of how the overall simulation should be performed. Companies are encouraged to comment further on these matters.

This would need further discussion (likely in the offline session).

## Q5.1: Please provide comments on : - whether the central beam only, or all the beams (excluding wrap-around beams) should be considered for the evaluation of connection density - Any comments on general evaluation methodology

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | According to M.2514 Table 1, “Influence of adjacent beam interference on the results should be accounted for, e.g. by collecting statistics only from the **inner spot beams**”. In 38.821 Figure 6.1.1.1-1, inner beams refers to inner-19 beams, not including the other wrap-around beams. So we suggest to follow M.2514 and 38.821 to collect statistics from inner-19 spot beams. |
| Nokia, Nokia Shanghai Bell | We propose to consider central beam only, and we see think that is the most important in evaluation in the low frequency of FDD. |

Proposal 5.4 is modified to include SCS of 15kHz, in view with MediaTek’s comment:

## **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 |  |  |
| SCS | 15kHz | 15kHz | 15kHz |
| 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 |  |  |  |
| UL DMRS config |  |  |  |

For proposal 5.5, several comments were received:

* Huawei: The bandwidth to fulfil the requirement should be reported, so 180kHz x N may also apply to NR. For eMTC, we can also reuse 180kHz x N.
  + [Moderator comment] Understood, I tried to clarify in the table. Also, added proposal 5.6 clarifying that the simulation bandwidth for NR is also 180kHz x N, and that the value of N should be reported together with the connection density.

## **Proposal 5.5: RAN1 to discuss additional SLS parameters for eMTC and NB-IoT, taking the following table as starting point:**

|  |  |  |
| --- | --- | --- |
| Radio Access | NB-IoT | eMTC |
| Data transmission procedure (for non-full buffer only) | RRC resume, data after msg5, RRC suspend | RRC resume, data after msg5, RRC suspend |
| Waveform | DL: OFDMA UL: SC-FDMA | DL: OFDMA UL: SC-FDMA |
| Duplexing | HD-FDD | HD-FDD |
| Numerology | 15kHz | 15kHz |
| Bandwidth | B = 180kHz x N  (Bmax = 30MHz  *TBD: if scaling by 200kHz needed*) | B = 180kHz x M  (Bmax = 30MHz  *TBD: if scaling by 1.4MHz needed*) |
| PRACH configuration (for non-full buffer only) | TBD | TBD |
| PUSCH Scheduling Unit | Single tone | 180kHz |
| Power control parameter | TBD | TBD |
| UL DMRS | 2 symbols per 14 OFDM symbols | |
| UEs coverage distribution | TBD | |
| UE mobility model | Stationary | |
| Scheduler | PF | |

**Proposal 5.6: For mMTC-s connection density evaluations:**

* **The bandwidth is B = 180kHz x N for NB-IoT, eMTC and NR.**
* **Companies are to report the value of N together with the achieved connection density.**

## Q5.2: Please provide comments on proposal 5.4, 5.5 and 5.6

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | OK at least for full buffer case. |
| Nokia, Nokia Shanghai Bell | Proposal 5.4: OK  Proposal 5.5: OK  Proposal 5.6: OK |

# Reliability – HRC-s (#11)

For this section, no major comments have been received in the previous round (except for a typo correction by Huawei). The next step would be to try to agree on a set of parameters.

## **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.**

**FFS: Whether and how interruptions (e.g. due to IDC or measurements) are taken into account in the reliability evaluations.**

## **Proposal 6.2: For reliability evaluations, RAN1 to 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 |  |  |
| DMRS config |  |  |
| Antenna configuration at Satellite |  |  |
| Antenna configuration at UE |  |  |
| Transmission mode | SISO |  |
| Transmission rank | 1 |  |
| TBS |  |  |
| Modulation order |  |  |
| Number of repetition |  |  |
| Channel estimation |  |  |
| Channel coding scheme | LDPC |  |
| Doppler spread |  |  |

## Q6.1: Please provide comments on the parameters to be used for uplink and downlink LSS in HRC-s

**Downlink:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Simulation bandwidth | DMRS config | Link-level Channel model | Antenna configuration at Satellite | Antenna configuration at UE | Transmission mode |
| Company 1 |  |  |  |  |  |  |
| Company 2 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Transmission rank | TBS | Modulation order | Number of repetition | Doppler spread |
| Company 1 |  |  |  |  |  |
| Company 2 |  |  |  |  |  |

**Uplink:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Simulation bandwidth | DMRS config | Link-level Channel model | Antenna configuration at Satellite | Antenna configuration at UE | Transmission mode |
| Company 1 |  |  |  |  |  |  |
| Company 2 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Transmission rank | TBS | Modulation order | Number of repetition | Doppler spread |
| Company 1 |  |  |  |  |  |
| Company 2 |  |  |  |  |  |

# Mobility – eMBB-s (#12)

The proposals seem agreeable, the next step would be to agree on a set of parameters:

## **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 |  |
| DMRS config |  |
| Antenna configuration at Satellite |  |
| Antenna configuration at UE |  |
| Transmission mode | SISO |
| Transmission rank | 1 |
| TBS |  |
| Modulation order |  |
| Number of repetition |  |
| Channel estimation |  |
| Channel coding scheme | LDPC |
| Doppler spread |  |

