**3GPP TSG-RAN Meeting #103 RP-240711**

**Maastricht, Netherlands, March 18th – 22nd, 2024**

**Title: Moderator's summary for discussion on NTN evolution in RAN4**

**Agenda Item: 9.1.4.6**

**Source: RAN4 chair (Huawei)**

**Document for: Information**

# Introduction

This document provides the summary for potential RAN4 Rel-19 NTN evolution work item based on companies’ contributions and the summary provided by RAN Chair and RAN4 Chair.

This document is divided into four parts: High power UE for NTN, NTN testing for NGSO, less than 5MHz for NTN, and other proposals.

# HPUE for NTN

The summaries in RP-240019 for NTN HPUE are as follow:

|  |  |
| --- | --- |
| **NTN evolutions in RAN4 (3 topics)**   * **High power UE for NTN** * NTN testing for NGSO * NR Channel BW less than 5MHz for NTN | **WI** |

**NTN evolutions in RAN4: (I) UE RF: High power UE (HPUE) for NTN**

* References: [RP](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-231540.zip)[-](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-232745.zip)[233918](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-233918.zip)
* Potential objectives:
  + Important to ensure reasonable load
  + Introduce PC2 for NR/IoT NTN UE in NTN FR1 bands for both handheld and non-handheld (need confirmation on the co-existence)
  + Introduce PC1 for NR NTN UE in NTN FR1 bands for non-handheld (the study on co-existence is needed)
  + Introduce PC1.5 for NR NTN UE in NTN FR1 bands (the study on co-existence is needed)
  + Need further discussion on whether the PC1.5 and PC1 are supported for non-handheld UE only or both handheld UE and non-handheld UE.
  + Need further discussion on whether IoT NTN UE can support PC1 and PC1.5.
  + Need further discussion on the prioritization of NTN work in terms of co-existence study.
  + Need further discussion on high power UE in NTN FR2 bands for non-handheld UE

Companies’ main proposals for NTN HPUE are summarized in the tables below.

|  |  |  |
| --- | --- | --- |
| **Potential objectives** | **Companies** | **Views** |
| **Introduce PC2 for NR/IoT NTN UE in NTN FR1 bands for both handheld and non-handheld (need confirmation on the co-existence)**  **Introduce PC1 for NR NTN UE in NTN FR1 bands for non-handheld (the study on co-existence is needed)**  **Introduce PC1.5 for NR NTN UE in NTN FR1 bands (the study on co-existence is needed)** | KT0315 | including high power UE for NTN |
| VIVO0130 | FR1 HPUE for satellite access to improve UL coverage is urgent commercial demand  IoT-NTN link budgets is also power starved, especially in the UL |
| Apple0509 | Enable PC2 and PC1 power classes for the NR NTN FR1 bands.  Enable PC2 and PC1 power classes for the IoT NTN FR1 bands. |
| Intel0544/7 | To reduce workload, recommend to down-select or prioritize between PC1 and PC1.5 for NR NTN based on NTN industry inputs and commercial needs. |
| MTK0452/6 | Focus on Power Class 2 for NR and IoT NTN  Specific need for PC1 and PC1.5 need more discussion and likely require additional considerations on coexistence modelling vs. PC2 |
| Ericsson0485 | HPUE for PC2 is considered for both NR and NB-IoT  PC2 may be handheld or non-handheld  Co-existence should be checked for PC2 |
| Nokia0262 | Priority for Rel-19 NTN should be enhancing High-Power UEs and sufficient testing of UE support of NTN |
| CATT0397 | Prefer to define PC2 first in this release, then PC1/PC 1.5 in future release. |
| ZTE0474 | The prioritize the RF requirement definition for PC2 for NR/IoT NTN UE in NTN FR1 bands. |
| Huawei0434 | PC1 for non-hand held device and PC2 for hand-held device |
| Inmarsat0506 | HPUE for NR NTN – For all FR1 NTN bands, with support for PC2 (+26 dBm), PC 1.5 (+29 dBm) and PC1 (31 dBm), reusing existing TN assumptions for FDD HPUE  HPUE for IoT NTN - For all FR1 IoT NTN bands including especially for NB-IoT NTN, with support for PC2 (+26 dBm) and PC1 (31 dBm). |
| Thales0062 | Support of High power UE in FR1-NTN for NR-NTN   * Support of UE with PC2 applies to handheld terminals with omni antenna and automotive terminals with characteristics as per LS by 5GAA [RP-232733] * Support of UE with PC1 apply to non handheld terminals with omnidirectional or non omnidirectional antenna * Support of UE with PC1.5   Support high power feature for eMTC IoT NTN UEs (Cat M1) and NB-IoT NTN UEs (Cat NB1, NB2)   * Support of UE with PC2 applies to handheld terminals with omni antenna and automotive terminals with characteristics as per LS by 5GAA [RP-232733] * Support of UE with PC1 apply to non handheld terminals with omnidirectional or non omnidirectional antenna |

