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Title: Simulation assumption for NTN co-existence study

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Document for: Discussion

# Introduction

This document captures initial simulation assumptions for the NTN coexistence study.

# Discussion

## 2.1 Co-existence simulation scenarios

In [3], the proposed scenarios for coexistence study are duplicated in the following table.

Table 2.1-1 Proposed scenarios for NTN-NTN/TN co-existence

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **Set 1** | | | | **Set 2** | | | |
| GEO | LEO 600km | LEO 1200km | HIBS | GEO | LEO 600km | LEO 1200km | HIBS |
| **NR / NB-IoT** | Rural | | X | X | X | X | X | X | X | X |
| Urban macro | | X | X | X | X | X | X | X | X |
| Dense Urban | | X | X | X | X | X | X | X | X |
| Micro/small cell outdoor | | X | X | X | X | X | X | X | X |
| Indoor hotspot | | X | X | X | X | X | X | X | X |
| **NTN** | GEO | Set 1 | X | X | X | X | N/A | N/A | N/A | N/A |
| LEO 1200km | X | X | X | X | N/A | N/A | N/A | N/A |
| LEO 600km | X | X | X | X | N/A | N/A | N/A | N/A |
| HIBS | X | X | X | X | N/A | N/A | N/A | N/A |
| GEO | Set 2 | N/A | N/A | N/A | N/A | X | X | X | X |
| LEO 1200km | N/A | N/A | N/A | N/A | X | X | X | X |
| LEO 600km | N/A | N/A | N/A | N/A | X | X | X | X |
| HIBS | N/A | N/A | N/A | N/A | X | X | X | X |
| Note 1: Only consider earth fixed beam for satellite.  Note 2: Set 1 and Set 2 could be found in Table 6.1.1.1-6 of TR 38.821. A deeper analysis of set 1 and set 2 is needed to identify if one set would be more stringent and so, if all simulations would be needed for both sets.  Note 3: LEO @1200km is deprioritized.  Note 4: GEO and LEO is only operated at adjacent channel. | | | | | | | | | | |

The aggressor and victim combination is list in Table 2.1-2.

Table 2.1-2 Aggressor and victim

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Combination | **Aggressor** | **Victim** | Notes |
| 1 | TN with NTN | TN DL | NTN DL |  |
| 2 | TN with NTN | TN UL | NTN UL |  |
| 3 | TN with NTN | NTN DL | TN DL |  |
| 4 | TN with NTN | NTN UL | TN UL |  |
| 5 | TN with NTN | NTN UL | TN DL | Applicable for satellite operating in S band, e.g. coexistence with Band 34 TDD. |
| 6 | TN with NTN | TN UL | NTN DL | Applicable for satellite operating in S band, e.g. coexistence with Band 34 TDD. |
| 7 | TN with NTN | NTN DL | TN UL | Applicable for satellite operating in S band, e.g. coexistence with Band 34 TDD. |
| 8 | TN with NTN | TN DL | NTN UL | Applicable for satellite operating in S band, e.g. coexistence with Band 34 TDD. |
| 9 | NTN with NTN | NTN DL | NTN DL |  |
| NTN UL | NTN UL |  |

The proposed frequency and bandwidth are listed as table 2.1-3.

Table 2.1-3. Proposed frequency and bandwidth for co-existence study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Frequency** | **Bandwidth** | **Duplex mode** | **Frequency reuse factor** |
| Rural | 2 GHz | TBD | FDD, TDD | [1] |
| Urban macro | 2 GHz | TBD | FDD, TDD | [1] |
| Dense Urban | 2 GHz | TBD | FDD, TDD | [1] |
| GEO | 2 GHz | 30 MHz for FR1 | FDD | [1] or [3]? |
| LEO | 2 GHz | 30 MHz for FR1 | FDD | [1] or [3]? |
| HAPS | 2 GHz | TBD | FDD | [1] |
| Note: Inclusion of Ka band for satellite is pending RAN decision. | | | | |

## 2.2. Network layout model

Cellular cell structure is considered for both NTN and TN network layout.

**Co-existence between NTN and TN**

For co-existence between NTN/HAPS and TN, it is proposed to only consider single satellite. An example layout is shown in figure 2.2-1. The number of TN IMT BS should be large enough to emulate the interference seen by the satellite from the IMT systems. It is FFS on exact range of TN BS deployment based on simulations.