## Q7.1: Please provide comments on the parameters to be used for uplink eMBB-s mobility evaluations

**Uplink:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Simulation bandwidth | Number of users in simulation | Link-level Channel model | Antenna configuration at Satellite | Antenna configuration at UE | Transmission mode |
| Company 1 |  |  |  |  |  |  |
| Company 2 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Transmission rank | TBS | Modulation order | Number of repetition | Doppler spread |
| Company 1 |  |  |  |  |  |
| Company 2 |  |  |  |  |  |

# [CLOSED] Round 2

## General considerations and parameters

For proposal 2.1in the first round, the following comments were received (only comments that are directly actionable are mentioned, comments directed to FFS are not included):

* Samsung:
  + We should consider BS processing delay and UE processing delay for CP and UP latency.
    - [Moderator comment] Addressed with NOTE 2 (note that NOTE 2 also addresses Huawei’s comment)
* Huawei:
  + For deciding the “ideal conditions”, we may need to perform simulations to decide on corresponding parameters.
    - [Moderator comment] Addressed with NOTE 1
  + On UP/CP latency, energy efficiency and mobility interruption, these would be up to RAN2 and may need some assumptions.
    - [Moderator comment] Addressed with NOTE 2 (note that NOTE 2 also addresses Samsung’s comment)

Updated proposal 2.1 tries to accommodate the input from companies. Note that the “may” in NOTE 1 is just to reflect the dependency on Proposal 3.3, it does not mean that we will need to do the evaluations.

### **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) (NOTE 1)** |
| **#2** | **Peak spectral efficiency** | **Analytical** | **§ 7.2.2** | **eMBB-s** | **Yes (modulation, #layers, etc) (NOTE 1)** |
| #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 | NOTE 2 |
| #8 | Control plane latency | Analytical and Inspection | § 7.2.7.2 | eMBB-s | NOTE 2 |
| **#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 | NOTE 2 |
| #14 | Bandwidth | Inspection | § 7.2.13 | N/A | No |
| NOTE 1: How to determine the appropriate parameters (MCS, bandwidth, etc.) may be subject to evaluations.  NOTE 2: To be evaluated by RAN2. RAN2 may need to develop assumptions for these metrics. If needed, RAN1 can provide input on aspects such as UE and gNB processing time. | | | | | |

For proposal 2.2, most of the actions are directed to the FFS part:

* Huawei:
  + Consider regenerative payload
    - [Moderator comment] Added to FFS
  + Remove KA band with VSAT
    - [Moderator comment] Removed due to multiple comments
* Thales, Nokia, Huawei
  + Downprioritize Ka band (not in Rel-17, evaluation focused on handheld, RAN4 may not finish before submission)
    - [Moderator comment] Although this was an FFS, I will remove it due to several companies proposing it. If there is consensus in a future meeting, we can reconsider adding Ka band + VSAT

The updated proposal 2.2 is as follows:

### **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 regenerative payload.**

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

|  |  |
| --- | --- |
| Company | Comment |
| Panasonic | Fine with proposals 2.1 and 2.2. |
| Huawei/HiSilicon | Proposal 2.1: Agree  Proposal 2.2: Our reading of company responses and moderator summary is that directional terminals should also be removed from FFS, while in Proposal 2.2, directional terminals are still kept. Suggest to remove it together with Ka band. |
| Ericsson | P2.1: Ok.  P2.2: The scenarios in FFS are still out of scope of the ITU requirements which is the task at hand. Evaluating with regenerative payload wouldn’t make a difference for most requirements, apart from the latencies which will be handled by RAN2. The MTD characteristics in M.2514 are allowed to be chosen identical with the handheld ones and hence separate evaluations are not needed.. |
| Nokia, Nokia Shanghai Bell | Proposal 2.1: OK  Proposal 2.2: As stated in first round we are fine with the fundamentals of the proposal, but we dislike at least parts of the elements of the FFS (like directional terminals – and as mentioned in the GTW the regenerative would only reduce the lower layer latencies while when considering the core network we would still see the additional latency for the user data to “reach the ground”. |
| CATT | Proposal 2.1: Agree  Proposal 2.2: for regenerative payload, it might belong to Rel-19 feature, so it can be removed. For other FFS part, it is fine to us. |
| Thales | On Proposal 2.1: Regarding Note 1, we think to satisfy ITU-R 4B requirements the bandwidth in S-band should be 30MHz. So, bandwidth can be removed from the text between the brackets.  Regarding Note 2: We think that RAN1 will be also involved in the evaluation of User plane latency/control plane Latency: because the DL user plane procedure for NR NTN includes also RAN1 related aspects such as :   * UE and BS processing delays, * DL Frame alignment (transmission alignment) * UL frame alignment (transmission alignment): * HARQ retransmission: Impact of disabled HARQ, Support of 32 processes   In our view, the Note should be revised as: To be evaluated also by RAN2.  We think that for Mobility interruption time only Beam level mobility should be considered to satisfy the requirement. |
| Qualcomm | Regarding the “bandwidth” as commented by Thales, we think for uplink we may need to use less than 30MHz - for 30MHz the SNR without any losses (only polarization loss) would be -9dB. |
| MediaTek | Proposal 2.1: OK  Proposal 2.2: OK but agree with Ericsson comment on MTD UEs, as stated in 1st round (and described in our document). |