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| **Potential objectives** | **Companies** | **Views** |
| **Need further discussion on whether the PC1.5 and PC1 are supported for non-handheld UE only or both handheld UE and non-handheld UE** | VIVO0130 | For PC1.5 and PC1 NTN, we see clear commercial demand that the UE type should consider both handheld UE and non-handheld UE |
| CMCC0152 | If feasible, specify corresponding RF requirements for handheld and non-handheld UE. |
| Ericsson0485 | In case other power classes (PC1.5, PC1) are included, non-handheld should be considered for those |
| CTC0351 | Based on coexistence study outcome, introduce PC1.5 and PC1 for NR/IoT NTN UE in NTN FR1 bands for both handheld and non-handheld  The handheld UE is suggested to support PC1 for only working in the non-proximity way(e.g. hands free mode) |
| Samsung0380 | For PC 1 and PC 1.5, focus on non-handheld UE device type only in Rel-19 |
| ZTE0474 | PC1.5 and PC1 are supported for non-handheld UE only based on the commercial PA capability discussion on PC2 in the legacy FR1 FDD bands.  Need further discussion on whether the PC1.5 and PC1 are supported for non-handheld UE only or both handheld UE and non-handheld UE. |
| Huawei0434 | PC1 for non-hand held device and PC2 for hand-held device |
| **Need further discussion on whether IoT NTN UE can support PC1 and PC1.5** | VIVO0130 | IoT NTN should also support PC1 and PC1.5  a study phase may be needed  Focus on same example bands |
| ZTE0474 | For IoT UE with PC1 and PC1.5, it should be treated as low priority at the current phase. |
| **Need further discussion on the prioritization of NTN work in terms of co-existence study** | UNISOC0109 | PC2: high priority  PC1: low priority  PC1.5: medium priority |
| VIVO0130 | Co-existence study for each new power class is required |
| CMCC0152 | Study the co-existence for NTN/IOT-NTN HPUE in NTN FR1 bands, including PC2/1.5 and PC1. |
| MTK0452/6 | Coexistence studies will be needed for any higher Power Class. Focus on Power Class 2 for NR and IoT NTN |
| Ericsson0485 | PC1 and PC1.5 need co-existence studies   * Based around similar parameters and scenarios to existing work. * It is OK to include them, but there should be a clear motivation. |
| CTC0351 | Coexistence study for NTN UE support PC1.5 and PC1 |
| ZTE0474 | no prioritization on power class for NTN coexistence study |
| Thales0062 | Coexistence studies, shall be carried out considering same conditions (i.e. geographical separation between NTN UE and Terrestrial Networks (TN)) as in Rel-17 and 18 |
| **Need further discussion on high power UE in NTN FR2 bands for non-handheld UE** | VIVO0130 | Prioritize FR1 NTN bands in Rel-19, FR2 can be considered at a later release |
| Intel0544/7 | Focus on NTN FR1 |
| CTC0351 | Need further discussion on high power UE in NTN FR2 bands for non-handheld UE |
| Samsung0380 | Not consider high power UE for NTN FR2 bands in initial stage |
| ZTE0474 | Do not consider the high power UE in NTN FR2 bands for non-handheld UE. |

**Moderator’s observations:**

* Companies have different views on which power classes as well as the co-existence study and what UE form factors for each power should be considered in this WI. Based on the moderators’ observations, most companies can support PC2 for both handheld UE and non-handheld UE and PC1 for non-handheld UE.
* To keep the reasonable workload, the frequency ranges need be down-selected and the example bands may also need be decided. Based on the moderators’ observations, quite a number of companies explicitly excluded FR2 and other companies did not clearly mention whether FR2 needs be considered. So the moderator proposed to focus on FR1, and maybe focus on the example bands with more adjacent bands or overlapping bands
* Besides, the Rx requirements including MSD should also be specified in this WI.

