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Agenda Item: 8.15

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Title: Text proposal for TR 36.763 for RAN1#104e Agreements

Document for: Decision

# Introduction

This document contains Text Proposals for TR 36.763 based on agreements and Feature Lead recommendations in AI 8.15.1 at RAN1#103e. During RAN Plenary session #89e it was decided to start email discussions for RAN1 Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN) activities in November 2020 to proceed with the Study Item. The skeleton of TR 36.673 was submitted to RP#90 in [1]

TPs based on agreement as captured in Chairman RAN1#103-ereport on AI 8.15.1

* IoT NTN scenarios
* IoT NTN paramters

 TP based on Feature Lead recommendations in summary for AI 8.15.1 in R1-2008868

* IoT NTN Overview

# TP for Chapter 6 “IoT Non-Terrestrial Networks overview and scenarios” of TR 36.763

The Text Proposal on IoT NTN scenarios for TR 36.763 Chapter 6 shown below is as agreed and captured in Chairman report for RAN1#103e:

--- Start of text proposal ---

**6.2 Link Budget Analysis**

6.2.1 Link Budget Parameters

The following assumptions are agreed for a common set of link budget parameters:

* UE power class (PC5=20 dBm)
* UE Noise Figure (NF=9 dB)
* Channel Bandwidth for NB-IoT and eMTC as was included in IoT NTN reference scenario parameters agreed in RAN1#103e
	+ NB-IoT 180 kHz (DL), Up to 180 kHz with all permissible smaller resource allocations 12\*15 kHz, 6\*15 kHz, 3\*15 kHz, 1\*15 kHz, 1\*3.75 kHz
	+ eMTC: 1080 kHz (DL), Up to 1080 kHz with all permissible smaller resource allocations, including 2\*180 kHz, 180 kHz, 2\*15 kHz or 3\*15 kHz or 6\*15 kHz (UL)
* Other losses

|  |  |  |  |
| --- | --- | --- | --- |
| Other Losses | GEO (35786 km) | LEO (1200 km) | LEO (600 km) |
| Scintillation losses | 2.2 | 2.2 | 2.2 |
| Atmospheric losses | 0.2 | 0.1 | 0.1 |
| Polarization loss | 3 | 3 | 3 |
| Shadow margin  | 3 | 3 | 3 |

NOTE 1: With PC3 (23 dBm) there is a 3dB gain compared to the PC5 (20 dBm) assumption on UL.

NOTE 2: With NF=7 dB, there is a 2 dB improvement compare to NF=9 dB on DL.

NOTE 3: Link budgets with other link budget parameters are not excluded from being captured in the TR.

NOTE 4: These parameters are only for the purpose of link budget calculations.

NOTE 5: Atmospheric losses are a function of elevation angle.

Link budget analysis assumes 3 dB polarization loss for DL and 3 dB polarization loss on UL for satellite parameters Set 1, Set 2, Set 3, and Set 4

For the satellite parameter sets Set-3 and Set-4, the 3 dB beam width (HPBW), central beam center elevation and central beam edge elevation in the satellite parameter set(s) to be used in link budget calculations are given in Table 6.2-1 and 6.2-2. These parameters correspond to the satellite parameter Set 3 and Set 4 given in Tables 6.2-3 and 6.2-4 respectively.

Table 6.2-1: Set-3 parameters for link budget analysis

|  |  |  |  |
| --- | --- | --- | --- |
| SET 3  | GEO 35786 km | LEO-600 km | LEO-1200 km |
| 3 dB Beam width (HPBW) | 0.735 degree | 22.0631 degree | 22.0631 degree |
| Central beam center elevation  | 20.88 degree | 43.78 degree | 46.05 degree |
| Central beam edge elevation | 12.5 degree | 30 degree | 30 degree |
| Central beam edge satellite-UE distance | 40316 km | 1074 km | 1998 km |

Table 6.2-2: Set-4 parameters for link budget analysis

|  |  |
| --- | --- |
| SET 4  | LEO-600 km |
| 3 dB Beam width (HPBW) | 104.7 degree |
| Central beam center elevation | 90 degree |
| Central beam edge elevation | 30 degree |
| Central beam edge satellite-UE distance | 1076 km |

NOTE 1: The 3 dB beam width (HPBW) is already included in satellite parameter set 1 and Set 2 in TR 38.821 Table 6.1.1.1-1 and Table 6.1.1.1-2 respectively. The central beam center elevation for Set-1 and Set-2 is defined as the target elevation angle that is included in in TR 38.821 Table 6.1.3.2-1. The central beam edge satellite-UE distance can be derived from the central beam edge elevation and does not need to be included.