For proposal 2.3, the following comments were received:

* MediaTek:
  + For channel bandwidth, we can use multiple narrow channels to create the capacity (30MHz may be an upper bound)
    - [Moderator comment] I understand this is only for mMTC, added NOTE 1 to address this matter
  + The description in the table for the traffic model refers only to non-full buffer, clarify that full buffer can be applied
    - [Moderator comment] Although the text already has “for non full buffer system level simulation”, I slightly reworded the table to make it more clear, and mentioned explicitly that full buffer is also allowed.
  + Terminal types: For IOT NTN we have 1Tx / 1Rx
    - [Moderator comment] Clarified
* Panasonic:
  + Missing value of EIRP density
    - [Moderator comment] Added, apologies for the copy/paste error.
* Huawei:
  + Typo in M.2510
    - [Moderator comment] Corrected

### **Proposal 2.3: The following tables (Table 1 in M.2514-0 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 beams  Influence 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 (NOTE 1) | 30 MHz |
| 3 dB beam width | 4.41 degrees | | |
| Satellite EIRP density | 34 dBW/MHz | | |
| 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/device  or  1 message/2 hours/device  For non-full buffer system level simulation: Packet arrival follows Poisson arrival process  Full buffer system level simulation can also be applied. | Full buffer |
| UE antenna height | 1.5 m | | |
| NOTE 1: For mMTC evaluation using NTN IOT, multiple narrow channels (e.g. 180kHz for NB-IoT) may be used, using up to 30MHz of total bandwidth. | | | |

|  |  |
| --- | --- |
| Terminal types | Handheld |
| Examples | Handset, smartphone |
| Antenna type and configuration | Omni-directional |
| Polarisation | Linear: ±45°X-pol (NOTE 1) |
| Antenna gain (dBi) | 0 |
| Antenna temperature (K) | 290 |
| Noise figure (dB) | 7 |
| Tx transmit power | 200 mW (23 dBm) |
| NOTE 1: For NTN IOT, single linearly polarized antenna is assumed. | |

For proposal 2.4, the following comments were received. There are some items for further discussion

* ZTE:
  + Focus only on LOS
* MediaTek:
  + Is the intention that each company selects FRF1 or 3?
    - [Moderator comment] Yes, clarified.
  + LOS only may be OK
  + Channel model may be simplified for NTN IOT
* Huawei:
  + Clarify the section in “Large scale channel model”
    - [Moderator comment] Clarified
  + If we point to section 6.6, we don’t need to discuss LOS probability since it is modelled
    - [Moderator comment] Let’s keep this FFS for this round, I will create a separate question for this matter
  + For small scale, suggest to point to Section 6.7.1 / 6.7.2 in 38.811
    - [Moderator comment] Let’s keep this TBD, I’ll create a separate proposal for this.
* Thales:
  + Agree on 100% LOS probability
* Nokia:
  + Depending on propagation conditions we may need to select a different large scale channel model. Keep FFS for now
    - [Moderator comment] Added an FFS reflecting your comment, and clarified that at least for LOS conditions we use the large scale model of 38.811.

Updated proposal 2.4 is found below:

### **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 (declared by proponent) |
| Propagation conditions | FFS: Whether 100% LOS probability is assumed or not |
| Large scale Channel model | At least for LOS conditions, large scale model of Section 6.6 in 38.811  FFS: Whether LOS probability is assumed 100%.  FFS: Whether time-correlated model for LOS/NLOS conditions is needed (if LOS probability is smaller than 100%) |
| 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 |
| Panasonic | Fine with proposals 2.3 and 2.4. |
| Huawei/HiSilicon | For proposal 2.3, NOTE 1 should not be limited to IoT NTN, it should apply for NR NTN as well. We suggest to modify NOTE 1 as below:  NOTE 1: For Rural-mMTC-s evaluation (including both NR NTN and IoT NTN), multiple narrow channels (e.g. 180kHz) may be used, may using up to 30 MHz of total bandwidth if needed.  Reason:  According to M.2512, principles in M.2412 should be reused for connection density evaluation. M.2412 uses limited bandwidth (NOT the full available bandwidth) to evaluate the performance, and the simulation bandwidth used to fulfil the requirement is requested to be reported. As a results, in TR37.910 Section 7.1, only limited bandwidth starting from 180 KHz is used for NR, NB-IoT and eMTC. |
| Ericsson | P2.3: Ok.The maximum BW for NB-IoT is 16 narrowbands of 180 kHz = 2.88 MHz which should meet the requirements still.  P2.4: Ok. |
| Nokia, Nokia Shanghai Bell | Proposal 2.3: If majority of companies insists on having unrealistic assumptions for UE antenna gain, we would be willing to compromise. But companies should also acknowledge that the results may not be representative of reality.  Proposal 2.4: Companies should be aware that introducing frequency reuse factor larger than 1 would potentially impact the reliability conditions, as the UE may at times be forced to do inter-frequency measurements to scan for neighbours. |
| CATT | Fine with proposals 2.3 and 2.4. |
| Thales | Ok with proposals 2.3 and 2.4 |
| MediaTek | Fine with proposals 2.3 and 2.4.  To Ericsson, we don’t believe there needs to be restriction to 16 channels, as it would only be for a Connection Density (capacity) scenario.  To Huawei, ok to discuss your Note1 update further (not sure I fully understood it all though). |