**Moderator proposals to refine the candidate objectives based on summary RP-240019**

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| **Core part only**   * Conduct the coexistence analysis based on TR 38.863 for the above example bands and corresponding power classes   + Evaluate the impact on the uplink performance of TN (Terrestrial network)     - Example bands include bands n256 and 256, n255 and 255     - PC2, PC1.5 (for NR-NTN only) and PC1 will be evaluated for ACLR and ACS     - For NR-NTN and IoT-NTN: coexistence studies shall be carried out under the same conditions, including. geographical separation between NTN UE and Terrestrial Networks (TN), as the co-existence studies in Rel-17 and Rel-18 * Specify high power UE (HPUE) for NR-NTN (Non-Terrestrial Networks) and IoT-NTN (NB-IoT and eMTC based NTN) in FR1-NTN bands and the corresponding LTE NTN bands for the single uplink (UL) carrier scenario   + Support UE with power class 2 (PC2, 26 dBm) that applies to both handheld and non-handheld based on the co-existence study.   + Support other power classes based on the co-existence and feasibility study     - Non-hand held UE is prioritized   + Specify RF requirements for all considered power classes for NR-NTN and IoT-NTN in FR1-NTN bands and the corresponding LTE NTN bands     - Necessary Tx requirements including     - Investigate and if necessary, specify the solution to address potential SAR (Specific Absorption Rate restriction) requirements for handheld UE     - Specify MPR and A-MPR for the example bands considering the regulation for the corresponding bands, if necessary     - Necessary Rx requirements for example bands       * Specify the RSD requirements on the example bands, if necessary * Specify the necessary signaling to support the above objectives |

**Discussions:**

# NTN testing for NGSO

The summaries in RP-240019 for NTN HPUE are as follow:

|  |  |
| --- | --- |
| **NTN evolutions in RAN4 (3 topics)**   * High power UE for NTN * **NTN testing for NGSO** * NR Channel BW less than 5MHz for NTN | **WI** |

**NTN evolutions in RAN4: (I) UE RF: High power UE (HPUE) for NTN**

* References: [RP](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-231540.zip)[-](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-232745.zip)[233918](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-233918.zip)
* Potential objectives:
  + NTN performance requirements/testing for NGSO for UEs
    - FFS: whether the new core requirement is needed for NGSO

Companies’ main proposals for NTN UE NGSO testing are summarized in the tables below.

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| **Potential objectives** | **Companies** | **Views** |
| **NTN performance requirements/testing for NGSO for UEs**  **FFS: whether the new core requirement is needed for NGSO** | MTK0452/6 | Focus on the performance part (test case) change without revisiting core part (RF & RRM) requirements |
| RS0255 | RAN Plenary shall include to R19 WI „NTN\_enh\_2“ a performance part on NGSO Testing  NGSO Testing shall include Channel model following the ephemeris seen by UE |
| Intel0547 | The work shall focus on RRM/Demodulation performance requirements and consider to introduce realistic and testable NGSO propagation conditions. |
| Ericsson0485 | Requirements need to consider Doppler and time-shift to enable better test coverage |
| Nokia0262 | Priority for Rel-19 NTN should be enhancing High-Power UEs and sufficient testing of UE support of NTN |
| CTC0351 | Parameters as DL arrival timing and Doppler frequency needs to be optimized to facilitate LEO channel modeling and guarantee NTN UE performance by specifying both demod and RRM test requirements. |
| Samsung0380 | No core requirements impact (both UE RF and RRM core requirements) for NGSO testing  Similar HST demodulation requirements, new demodulation test case can be introduced to verify NTN UE performance with time varied doppler shift and time shift due to satellite movement refer to the model in TR 38.811 |
| CATT0397 | Investigate and specify the channel model to accommodate the joint delay and Doppler variation for NGSO for both FR1 NR-NTN and IoT-NTN. |
| Huawei0434 | Focus on the RF frequency error requirement, RRM uplink timing requirement/test, and a limited number of demodulation performance requirements to verify the performance of UE supporting NGSO in the new TE-emulated channel model with varying Doppler and delay shifts matching the satellite motion trajectory based on the ephemeris. |
| Thales0062 | Add reference in the relevant specification(s) of the joint delay and Doppler variation model related to NGSO of TR 38.811 [RAN4/RRM]  Define demod requirements under these delay and Doppler variation conditions for respectively NR-NTN and IoT-NTN [RAN4/Demod]  Update RRM requirements (e.g. timing), as applicable [RAN4/RRM]  FFS: Update RF requirements (e.g. frequency accuracy), as applicable [RAN4/RF] |

**Moderator’s observations:**

* Most companies proposed to just specify performance requirements.
* Except for RF/RRM, most companies proposed to specify the demodulation performance requirements.
* In addition, it is better to focus on FR1-NTN bands to control the work load in the moderator’s view.