NOTE 2: Central beam center elevation is the beam center elevation of the central beam in the beam layout.

NOTE 3: Central beam edge elevation is the minimum beam edge elevation of the central beam in the beam layout.

NOTE 4 In SLS evaluation with a multiple beam layout, the central beam is the serving beam for UEs. The outer beams have beam center elevation that is different from the central beam center elevation.  For the interference modelling, the interference due to the outer beams is determined by using their respective beam center elevations.

NOTE 5: For the multiple-beam satellite cell, the longest beam edge distance will correspond to the minimum beam edge elevation of the most outer beam as illustrated in figure below.

Figure 6.2-1 Illustration of beam layout and elevation angles for IoT NTN



The following satellite set parameters Set-1, Set-2, Set-3, and Set-4 can be used for the for the system level simulator calibration:

* Set 1 satellite parameters (based on TR 38.821, Table 6.1.1.1-1)

|  |  |  |  |
| --- | --- | --- | --- |
| Satellite orbit | GEO | LEO-1200 | LEO-600 |
| Satellite altitude | 35786 km | 1200 km | 600 km |
| Satellite antenna pattern | Section 6.4.1 in TR 38.811 | Section 6.4.1 in TR 38.811 | Section 6.4.1 in TR 38.811 |
| Central beam center elevation | 12.5 degrees | 30 degrees | 30 degrees |
| Central beam edge elevation | 2.3 degrees | 26.3 degrees | 27.0 degrees |
| Payload characteristics for DL transmissions |
| Equivalent satellite antenna aperture (Note 1) | S-band(i.e. 2 GHz) | 22 m | 2 m | 2 m |
| Satellite EIRP density | 59 dBW/MHz | 40 dBW/MHz | 34 dBW/MHz |
| Satellite Tx max Gain | 51 dBi | 30 dBi | 30 dBi |
| 3dB beamwidth | 0.4011 deg | 4.4127 deg | 4.4127 deg |
| Satellite beam diameter (Note 2) | 250 km | 90 km | 50 km |
| Payload characteristics for UL transmissions |
| Equivalent satellite antenna aperture (Note1) | S-band (i.e. 2 GHz) | 22 m | 2 m | 2 m |
| G/T | 19 dB K-1 | 1.1 dB K-1 | 1.1 dB K-1 |
| Satellite Rx max Gain | 51 dBi | 30 dBi | 30 dBi |
| NOTE 1: This value is equivalent to the antenna diameter in Sec. 6.4.1 of [2].NOTE 2: This beam size refers to the Nadir pointing of the satellite NOTE 3: All these satellite parameters are applied per beam.NOTE 4: The EIRP density values are considered identical for all frequency re-use factor options.NOTE 5: The EIRP density values are provided assuming the satellite HPA is operated with a back-off of [5] dB.NOTE 6: The parameters corresponding to Ka-band for DL and UL in TR 38.821 Table 6.1.1.1-1 were removed. |

* Set 2 satellite parameters (based on TR 38.821, Table 6.1.1.1-2)