### Q2.3: Please provide comments on the following issues:

* Whether 100% LOS probability should be assumed.
* Whether and how small scale fading should be modelled

|  |  |
| --- | --- |
| Company | Comment |
| Panasonic | We prefer 100% LOS probability. Necessity of time-correlated model for LOS/NLOS is not clear. “Coin flipping” would be sufficient even if <100% LOS probability.  Regarding small scale fading, as described in Table 6.1.1.1-7 of TR38.821, Frequency selective channel model listed in TR38.811 can be used. |
| Huawei/HiSilicon | Considering that 38.821 already assumes 100% LOS probability and M.2514 does not give requirement on NLOS probability, we are fine to follow 38.821 with 100% LOS probability.  For small scale fading, 38.821 (in Table 6.1.1.1-7) adopts frequency selected channel model in 38.811. In M.2514, modelling of fast fading is also required. So we suggest frequency selected channel model in 38.811 is used for the evaluation. |
| Ericsson | As previously mentioned, we can simulate the channel model as is, but are OK with simplifications. |
| Nokia, Nokia Shanghai Bell | We think that we should decide to either have 100% LOS probability or have a time-correlated model for the LOS/NLOS conditions. After all, having a coin toss will potentially cause many on/off effects that may make it difficult to perform proper link adaptation. |
| CATT | Given the evaluation purpose for typical scenarios, 100% LOS probability can be assumed.  For low frequency band, small scale fading can be modelled as TR38.811. However, if evaluating the performance of Ka band, small scale fading is not needed. |
| MediaTek | (Still double checking) |

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

There were no comments received for proposals 3.1 and 3.2, so the moderator considers them stable and not for further discussion. The two proposals are reproduced below for completeness.

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

### **Proposal 3.2: The peak data rate is calculated as , assuming single carrier operation.**

For proposal 3.3 and the values for SE, the following comments were received:

* Huawei:
  + Wording change for the proposal to be more specific
* Nokia:
  + Specify clearly what are the parameters for determining modulation / code rate / etc.
* Ericsson:
  + Rather than performing link budget analysis, we can pick parameters conservatively.
* ZTE:
  + if VSAT is assumed, the link budget is much better
* Panasonic:
  + If we assume 600km, we cannot meet the requirements for uplink data rate

We need to have more discussion on this particular topic since the views are quite diverse.

### Q3.1: Further discuss the methodology for determining the parameters for peak data rate, including:

* Whether they are based on the best case link budget under the assumptions of eMBB-Rural (e.g. 90 degree elevation, no shadowing / scintillation / atmospheric losses).
* Whether they are based on conservative parameters without resorting to evaluations.
* Whether other types of terminal (e.g. VSAT) can be considered.

|  |  |
| --- | --- |
| Company | Comment |
| Panasonic | Because the peak rate is defined as ideal case, peak rate calculation based on the best case link budget (90 degree elevation, no shadowing / scintillation / atmospheric losses) would be ok. |
| Huawei/HiSilicon | Our preference is to have link budget analysis under ideal channel condition (90 degree elevation, no shadowing / scintillation / atmospheric losses), then to derive achievable modulation and coding rate based on link-to-system curve. In order to save evaluation effort, we are also fine with Ericsson approach that companies to propose realistic parameters (based on company’s analysis and proof that such parameters are achievable under idea channel condition).  VSAT is not included according to Proposal 2.2. So VSAT should not be included here. |
| Ericsson | According to ITU, these should be evaluated under “ideal conditions”. We are fine to then use best-case link budget. Needs to be determined what exactly that means (e.g. which losses need to be included).  VSAT is out of scope. |
| Nokia, Nokia Shanghai Bell | We do not find it appropriate to consider VSAT for the handheld case. |
| CATT | Peak data rate can be evaluated for the ideal channel conditions (90 degree elevation, no shadowing / scintillation / atmospheric losses), but other parameters for overhead or receiver should be based on realistic conditions. |
| Thales | For the sake of clarity, the following can be added under the generic formula in Proposal 3.1:  Rmax = 948/1024  is the maximum number of layers  is the maximum modulation order  is the scaling factor: The scaling factor can take the values 1, 0.8, 0.75, and 0.4.  is signaled per band  is the numerology (as defined in TS 38.211)  is the average OFDM symbol duration in a subframe for numerology , i.e. .  Note that normal cyclic prefix is assumed.  is the maximum RB allocation in bandwidth with numerology , as defined in TS 38.101-5, where is the UE supported maximum bandwidth in the given band  is the overhead calculated as the average ratio of the number of REs occupied by L1/L2 control, Synchronization Signal, PBCH and reference s*ignals etc. with respect to the total number of REs in effective bandwidth time product**.* |
| Qualcomm | We should be a bit careful on how we evaluate “ideal conditions”.  Based on a quick calculation, if we use 180\*6=1.04MHz, the uplink SNR is 5.51dB (only loss is polarization loss). At this SNR and with this bandwidth, based on some quick evaluations, we cannot meet 2Mbps – we need around 8dB SNR for that (even the Shannon capacity is 2.2Mbps at 1.04MHz / 5.5dB):   |  |  | | --- | --- | | UE Tx EIRP (dBm) | 23 | | Orbit height (km) | 600 | | Elevation angle (deg) | 90 | | Sat G/T (dB/K) | 1.1 | | Polarization loss | 3 | | Carrier frequency (Hz) | 2.000E+09 | | Bandwidth (Hz) | 1.04E+06 | | FSPL | -154.03 | | Distance to satellite (km) | 600.0 | | **SNR (dB)** | **5.51** | |

