3GPP TSG-RAN WG4 Meeting # 109 R4-2318145

Chicago, USA, Nov 13 – Nov 17, 2023

**Agenda item:** 8.26.9

**Source:** Moderator (ZTE)

**Title:** Topic summary for [109][139] NR\_NTN\_enh\_UERF

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

It is appreciated that the delegates for this topic put their contact information in the table below.

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #1: NTN UE RF requirement

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2319179**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip) | Samsung | Discussions on NTN UE RF  **Observation 1**: From existing agreements [1] to [6], the NTN UE types should cover following dimensions: 1) Antenna steering type; 2) Mobility; 3) Satellite orbit; 4) Noise figure class. And 5) Antenna type; 6) Multiple connections; 7) Multiple antennas may also be helpful, but can be down-selected in this release 18 for simplification.  **Observation 2**: By introducing the regulatory framework into the RAN4 requirements, including on-axis emission levels, off-axis eirp mask, power flux density mask, etc., the categorization of above-mentioned 2) Mobility and 3) satellite orbit should be taken into consideration by the existing regulatory framework.  **Proposal 1: We propose to clearly categorize the NTN UE for above 10GHz in following dimensions in this release:**   * **Antenna steering type**: Mechanical steering or Electronic steering * **Mobility**: Fixed earth station or Earth station in motion * **Satellite orbit**: GSO or non-GSO * **Noise figure**: Class 1 or Class 2   **Proposal 2: We propose the following valuable categories, which were discussed or agreed in RAN4, can be postponed to future releases.**   * **Multiple connections**: Single satellite or multiple satellite * **Multiple antennas**: Single beam/aperture or multiple beam/apreture. * **Antenna type**: Parabolic antenna or Phased-array antenna   **Proposal 3: By considering all the previous agreements and differences, in Rel-18, we should consider at least 5 types UEs as below:**   |  |  | | --- | --- | | **UE type** | Type description | | 1 | Fixed NTN UE communicating with GSO and non-GSO with mechanical steering antenna. | | 2 | Fixed NTN UE communicating with GSO and non-GSO with electronical steering antenna. | | 3 | Fixed NTN UE communicating with non-GSO only with electronical steering antenna. | | 4 | Mobile NTN UE communicating with GSO with mechanical steering antenna. | | 5 | Mobile NTN UE communicating with GSO with electronical steering antenna. | | **Note1**: Assuming that UE has single beam towards one single satellite at a given time in Rel-18.  **Note2**: The Mobile NTN UE communicating with non-GSO is not considered in Rel-18. | |   **Observation 3**: The existing IE for Rel-17 NTN UE, ***ntn-ScenarioSupport-r17***, can be used to indicate whether NTN UE support GSO only, NGSO only or both GSO and NGSO, which can be sufficient to separate the NTN UE with different capability to different SAN orbits, and different noise figure classes.  **Observation 4**: The fixed or mobile NTN UE (VSAT) will have different requirements in   * RF (on/off-axis eirp requirements and others related to the regulatory framework which were made differently for fixed and mobile VSAT) and * RRM (mobility impact due to the locating accuracy differences, cell-reselection restriction due to the regulatory terms were different for fixed and mobile VSAT)   **Observation 5** The electronical-steered and mechanical-steered NTN UE (VSAT) will have different requirements in   * RF (the regulatory framework have different antenna design ITU-R recommendations and eirp masks for electronic-steered and mechanical-steered VSAT, and impacts on beam correspondence, EIRP and EIS) and * RRM (mobility impact due to the big differences in rotation speed and timing, etc.)   **Proposal 4: We propose to specify 5 new UE types or UE power classes, e.g. UE power classes/types 1~5, to reflect one of the each UE types defined in the above table.**  **Proposal 5: We propose to specify new power classes, e.g. Power Class [8] and [9], to reflect the Fixed and Mobile VSAT due to its differences from RF and RRM requirements.**  **Proposal 6: We propose to specify a UE capability to reflect the UE differences in antenna steering types, which is electronic-steered or mechanical-steered.**  **Proposal 7: We propose to consider 76.2 dBm as maximum EIRP limit for VSAT considering the co-ex study assumptions including 33dBm Tx power and 43.2dBi maximum Tx antenna gain.**  **Proposal 8: The minimum EIRP requirement of NTN UE (VSAT) should consider both network link budget and implementation budget.**  **Proposal 9: From above discussions and proposals, we proposed the following UE feature list: see Table-3** |
| [**R4-2319180**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319180.zip) | Samsung | Draft CR to TS 38.101-5: sub-clause 9.2.1 |
| [**R4-2319181**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319181.zip) | Samsung | Draft CR to TS 38.101-5: regulatory related RF requirements |
| [**R4-2319568**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319568.zip) | Ericsson | NTN enhancement: UE RF requirements  **Proposal1: RAN4 to confirm if MPR and A-MPR (and so NS signalling) are not needed in the context of FR2-NTN.**  **Proposal2: Add the following note in TS 38.101-5 NTN UE maximum output power sub-clause:**  **Note: Additional regulatory power flux density requirements have been specified for a certain type of mobile VSAT operating in band n512 (ECC Decision(13)01 Annex 2).** |
| [**R4-2319572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319572.zip) | Ericsson | NTN enhancement: draft CR to TS 38.101-5 NTN Ka-band - clause 5 |
| [**R4-2319573**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319573.zip) | Ericsson | NTN enhancement: draft CR to TS 38.101-5 NTN Ka-band - clauses 9.1 |
| [**R4-2319574**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319574.zip) | Ericsson, Verizon | NTN enhancement: draft CR to TS 38.101-5 NTN Ka-band - clauses 9.2.2 |