|  |  |  |  |
| --- | --- | --- | --- |
| Satellite orbit | GEO | LEO-1200 | LEO-600 |
| Satellite altitude | 35786 km | 1200 km | 600 km |
| Satellite antenna pattern | Section 6.4.1 in TR 38.811 | Section 6.4.1 in TR 38.811 | Section 6.4.1 in TR 38.811 |
| Central beam center elevation | 12.5 degrees | 30 degrees | 30 degrees |
| Central beam edge elevation | [TBC] degrees | 22.2 degrees | 23.8 degrees |
| Payload characteristics for DL transmissions |
| Equivalent satellite antenna aperture (Note 1) | S-band(i.e. 2 GHz) | 12 m | 1 m | 1 m |
| Satellite EIRP density | 53.5 dBW/MHz | 34 dBW/MHz | 28 dBW/MHz |
| Satellite Tx max Gain | 45.5 dBi | 24 dBi | 24 dBi |
| 3dB beamwidth | 0.7353 degrees | 8.8320 degrees | 8.8320 degrees |
| Satellite beam diameter (Note 2) | 450 km | 190 km | 90 km |
| Payload characteristics for UL transmissions |
| Equivalent satellite antenna aperture (Note1) | S-band (i.e. 2 GHz) | 12 m | 1 m | 1 m |
| G/T | 14 dB K-1 | -4.9 dB K-1 | -4.9 dB K-1 |
| Satellite Rx max Gain | 45.5 dBi | 24 dBi | 24 dBi |
| NOTE 1: This value is equivalent to the antenna diameter in Sec. 6.4.1 of [2].NOTE 2: This beam size refers to the Nadir pointing of the satellite NOTE 3: All these satellite parameters are applied per beam.NOTE 4: The EIRP density values are considered identical for all frequency re-use factor options.NOTE 5: The EIRP density values are provided assuming the satellite HPA is operated with a back-off of [5] dB.NOTE 6: The parameters corresponding to Ka-band for DL and UL in TR 38.821 Table 6.1.1.1-1 were removed. |

* Set 3 satellite parameters (Eutelsat R1-2101146 with central beam edge elevation 12.5 degree for GEO, and 30 degree for LEO-600 km and 1200 km)

Table 6.2-3: Set-3 satellite parameters for system level simulator calibration:

|  |  |  |  |
| --- | --- | --- | --- |
| Satellite orbit | GEO | LEO-1200 | LEO-600 |
| Satellite altitude | 35786 km | 1200 km | 600 km |
| Central beam edge elevation  | 12.5 degree | 30 degree | 30 degree |
| Central beam center elevation | 20.9 degree | 46.05 degree | 43.8 degree |
| Payload characteristics for DL transmissions |
| Equivalent satellite antenna aperture (NOTE 1) | S-band(i.e. 2 GHz) | 12 m | 0.4m | 0.4 m |
| Satellite EIRP density | 59.8 dBW/MHz | 33.7 dBW/MHz | 28.3 dBW/MHz |
| Satellite Tx max Gain | 45.7 dBi | 16.2 dBi | 16.2 dBi |
| 3dB beam width (HPBW) | 0.7353 degree | 22.1 degree | 22.1 degree |
| Satellite beam diameter (NOTE 2) | 459km | 470 km | 234 km |
| Payload characteristics for UL transmissions |
| Equivalent satellite antenna aperture (NOTE 1) | S-band (i.e. 2 GHz) | 12 m | 0.4 m | 0.4 m |
| G/T | 16.7dB K-1 | -12.8 dB K-1 | -12.8 dB K-1 |
| Satellite Rx max Gain | 45.7 dBi | 16.2 dBi | 16.2 dBi |

NOTE 1: This value is equivalent to the antenna diameter in Sec. 6.4.1 of TR 38.811

NOTE 2: Satellite beam diameter is at Nadir point

NOTE 3: Central beam center elevation is referred to as central beam elevation in TR 38.821

NOTE 4: Central beam edge elevation is the minimum beam edge elevation of the central beam in the beam layout.

* Set 4 satellite parameters (Thales, Sateliot, Gatehouse R1-2101019)

Table 6.2-4: Set-4 satellite parameters for system level simulator calibration:

|  |  |
| --- | --- |
| Satellite orbit | LEO-600 |
| Satellite altitude | 600 km |
| Central beam edge elevation | 30 degree |
| Central beam center elevation | 90 degree |
| Payload characteristics for DL transmissions |
| Equivalent satellite antenna aperture (NOTE 1) | S-band(i.e. 2 GHz) | 0.097 m |
| Satellite EIRP density | 21.45 dBW/MHz |
| Satellite Tx max Gain | 11 dBi |
| 3dB beam width (HPBW) | 104.7 degree |
| Satellite beam diameter (Note 2) | 1700 km |
| Payload characteristics for UL transmissions |
| Equivalent satellite antenna aperture (Note1) | S-band (i.e. 2 GHz) | 0.097 m |
| G/T | - 18.6 dB·K-1 |
| Satellite Rx max Gain | 11 dBi |