**Co-existence between NTN and NTN**

For co-existence between NTN and NTN, the following 2 cases are considered as candidates options.

* One satellite carries two neighbour carriers, where the footprints of the 2 carriers are the same and coordinated see figure 2.2-1.
* Two satellites (GEO and LEO) operate on two neighbour carriers but at different height, see figure 2.2-2. The number of LEO satellite and footprints are FFS.

**Co-existence between HAPS and TN**

For co-existence between HAPS and TN, the exact layout is FFS.

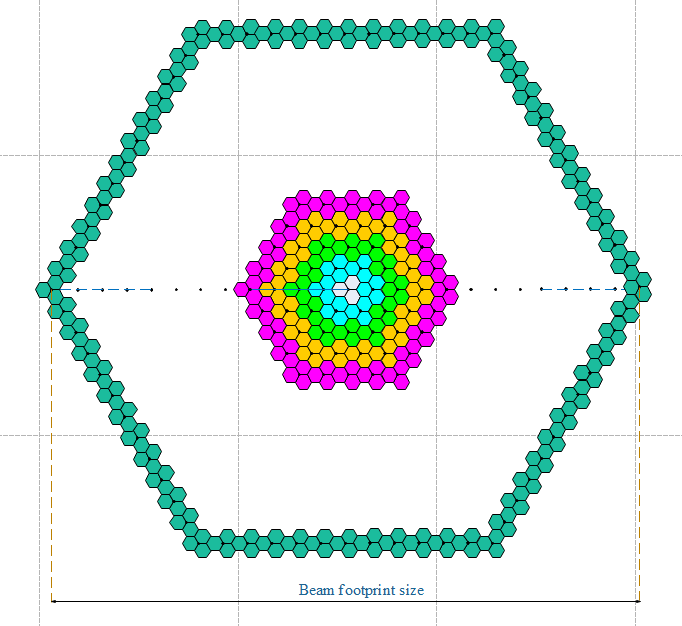


Figure2.1-1 Layout for coexistence between NTN and TN

Figure 2.2-2 Layout for coexistence between NTN systems

Figure 2.2-3 Layout for coexistence between NTN systems (different height satellites)

## 2.3. Simulation parameters

Two sets of satellite parameters are proposed in Table 2.3-1 and Table 2.3-2 according to TR 38.821.

Table 2.3-0 Simulation assumptions of NB-IoT and NR

|  | NB-IoT  standalone | NR |
| --- | --- | --- |
| Carrier frequency in GHz | 2 | 2 |
| Size of each nominal channel BW in MHz | 0.2 | 20 |
| Transmission bandwidth in MHz | 0.18 | 9 |
| Environment | Urban macro  Sub-urban  Rural | Urban macro  Sub-urban  Rural |
| Network layout | 19-sites [57 sectors] with wrap-around | 19-sites [57 sectors] with wrap-around |
| Inter-site distance in meter | 500 for 2GHz band for UMA | 500 for 2GHz band for UMA |
| System loading and activity | Full buffer 100% | Full buffer 100% |
| Network location | Non co-located (at cell edge of legacy) | FFS |
| DL subcarrier spacing | 15kHz | 15kHz |
| UL | See RP-152284 | OFDMA |
| DL power control | No | No |
| UL power control | 36.942 section 5.1.1.6 (set 1) by bandwidth scale, target SNR at BS is 15 dB | 36.942 section 5.1.1.6 (set=1) |
| Frequency reuse | 1 | 1 |
| Number of scheduled UE per cell (DL) | 1 | 1 |
| Number of scheduled UE per cell (UL) | 3 for multi-tone (60kHz per UE), 12 for 15kHz single-tone, 48 for 3.75kHz single-tone | 3 |
| BS antenna height in meter | 30 | 30 |
| BS max TX power in dBm | 43dBm/200kHz | 46 |
| BS antenna gain including feeder loss in dBi | 15 | 15 |
| BS antenna pattern | Horizontal (36.942) | 8x4x2 AAS BS |
| BS antenna front-back ratio in dB | 20 | 20 |
| UE antenna height in meter | 1.5 | 1.5 |
| UE TX power in dBm | -40 to 23 | -40 to 23 |
| UE antenna gain in dBi | 0 | 0 |
| Building penetration loss | 45.820 Annex D.1 | n/a |
| Cell selection margin in dB | 3 | 3 |
| BS-MS min couple loss in dB | 70 | 70 |
| BS ACLR in dB | 40 to 60 | 45 |
| BS ACS in dB | 40 to 50 | 45 |
| UE ACLR in dB | 20 to 50 | 30 (ACLR1) 43 (ACLR2) |
| UE ACS in dB | 20 to 40 | 33 |
| BS noise figure in dB | 5 | 5 |
| UE noise figure in dB | 9 | 9 |
| BS-UE path-loss model | TR36.942 macro urban | TR36.942 macro urban |
| Standard deviation of BS-UE log-normal shadow fading in dB | 10 | 10 |
| Shadowing correlation | Inter-cell 0.5 intra-cell 1 | Inter-cell 0.5 intra-cell 1 |
| Link-level performance model |  | As in Annex A.1 in 36.942 |
| Evaluation metrics | SINR vs ACS (as victim) | SINR and throughput loss vs standalone NB-IoT ACLR (as victim); SINR and throughput loss vs in-band/guard-band IoT |
| Carrier separation | 0.3MHz to GSM  2.6MHz to UMTS  5.1MHz to LTE | See NB-IoT(standalone case) |
| Location of NB-IoT carrier | - | - |