**Moderator proposals to refine the candidate objectives based on summary RP-240019**

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| **Core part**   * Investigate whether the RF core requirements, e.g., frequency error requirements, can be met, and if not, update the requirements for NR-NTN and IoT-NTN in the FR1-NTN and the corresponding LTE bands   + Use the TE-emulated channel model for NR-NTN (NR based Non-Terrestrial Networks) and IoT-NTN (NB-IoT and eMTC based NTN)   **Perf. part**   * Specify the TE-emulated channel model with varying Doppler and delay shifts for NR-NTN and IoT-NTN in the FR1-NTN bands and the corresponding LTE bands   + Match the satellite motion trajectory based on the ephemeris for NGSO (Non-Geostationary Orbit) scenarios   + Inform RAN5 to assist specifying RF frequency error tests, if needed * Specify UE RRM performance test of uplink timing for NGSO for NR-NTN and IoT-NTN in the FR1-NTN bands and the corresponding LTE bands based on the above channel model * Specify UE demodulation performance requirement(s) of PDSCH for NGSO for NR-NTN and IoT-NTN in the FR1-NTN bands and the corresponding LTE bands based on the above channel model   + Minimize the number of demodulation performance requirements |

**Discussions:**

# Less than 5MHz for NTN

The summaries in RP-240019 for NTN HPUE are as follow:

|  |  |
| --- | --- |
| **NTN evolutions in RAN4 (3 topics)**   * High power UE for NTN * NTN testing for NGSO * **NR Channel BW less than 5MHz for NTN** | **WI** |

**NTN evolutions in RAN4: (I) UE RF: High power UE (HPUE) for NTN**

* References: [RP](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-231540.zip)[-](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-232745.zip)[233918](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-233918.zip)
* Potential objectives:
  + Aim for minimal spec impact
  + NR Channel BW less than 5 MHz (focusing on 3MHz) (study phase is needed)
    - No RAN1 impact is expected

Companies’ main proposals for NTN less than 5MHz channel bandwidth are summarized in the tables below.

|  |  |  |
| --- | --- | --- |
| **Potential objectives** | **Companies** | **Views** |
| **NR Channel BW less than 5 MHz (focusing on 3MHz) (study phase is needed)**  **No RAN1 impact is expected** | MTK0452/6 | First verify that existing TN spec can be re-applied |
| Intel0547 | The work shall cover necessary RF/RRM/Demodulation requirements. To limit the scope, the work can focus on 3MHz CBW. No additional study stage is requirement. |
| Ericsson0485 | Re-use TN 3MHz design to the greatest extent possible.  It is not clear that a significant study phase is needed if the specifications are exactly the same as for 3MHz TN.   * One thing to clarify is whether the same sync raster design can be used in Satellite bands as currently defined * If new raster points are needed then a RAN1 checking of k\_ssb, Offset\_RB applicable for the raster points may be needed. * Another is whether the 12PRB is really needed |
| CTC0351 | With one of the commercial satellite services as low date rate voice and short message, supporting less than 5MHz is necessary for NR NTN. |
| Samsung0380 | Link-budget analysis required to check the feasibility for less than 5MHz operation under NTN by assuming no impact to RAN1 |
| CATT0397 | Supportive of this scope |
| Huawei0434 | Investigate and specify the system parameters to enable less than 5MHz channel bandwidth for NR-NTN  Specify the necessary Tx and Rx requirements  Investigate and specify the necessary RRM/RLM core and performance requirements to support less than 5MHz channel bandwidth  Investigate and specify the necessary demodulation performance requirements to support less than 5MHz channel bandwidth |
| Inmarsat0506 | At least enabling support for 3 MHz channel BW and 12 PRB transmission, as already specified by NR\_FR1\_lessthan\_5MHz\_BW also for NTN bands. This is critical to enable NR NTN deployments within the context of existing non-3GPP services, as well as to support EIRP limited satellites and maximize frequency reuse efficiency. |
| Thales0062 | re-use the work done in TN Rel-18 NR support for spectrum less than 5 MHz and focus on the RAN4 requirements for NTN   * Re-use the same assumptions as adopted for terrestrial, in respect to maintaining current PSS/SSS without puncturing, reusing the PBCH design with puncturing and appropriate CORESET formats supporting 12 and 15 PRB transmission, and consider reusing the 3 MHz sync raster defined for TN at least for 3 MHz channel BW. Hence no additional work is expected in RAN1 and RAN2. * GSO and NGSO to be considered |