NOTE 1: This value is equivalent to the antenna diameter in Sec. 6.4.1 of TR 38.811

NOTE 2: Satellite beam diameter is at Nadir point

NOTE 3: Central beam center elevation is referred to as central beam elevation in TR 38.821

NOTE 4: Central beam edge elevation is the minimum beam edge elevation of the central beam in the beam layout.

--- End of text proposal ---

**6.2 Enhancements to time and frequency synchronization**

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The following aspects related to enhancements to time and frequency synchronization will be studied:

* GNSS measurement window for initial access.
* Potential impact of GNSS Position fix on UE power consumption considering at least the following parameters
	+ GNSS power consumption value
	+ GNSS position Time To First Fix
* Potential impact of NTN SIB carrying the satellite ephemeris on
	+ UE power consumption in NB-IoT and eMTC
	+ Accuracy of satellite location tracking
	+ RACH congestion
* UE pre-compensation of satellite delay and satellite Doppler shift during long UL transmission on (N-)PUSCH and PRACH in NB-IoT and eMTC.

--- End of text proposal ---

**6.3 Timing relationships enhancements**

--- Start of text proposal ---

The following aspects related to timing relationships enhancements will be studied to check whether enhancement is necessary and beneficial:

For NB-IoT:

* NPDCCH to NPUSCH format 1
* RAR grant to NPUSCH format 1
* NPDSCH to HARQ-ACK on NPUSCH format 2
* NPDCCH order to NPRACH
* Timing advance command activation
* FFS: Other NB-IoT timing relationships

For eMTC:

* MPDCCH to PUSCH
* RAR grant to PUSCH
* PDCCH order to PRACH
* MPDCCH to scheduled uplink SPS
* PUSCH to HARQ-ACK on PUCCH
* CSI reference resource timing
* MPDCCH to aperiodic SRS
* Timing advance command activation
* FFS: Other eMTC timing relationships

Impact of large RTD (which impacts TA) on HD-FDD UL-DL timing relationships

The study will identify IoT-NTN configurations needing activation/de-activation via MAC CE and their timing relationships.

--- End of text proposal ---

**6.4 Enhancements on HARQ**

--- Start of text proposal ---

For NTN IoT, potential HARQ enhancements need to consider the main characteristics of an IoT device, which are low complexity, low cost, low power consumption and low throughput, and key requirements of IoT services which are extended coverage, delay-tolerant and infrequent data transmissions, and support of massive communications.

The peak throughput of IoT UEs operating over NTN is not expected to be higher than the peak throughput of IoT UEs operating over TN.

The following aspects related to HARQ enhancements will be studied:

Potential benefits and/or drawbacks of

* Increasing the number of HARQ processes on throughput, latency, power consumption and complexity
* Disabling HARQ feedback for NB-IoT
* Disabling HARQ feedback for eMTC.

Necessity, potential benefits and/or drawbacks relation to HARQ operation in IoT NTN

* Any other potential HARQ feedback mechanisms
* Reduced PDCCH monitoring
* Coverage enhancements
* Uplink transmission gaps with multiple HARQ processes
* Maintaining HARQ process continuity in serving cell change
* Multiple Transport Blocks scheduling
* Throughput enhancements

The study will identify whether HARQ stalling happens at least in the GEO satellite scenario.

--- End of text proposal ---

# Conclusion

In this contribution, we provided Text Proposals for inclusion in TR 36.763 Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN) (Release 17) as follows:

TPs based on agreement as captured in Chairman RAN1#104-ereport on AI 8.15.1 for the following Agenda Items

* Scenarios applicable to NB-IoT/eMTC
* Enhancements to time and frequency synchronization
* Timing relationship enhancements
* Enhancements on HARQ

# References