Table 2.3-1 Set-1 satellite parameters for co-existence study

|  |  |  |  |
| --- | --- | --- | --- |
| Satellite orbit | | GEO | LEO-1200 |
| Satellite altitude | | 35786 km | 1200 km |
| Payload characteristics for DL transmissions | | | |
| Satellite EIRP density | 2GHz | 59 dBW/MHz | 40 dBW/MHz |
| Satellite Tx max Gain | 51 dBi | 30 dBi |
| 3dB beamwidth | 0.4011 deg | 4.4127 deg |
| Satellite beam diameter | 250 km | 90 km |
| Satellite EIRP density | 20GHz | 40 dBW/MHz | 10 dBW/MHz |
| Satellite Tx max Gain | 58.5 dBi | 38.5 dBi |
| 3dB beamwidth | 0.1765 deg | 1.7647 deg |
| Satellite beam diameter | 110 km | 40 km |
| Payload characteristics for UL transmissions | | | |
| G/T | 2 GHz | 19 dB K-1 | 1.1 dB K-1 |
| Satellite Rx max Gain | 51 dBi | 30 dBi |
| G/T | [20] GHz | 28 dB K-1 | 13 dB K-1 |
| Satellite RX max Gain | 58.5 dBi | 38.5 dBi |
| Note: Ka band pending RAN decision. | | | |

Table 2.3-2 Set-2 satellite parameters for co-existence study

|  |  |  |  |
| --- | --- | --- | --- |
| Satellite orbit | | GEO | LEO-1200 |
| Satellite altitude | | 35786 km | 1200 km |
| Payload characteristics for DL transmissions | | | |
| Satellite EIRP density | 2GHz | 53.5 dBW/MHz | 34 dBW/MHz |
| Satellite Tx max Gain | 45.5 dBi | 24 dBi |
| 3dB beamwidth | 0.7353 deg | 8.8320 deg |
| Satellite beam diameter | 450 km | 190 km |
| Satellite EIRP density | 20GHz | 32 dBW/MHz | 2 dBW/MHz |
| Satellite Tx max Gain | 50.5 dBi | 30.5 dBi |
| 3dB beamwidth | 0.4412 deg | 4.4127 deg |
| Satellite beam diameter | 280 km | 90 km |
| Payload characteristics for UL transmissions | | | |
| G/T | 2 GHz | 14 dB K-1 | -4.9 dB K-1 |
| Satellite Rx max Gain | 45.5 dBi | 24 dBi |
| G/T | [20] GHz | 20 dB K-1 | 5 dB K-1 |
| Satellite RX max Gain | 50.5 dBi | 30.5 dBi |
| Note: Ka band pending RAN decision. | | | |

Table 2.3-3 HAPS parameters for co-existence study (TBD)