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

No major comments were received for Proposal 4.1, a couple of highlights:

* Panasonic:
  + It would be OK to have these values reported by companies.
    - [Moderator comment] Captured in the new proposal.
* Thales:
  + 0dBi antenna gain is assumed.
* Nokia:
  + Prefer to have a realistic antenna gain. Assume 32 HARQ processes and PF scheduler.

In line with the above, and the process for IMT-2020 terrestrial, the objective would be to agree to a set of default parameters, but results from companies would also be captured if the parameters differ from the default ones.

Also, a new table is added in Q4.2 to discuss the default parameters.

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

* NOTE: The objective is to define a set of default parameters to be used by companies. If companies follow a different set from the default set, they can declare it and the results will be captured in the TR.

|  |  |
| --- | --- |
| 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.2514 (0dBi) 🡺 Changed added by Qualcom in v108 |
| 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 |

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

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | OK |
| Ericsson | In general, we should follow the assumptions in 38.821. |
| Nokia, Nokia Shanghai Bell | Ok to further discuss |
| CATT | OK |
| Thales | The proposal is referring to ITU report M.2510, should not be ITU-R M.2514 ?  We reiterate our comment in first round of discussion on UE antenna gain which should be = 0dBi.  For Rel-17 NTN CE based on worst conditions a realistic assumptions on antenna gain of -5.5dBi was considered for a commercial smartphone. However, a different approach should be adopted for the evaluation for IMT 2020-Sat: The user terminal considered in ITU is a handheld which is not necessary a smartphone. UE Antenna gain should be = 0dBi as per the Report ITU-R M.2514.  Further, we do not understand why we can simply adopt the same UE antenna gain as for TN 5G IMT-2020 submission? |

### Q4.2: Please provide input on the default parameters

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | CSI feedback | Frequency offset | Frequency drift | UE speed | UE antenna configuration | DL CSI measurement |
| Panasonic | 20ms periodicity | 0 ppm (perfect post-compensation) or 0.1ppm | 0 (perfect pre-compensation) | 3km/h | (1,1,2) with omni | CQI only |
| Ericsson | Rel-15, as in 38.821 | 0.1 ppm, as in 38.821 | as in 38.821 | 3 km/h | (1,1,2) with omni | 1 layer / 1-port CSI-RS |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | PRB bundling | Codeword (CW) | Transmission scheme | Scheduler | Number of HARQ processes | HARQ-ACK delay |
| Panasonic |  |  | No MIMO | PF | Up to 32 | N+4 |
| Ericsson | wideband | single CW | one layer | to be reported | up to 32 | N+4 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Retransmission delay | Antenna gain | Frame structure | PDCCH resource sharing | Overhead |  |
| Panasonic | Larger than RTT | 0dBi | FDD |  |  |  |
| Ericsson | to be reported | 0 dBi | FDD |  | same as for peak data rate calculations |  |
| Nokia, Nokia Shanghai Bell |  |  | **FDD** |  |  |  |

## Connection density – mMTC-s (#9)

For proposal 5.1, the only comment (from MTK) is to clarify that the 10s packet delivery restriction as IMT-2020 is applied. The proposal is updated below:

### **Proposal 5.1: For connection density evaluation, non-full buffer and full-buffer evaluations (as described in M.2412) are allowed. The maximum transmission delay is 10 seconds.**

For proposal 5.2, there is divergence of views regarding the computation of the area:

* Huawei: All beams not including wrap-around beams.
* Thales: Only central beam.
* Nokia: Only central beam

Further discussion is needed for this proposal, which is in Q5.2. A clarification is made regarding that the wrap-around beams will not be included in any case

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

* **Only the central beam**
* **All the beams (excluding wrap-around beams)**

For proposal 5.3, the only comment from MTK is regarding the modeling on small-scale fading. The equation can be easily modified to just model the channel as a 1-tap deterministic channel.

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

**NOTE: If small scale fading is not considered for evaluation, the “pre-processing SNR” equation may be modified accordingly (e.g. by setting , and )**

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

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | OK with the revision. See further comments for Q5.2 |
| Ericsson | P5.1: Why does the maximum delay need to be clarified, it is clearly stated in M.2412?  P5.2: With 19 beams one could use the central 7 for statistics collection.  P5.3: Ok. |
| Nokia, Nokia Shanghai Bell | Proposal 5.1: OK  Proposal 5.2: OK  Proposal 5.3: OK |
| CATT | Proposal 5.1 is ok.  For Proposal 5.2, RAN1 can consider the central beams for computing the connection density.  Proposal 5.3 is ok. |
| Qualcomm | We would be OK with the proposals |
| MediaTek | We would be OK with the proposals,  Ericsson, agree 10 seconds is stated in M2412 but it is not stated in M.2514. |