**Moderator’s observations:**

* Some companies clearly mentioned that no study phase (for link budget with reduced SSB) is needed.
* Regarding the sync raster, the company proposed to try to reuse the existing sync raster.
* In addition, it would be better to focus on

**Moderator proposals to refine the candidate objectives based on summary RP-240019**

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| --- |
| **Core part**   * Specify the system parameters for channel bandwidth of less than 5 MHz for NR-NTN (NR based Non-Terrestrial Networks) in FR1-NTN bands   + Consider the NR-NTN bands n255, n256, and n254   + Add less than 5MHz channel bandwidth     - Focus on 3MHz   + Investigate and if necessary, specify the additional synchronization (sync) raster(s) for the additional channel bandwidth * Specify the necessary SAN RF core requirements, including SAN reference sensitivity requirements as well as reference measurement channel with less than 5MHz channel bandwidth, for NR-NTN in FR1-NTN bands * Specify the necessary NR-NTN UE RF core requirements for less than 5 MHz for NR-NTN in FR1-NTN bands   + Focus on power class 3 (PC3) for Tx RF requirements * Specify the necessary RRM/RLM core requirements for less than 5 MHz for NR-NTN in FR1-NTN bands * Specify the necessary signaling to support the above objectives   **Perf. part**   * Specify the necessary RRM/RLM performance requirements for less than 5 MHz for NR-NTN in FR1-NTN bands * Specify the necessary demodulation performance requirements for less than 5 MHz for NR-NTN in FR1-NTN bands |

**Discussions:**

# Other proposals

Beyond the scope of summary RP-240019, companies also had the following proposals for NTN in RAN#103

**Mobile VSAT with NGSO**

* References: [RP](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-231540.zip)[-](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-232745.zip)[233920](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-233920.zip)
* Potential objectives: - Check in Dec’2024
  + ~~Specify In-band/[guard] band coexistence of NB IoT w/ NR NTN~~
  + ~~Vehicular NTN device for NR-NTN and IoT-NTN~~

Companies’ proposals are summarized below.

|  |  |  |
| --- | --- | --- |
| **Potential objectives** | **Companies** | **Views** |
| **Mobile VSAT with NGSO** | MTK0452/6 | Recently requested by NTN stakeholders   * Compelling use-cases (e.g. automotive) * WRC-23 Resolution COM5/3 enabling non-GSO ESIMs in misc. frequency bands >10GHz |
| CATT0397 | Supportive of this scope, low priority if TU is limited. |
| Eutelsat0079 | Mobile VSATs support by NGSO constellations is a commercially important use case as can be inferred from automotive, avionics, maritime or rail services requirements, and shall be standardized in Rel-19. |
| Thales0062 | Update if necessary, RRM timing requirements |

**NTN NB-IoT in band operation co-existence with NTN NR**

* References: [RP](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-231540.zip)[-](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_101/Docs/RP-232745.zip)[233920](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-233920.zip)
* Potential objectives: - Check in Dec’2024
  + ~~Specify In-band/[guard] band coexistence of NB IoT w/ NR NTN~~
  + ~~Vehicular NTN device for NR-NTN and IoT-NTN~~

Companies’ proposals are summarized below.

|  |  |  |
| --- | --- | --- |
| **Potential objectives** | **Companies** | **Views** |
| **NTN NB-IoT in-band operation co-existence with NTN NR** | Thales0062 | Specify for NTN NB-IoT in-band operation co-existence with NTN NR. |

**Others**

Companies’ proposals are summarized below.

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| **Potential objectives** | **Companies** | **Views** |
| **Others** | Inmarsat0506 | NTN-NTN intra-SAN Carrier aggregation (CA) - Focused on improving throughput per user and aggregating BW across different NTN frequency blocks within the same SAN (e.g. intra-band and inter-band L + S)  Better Support of Fragmented Spectrum - To accommodate situations where the existing legacy services may interrupt a 5G NR channel allocation, requiring 5G NR NTN services to be scheduled around, with a larger system bandwidth  4RX for NR NTN – To improve receive performance and align NR NTN UE with TN specification and requirements for devices that can fit up to four L and S-band antennas.  In-Band NB-IoT NTN with NR NTN in same SAN – Currently, deployment of NB-IoT within 5G NR carriers is already supported for terrestrial networks as of Rel-16, helping greatly improve spectrum usage efficiency and deployment flexibility. |

# Conclusions

During the offline sessions, the potential objectives are provided as follows for Rel-19 NTN RAN4-led WI.

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