Table 2.3-4 UE characteristics for co-existence study

|  |  |  |
| --- | --- | --- |
| Characteristics | [VSAT] | Handheld |
| Frequency band | [30 GHz UL and 20 GHz DL] | 2 GHz |
| Polarisation | circular | Linear: +/-45°X-pol |
| Rx Antenna gain | 39.7 dBi | 0 dBi per element |
| Antenna temperature | 150 K | 290 K |
| Noise figure | 1.2 dB | 7 dB |
| Tx transmit power | 2 W (33 dBm) | 200 mW (23 dBm) |
| Tx antenna gain | 43.2 dBi | 0 dBi per element |
| Note: Whether to consider VSAT or not depends on RAN decision for Ka band. | | |

Table 2.3-5 ACLR/ACS for TN

|  |  |  |  |
| --- | --- | --- | --- |
|  | | **2GHz** | **20 GHz and 30 GHz** |
| BS | ACLR | 45 dB | 28 dB |
| ACS | 45 dB |  |
| UE | ACLR | 30dB (ACLR1)  43dB (ACLR2) | 17 dB |
| ACS | 33 | 23 dB |

**Table 2.3-6: Other simulation parameters for NR**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **NR** | **NB-IOT** | **NTN** |
| Carrier frequency | 2GHz | 2GHz | 2GHz |
| Channel bandwidth | 20MHz | 20MHz | 20MHz |
| Scheduled channel bandwidth per UE (DL) |  |  |  |
| Scheduled channel bandwidth per UE (UL) |  |  |  |
| The number of active UE (DL) (Note 1) | 1 | 1 | 1 |
| The number of active UE (UL) (Note 1) | 1/3 | 1/3 | 1/3 |
| Traffic model | Full buffer | Full buffer | Full buffer |
| DL power control | NO | NO | NO |
| UL power control | YES | YES | YES |
| BS max TX power in dBm | 43 | 43 | 43 |
| UE max TX power in dBm | 23 | 23 | 23 |
| UE min TX power in dBm | -33 | -33 | -33 |
| BS Noise figure in dB | 5 (@2GHz) | 5 (@2GHz) | 5 (@2GHz) |
| UE Noise figure in dB | 9 | 9 | 9 |
| Handover margin | 3dB | 3dB | 3dB |
| Note 1 Same as the number of BS beam(s)  Note 2: 20dBm as optional case where CLx-ile should be reduced by 3dB | | | |

## Antenna and beam forming pattern modelling

Satellite and UE Antenna and beam forming pattern modelling of satellite could be referred to section 6.4.1 in TS 38.811 [5].

Antenna and beam forming pattern modelling of TN BS and UE could be referred to TR38.803 [6].

The antenna and beam forming pattern modeling for HAPS is FFS.

## 2.5. Propagation model

Propagation model between NTN and UE could be referred to section 6.6 in TR 38.811 [5].

Propagation model between TN BS and UE could be referred to section 5.2.2 in TR 38.803 [6].

## 2.6. Transmission power control model

For downlink scenario, no power control scheme is applied.

For uplink scenario, TPC model specified in Section 9.1 TR 36.942 [7] could be applied with following parameters.



Where, Pmax = 24dBm, Rmin = -54dB if UE minimum power is -30dBm (or Rmin = -64dB if UE minimum power is -40dBm), CLx-ile and γ are set as following:

- CLx-ile = 88 + 10\*log10 (200/X) + 11 – Y,

where X is UL transmission BW (MHz) and Y is the BS noise figure

- γ = 1

## 2.7. Received power model

The received power in downlink and uplink scenarios is defined as below:

*RX\_PWR = TX\_PWR – Path loss + G\_TX + G\_RX*

Where,

RX\_PWR is the received power

TX\_PWR is the transmitted power

G\_TX is the transmitter antenna gain (directional array gain)

G\_RX is the receiver antenna gain (directional array gain).

## 2.8. Performance metric

The throughput loss of victim system should be less than 5%.

## 2.9. Throughput ~ SNR mapping

Use section 5.2.7 of TR 38.803.

# Conclusion

It is proposed to use the simulation assumptions in this paper as the starting point for NTN co-existence study.

# Reference

[1] R4-2100486

[2] R4-2100904

[3] R4-2101105

[4] R4-2101812

[5] R4-2101859

[6] R4-2101964

[7] R4-2102174

[8] R4-2102508