### Q5.2: Please provide comments on whether the central beam only, or all the beams (excluding wrap-around beams) should be considered for the evaluation of connection density

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | According to company responses in the first round and the revised question, now the question is not limited to how to calculate the area but also includes how to run the simulation.  **Regarding how to run simulation:**  From our view, central beam and other non-wraparound beams have different propagation condition and hence with different performance. Connection density evaluation should take into account such differences like other simulations (for e.g. spectrum efficiency). In this way, more realistic performance can be obtained. Some company comments on issue with too high number of UEs in a beam. But this is issue was well handled in evaluation of terrestrial component of IMT-2020, with 1 million users per square kilometre requirement. For 1732 ISD, 1 million users per square kilometre corresponds to 0.86 million users per cell. We did not see why it becomes an issue for evaluation of satellite component of IMT-2020.  **Regarding how to calculate the area (assuming simulation for all 19 beams):**  Due to satellite characteristics, different beams in different tie are of different area. Such difference should be reflected in area calculation. Considering it might be difficult to calculate the exact area, we are fine with to consider all beams with necessary approximation (not including wrap-around beams). |
| Ericsson | See Q5.1, with 19 beams one could use the central 7 for statistics collection. |
| Nokia, Nokia Shanghai Bell | We would prefer to consider central beam only. |
| Thales | For connection density we think that only the inner/central beam should be considered for statistics collection. |
| Qualcomm | We would prefer to consider central beam only, or only the non-wrap around beams. |
| MediaTek | Central beam only seems simplest to consider, but ok to discuss a bit further the alternative.  To Huawei, we understand the number of UEs would be at least 18.6 million for non-full buffer simulation over 19 beams, which we thought might be a lot to process. For full buffer, we understand it is simpler due to extrapolation. See the simulation process in our document. |

Regarding the LLS parameters, the following comments have been received:

* MTK:
  + Need to add PUSCH scheduling unit, SCS, UL DMRS, PRACH configuration, duplex mode.
    - [Moderator summary] Added to the table “subcarrier spacing” and “UL DMRS”

### **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 |  |  |
| SCS |  | 15kHz | 15kHz |
| 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 |  |  |  |
| UL DMRS config |  |  |  |

For the SLS part in this KPI, additional SLS parameters would be needed for the evaluation of eMTC / NB-IoT (for NR, the same parameters as for spectral efficiency are assumed).

### **Proposal 5.5: RAN1 to discuss additional SLS parameters for eMTC and NB-IoT, taking the following table as starting point:**

|  |  |  |
| --- | --- | --- |
| Radio Access | NB-IoT | eMTC |
| Data transmission procedure (for non-full buffer only) | RRC resume, data after msg5, RRC suspend | RRC resume, data after msg5, RRC suspend |
| Waveform | DL: OFDMA UL: SC-FDMA | DL: OFDMA UL: SC-FDMA |
| Duplexing | HD-FDD | HD-FDD |
| Channel Bandwidth | 180kHz | 1.08MHz |
| Numerology | 15kHz | 15kHz |
| Total Aggregated Bandwidth | B = 180kHz x N  (Bmax = 30MHz  *TBD: if scaling by 200kHz needed*) | B = 1.08MHz x M  (Bmax = 30MHz  *TBD: if scaling by 1.4MHz needed*) |
| PRACH configuration (for non-full buffer only) | TBD | TBD |
| PUSCH Scheduling Unit | Single tone | 180kHz |
| Power control parameter | TBD | TBD |
| UL DMRS | 2 symbols per 14 OFDM symbols | |
| UEs coverage distribution | TBD | |
| UE mobility model | Stationary | |
| Scheduler | PF | |

### Q5.3: Please provide comments on proposal 5.5

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | For total aggregated bandwidth and also channel bandwidth, see our response to proposal 2.3. B = 180kHz x N with Bmax = 30MHz applies not only for NB-IoT, it applies also for NR and eMTC, especially for full buffer traffic. “B = 1.08MHz x M” is not necessary for eMTC. Furthermore, The simulation bandwidth used to fulfil the requirement should be reported, and it not simply to use maximum bandwidth to simulate connection density. See reference evaluation in 37.910 Section 7.1 for terrestrial component of IMT. |
| Ericsson | OK |
| Nokia, Nokia Shanghai Bell | Ok to discuss |
| CATT | OK |
| MediaTek | Ok but for proposal 5.4 would propose to add 15kHz also for NB-IoT.  Huawei, are you saying the NB-IoT formula would apply for aggregated BW in NR/eMTC too? We agree we could report max bandwidth used to reach target (like for IMT-2020), although it seems not explicitly requested.  On UL DMRS, I assume we should align the LLS to the SLS configuration. |

## Reliability – HRC-s (#11)

For proposal 6.1, there is only one major comment from Nokia:

* Nokia:
  + The reliability of uplink transmissions may be affected by the device doing other things, e.g. measurement gaps / IDC muting
    - [Moderator comment] In my understanding, these interruptions were not taken into account in IMT-2020 evaluations. Having said this, I added an FFS to further discuss this aspect

The updated proposal 6.1 is shown below. Proposal 6.2 has been modified to remove “number of resource units” (only applicable to NB-IoT), and DMRS configuration is added to both uplink and downlink. A new question Q6.2 is added to capture the detailed simulation parameters.