| [**R4-2319575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319575.zip) | Ericsson | NTN enhancement: draft CR to TS 38.101-5 NTN Ka-band - clauses 9.2.3 |
| [**R4-2319576**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319576.zip) | Ericsson | NTN enhancement: draft CR to TS 38.101-5 NTN Ka-band - clauses 10.7 |
| [**R4-2319891**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319891.zip) | Huawei, HiSilicon | Draft CR for 38.101-5 to introduce clause 10.1~10.3 |
| [**R4-2319892**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip) | Huawei, HiSilicon | Discussion on Ka band NTN UE  **Proposal 1: To specify a UE capability and a network IE to distinguish a mobile VSAT or a fixed VSAT in Ka band.**  **Proposal 2: To specify a UE capability to distinguish electronically-steered beam UEs (Type 1) and mechanically-steered beam UEs (Type 2) due to the potential different off-axis EIRP requirements.**  **Observation 1: when UE EIRP is 60dBm, the UL SNR can still reach 4.2dB for LEO600.**  **Proposal 3: For fixed VSAT communicating with LEO only with electronical steering antenna, it’s proposed to specify the minimum EIRP as 60dBm.**  **Observation 2: The range of G/T is about -15dB/K to 15dB/K to cover different implementations for Ka band NTN UE.**  **Observation 3: -15dB/K G/T can still achieve DL 4.2dB SNR for LEO600 scenario.**  **Proposal 4: For fixed VSAT communicating with LEO only with electronical steering antenna, it’s proposed to specify the minimum EIS as -107dBm for 50MHz channel bandwidth.**  **Proposal 5: it’s proposed to specify -100dBm as OTA maximum input level for Ka band NTN UE.** |
| [**R4-2320332**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320332.zip) | ZTE Corporation | Further discussion on UE RF requirements for NTN in Ka-band  **Proposal 1:** for VSAT with phase antenna array antenna if introduced, antenna array size should be limited as 1024 in the UL direction.  **Proposal 2:** postpone the support of Pi/2 BPSK for NTN VSAT in Rel-18 into future release.  **Proposal 3:** RAN4 need to further discuss the following transmitter signal quality requirement:   * the necessity of carrier leakage requirement for NTN VSAT * the necessity of in-band emission for NTN VSAT * the necessity of EVM equalizer spectrum flatness requirement for NTN VSAT   **Proposal 4:** RAN4 need to further discuss the the following requirement for NTN VSAT.   * [The minimum output power] * The OFF output power * The transition period requirement * Power control requirement,   **Proposal 5:** for the out-of-band emission requirement, propose to use the ITU-R SM.1541-6, Annex 5 OoB domain emission limits for space services (earth and space stations) as starting point and further discuss any modification if necessary (e.g. to keep consistency with other regional out-of-band emission requirement).  **Proposal 6:** for the general transmitter spurious emission requirement, propose to follow the ITU-R SM.39 recommendation.  **Observation 1:** for parabolic antenna**,** Rx antenna gain as 39.7dBs seems to be reasonable assumption for both VSAT connecting with GEO/LEO with NF as 2.5dB and VSAT connecting with LEO with NF as 6dB;  **Proposal 7:** if typical scenario for NTN Ka-band for each beam is transmitted with single polarization, e.g. LHCP or RHCP, then polarization diversity gain.  **Observation 2:** the OTA maximum input power is around -107dBm prior to antenna.  **Observation 3:** for Fixed VSAT, the 8dB ACIR requirement from transmitter perspective is enough.  **Observation 4:** for L-ESIM, the 0dB ACIR requirement from transmitter perspective is workable due to high coupling loss between NTN VSAT and TN UL  **Observation 5:** for Fixed VSAT, more than 40dB ACIR requirement from receiver side is needed for some scenarios.  **Observation 6:** for L-ESIM, the 32dB ACIR requirement from transmitter perspective is enough.  **Proposal 8:** for in-band blocking requirement for VSAT, propose to specify the power level of IBB to the same as power level of interfering signal of ACS requirement and reuse the freq offset of FR2 TN UE in-band blocking requirement. |
| [**R4-2320333**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320333.zip) | ZTE Corporation , Thales, Samsung, Ericsson, Huawei | Joint contribution for NTN VSAT RF requirements in Ka-band |
| [**R4-2320337**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320337.zip) | ZTE Corporation | Draft CR to TS 38.101-5 Clause 9.3 Output power dynamics |
| [**R4-2320338**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320338.zip) | ZTE Corporation | Draft CR to TS 38.101-5 Clause 10.4 Maximum input power requirement |
| [**R4-2320339**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320339.zip) | ZTE Corporation | Draft CR to TS 38.101-5 Clause 10.6 Blocking requirement |
| [**R4-2320340**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320340.zip) | ZTE Corporation | Draft CR to TS 38.101-5 Annex: NTN VSAT related FRC |
| [**R4-2320900**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320900.zip) | THALES | Details on NTN UE terminal requirements based on different NTN UE types  **Proposal 1.** Companies to provide missing information for the second class of terminals using 6dB NF.   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | **Tx Power [W]** | **Antenna Gain [dBi]** | **NF [dB]** | **UE types** | | **VSAT UE Class 1** | **2W (33 dBm)** | **Tx: 43.2 dBi**  **Rx: 39.7 dBi** | **2.5 dB** | **Type 1, Type 2** | | **VSAT UE Class 2** | **TBD**  **[38 dBm?]** | **TBD**  **Tx: [20.2 dBi?]**  **Rx: [17 dBi?]** | **6 dB** | **Type 1 only** |   **Proposal 2.** It might be useful to differentiate in terms of EIRP and EIS between the previous 2 classes of terminals. |
| [**R4-2320903**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320903.zip) | THALES | Draft CR to TS 38.101-5: NTN UE in Ka-band |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1 General