### **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.**

**FFS: Whether and how interruptions (e.g. due to IDC or measurements) are taken into account in the reliability evaluations.**

### **Proposal 6.2: For mobility evaluations, RAN1 to 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 |  |  |
| DMRS config |  |  |
| Antenna configuration at Satellite |  |  |
| Antenna configuration at UE |  |  |
| Transmission mode | SISO |  |
| Transmission rank | 1 |  |
| TBS |  |  |
| Modulation order |  |  |
| Number of repetition |  |  |
| Channel estimation |  |  |
| Channel coding scheme | LDPC |  |
| Doppler spread |  |  |

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

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | OK in general  Just one typo, “Proposal 6.2: For mobility evaluations” should be revised to “Proposal 6.2: For reliability evaluations” |
| Ericsson | P6.1: Agree that no interruptions should be taken into account. The procedure should follow the terrestrial evaluation.  P6.2: Agree with the proposal. |
| Nokia, Nokia Shanghai Bell | Proposal 6.1: OK. In case interruptions are not taken into account, we will (once more) take the evaluations away from reflecting reality.  Proposal 6.2: Agree with Huawei comment. |
| CATT | Not sure how to address the reliability requirement. So far NTN specific UL coverage enhancement is only considered in Rel-18. From the proposal 6.1 and 6.2, we can’t find which assumption or parameter is related to reliability. |

### Q6.2: Please provide comments on the parameters to be used for uplink and downlink LSS in HRC-s

**Downlink:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Simulation bandwidth | DMRS config | Link-level Channel model | Antenna configuration at Satellite | Antenna configuration at UE | Transmission mode |
| Company 1 |  |  |  |  |  |  |
| Company 2 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Transmission rank | TBS | Modulation order | Number of repetition | Doppler spread |
| Company 1 |  |  |  |  |  |
| Company 2 |  |  |  |  |  |

**Uplink:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Simulation bandwidth | DMRS config | Link-level Channel model | Antenna configuration at Satellite | Antenna configuration at UE | Transmission mode |
| Company 1 |  |  |  |  |  |  |
| Company 2 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Transmission rank | TBS | Modulation order | Number of repetition | Doppler spread |
| Company 1 |  |  |  |  |  |
| Company 2 |  |  |  |  |  |

## Mobility – eMBB-s (#12)

Proposals 7.1 and 7.2 seem to be agreeable. The same modifications as to Proposal 6.2 are included in the updated proposal 7.2

### **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 |  |
| DMRS config |  |
| Antenna configuration at Satellite |  |
| Antenna configuration at UE |  |
| Transmission mode | SISO |
| Transmission rank | 1 |
| TBS |  |
| Modulation order |  |
| 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 |
| Huawei/HiSilicon | OK |
| Ericsson | Agree with the proposals. The procedure should follow the terrestrial evaluation. |
| Nokia, Nokia Shanghai Bell | Proposal 7.1: OK  Proposal 7.2: OK |
| CATT | OK |

### Q7.2: Please provide comments on the parameters to be used for uplink eMBB-s mobility evaluations

**Uplink:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | Simulation bandwidth | Number of users in simulation | Link-level Channel model | Antenna configuration at Satellite | Antenna configuration at UE | Transmission mode |
| Company 1 |  |  |  |  |  |  |
| Company 2 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Transmission rank | TBS | Modulation order | Number of repetition | Doppler spread |
| Company 1 |  |  |  |  |  |
| Company 2 |  |  |  |  |  |

# [CLOSED] Round 1

## 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. |
| Thales | Agree  Evaluation for MTD is not required as per the Report ITU-R M.2514 but may be provided if time allows.  Regarding Ka band: To our understanding, only the candidate IMT-2020 RIT/SRIT(s) submission by 3GPP based on Rel-17 NTN will be evaluated. Further, the final submission package should be ready by RAN#102, that is before ITU-R WP4B submission deadline (end of December 2023). RAN4 work on Ka band is ongoing and not sure this would be completed before submission deadline.  Regarding the comment from Huawei/HiSilicon. As per the SID, the work split between RAN1 and RAN2 will initially follow the split adopted for the previous 5G IMT-2020 submission. |
| Nokia, Nokia Shanghai Bell | Proposal 2.1: OK to have this as the starting point. As was discussed in the first GTW session, the starting point for bandwidth should be the 30 MHz deployment (and then we can further discuss whether to use scaling to meet the bandwidth assumptions)  Proposal 2.2: OK. Our understanding for this evaluation is that we would mainly focus on handheld under realistic assumptions, and under such conditions it may not be feasible to consider directional terminals. And the Ka band may not be beneficial when considering the link budget. |
| Ericsson | Support the proposals. The self-evaluations should focus on what ITU has considered as mandatory. Proposal 2.2 is in line with that. |

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 beams  Influence 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/device  or  1 message/2 hours/device  Packet 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” |
| Thales | Agree  We think 100% LOS probability should be assumed |
| Nokia, Nokia Shanghai Bell | Proposal 2.3: As mentioned in the GTW, we would prefer if the evaluations were performed under conditions that would at least to some extend reflect reality. But if UE and chipset manufacturers are willing to commit to being able to deliver handsets with 0 dBi antenna gain, we can accept this. We take the conditions mentioned in the table as a framework, such that it is not given that 3GPP will be delivering results for all use cases (for instance for HRC).  Proposal 2.4: For the “large scale channel model”, we find that this is strongly correlated to the propagation conditions (which are currently considered FFS). Hence we would prefer to have the large scale channel model as FFS as well. And for the propagation conditions we may need to modify the channel model in case we also incorporate the NLOS to this model. Further, in our paper we have a suggestion for the either going for 100% LOS or targeting a time correlated model for the LOS/NLOS conditions (which would be a bit more realistic compared to flipping a coin). |
| Ericsson | Fine with the proposals. Proposal 2.3 is according to example parameters give by ITU and should be flowed. On the UE antenna gain, 0 dB has been assumed by ITU when setting the requirements. Then the self-evaluations should be done with the same assumnptions.  On the channel model, we do not see a need for any modifications. |

## 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
* Based on the peak spectral efficiency, calculate the peak data rate as

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**

**Proposal 3.2: The peak data rate is calculated as , 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.** |
| Thales | Peak spectral efficiency and peak data rate should be provided at Nadir |
| Nokia, Nokia Shanghai Bell | Proposal 3.1: OK  Proposal 3.2: OK  Proposal 3.3: We would prefer if we define the conditions that would be applicable for the evaluation instead of judging whether or not they are “realistic”. For instance it would be better to simply highlight that we assume UE antenna gain, LOS conditions, no interference, lowest path loss, etc for the peak spectral efficiency and peak data rate. |
| Ericsson | Fine with the proposals. One proposal 3.3, given that the analysis is to be analytical and under ideal conditions, rather than involving link budget analysis, picking parameters conservatively can be used. |

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 |
|  | 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 |  |  |  |  |  |  |  |  |
| 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 |  |  |  |  |  |  |  |  |
| 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 |
| Thales | We may add a note regarding the 30MHz BW. The ITU requirements in S band were defined based on an assignable bandwidth of up to 30 MHz over one satellite beam. However, 30MHz BW is not yet supported in Rel-17. 30MHz BW in S band should be introduced by RAN4.  The Peak throughout formula (for one layer) can be simplified as: |
| Nokia, Nokia Shanghai Bell | At least for table 3.3 it should be considered which user bandwidth is being evaluated. After all, we would be limited by the UE’s tx power and hence also the power spectral density for a given transmission. Of course the UL system bandwidth may be considered as 30 MHz, but we would expect the UE bandwidth to be substantially smaller. |
| Ericsson | Again, ideal conditions should be the starting point. |

## 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 | Agree  OK 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. |
| Thales | The reference to ITU report should be corrected in the above table 🡪 Antenna gain: Other: use the value in M.2510 Report ITU-R M.2514 (0dBi)  We think that the antenna gain should be = 0dBi. A realistic assumptions on antenna gain of -5.5dBi was considered for Rel-17 NTN CE for a commercial smartphones. However, for the evaluation the user terminal considered in ITU is a handheld which is not necessary a smartphone. UE Antenna gain should be = 0dBi as per the Report ITU-R M.2514. Also, we need to use the same UE antenna gain as adopted for the previous 5G IMT-2020 submission. That is 0 dBi. |
| Nokia, Nokia Shanghai Bell | Proposal 4.1: OK to take the above as starting point. However, a few points to highlight: We would suggest/prefer to also capture that scheduler is assumed to be proportional fair, and 32 HARQ processes should be considered (full capable UE). As stated above, we still have the opinion that UE antenna gain should be considered in the more realistic range instead of the 0 dBi. |
| Ericsson | Fine with the proposal |

## 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: agree  Proposal 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 |
| Thales | Regarding Proposal 5.2:  For NTN scenario, given the large cell size (to be compared to ISD of 500m or 1732m used in TN evaluation), it would be enough to drop UEs within the inner beam with the user density of 500 which means that we need to manage 981747 UEs. For interference modelling, the user density within the other beams (18 beams wrap-around) might be lower. |
| Nokia, Nokia Shanghai Bell | Proposal 5.1: OK  Proposal 5.2: OK to discuss further, but our preference is to consider “only central beam” for this case.  Proposal 5.3: OK |
| Ericsson | Fine with the proposal |

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. |
| Thales | Agree |
| Nokia, Nokia Shanghai Bell | Proposal 5.4: OK to take the above as starting point |
| Ericsson | Fine with the proposal |

## 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 |
| Thales | Ok |
| Nokia, Nokia Shanghai Bell | Proposal 6.1: One aspect that should not be forgotten for the HRC evaluations (and we think this is the proper place to catch this here) would be that the reliability of UE UL transmissions may be impacted by the device doing other things (for instance UL muting due to IDC), as well as the DL performance potentially being impacted by the UE performing neighbor cell measurements where a neighboring satellite may not have the same SSB timing (due to different feeder links). Of course, under the assumption of wrap-around, this will never happen, but again how realistic is this?  Proposal 6.2: OK to use skeleton of table as starting point. |
| Ericsson | Fine with the proposal |

## 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 |
| Thales | Ok |
| Nokia, Nokia Shanghai Bell | Proposal 7.1: OK as a starting point  Proposal 7.2: OK as a starting point |
| Ericsson | Fine with the proposal |

# 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)