*Sub-topic description:*

**Issue 1-1 NTN UE power class/types definition**

* **Proposal 1:** [ZTE Corporation , Thales, Samsung, Ericsson, Huawei, [R4-2320333](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320333.zip)]

|  |  |  |
| --- | --- | --- |
| **UE/Power class** | **UE type** | Type description |
| [A] [fixed VSAT] | 1 | Fixed VSAT communicating with GSO and LEO with mechanical steering antenna. |
| 2 | Fixed VSAT communicating with GSO and LEO with electronical steering antenna. |
| 3 | Fixed VSAT communicating with LEO only with electronical steering antenna. |
| [B][Mobile VSAT] | 4 | Mobile VSAT communicating with GSO with mechanical steering antenna. |
| 5 | Mobile VSAT communicating with GSO with electronical steering antenna. |
| Note: Assuming that UE has single beam towards one single satellite at a given time. | | |

* **Proposal 2:** By considering all the previous agreements and differences, in Rel-18, we should consider at least 5 types UEs as below: [Samsung,[R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip) ]

|  |  |
| --- | --- |
| **UE type** | Type description |
| 1 | Fixed NTN UE communicating with GSO and non-GSO with mechanical steering antenna. |
| 2 | Fixed NTN UE communicating with GSO and non-GSO with electronical steering antenna. |
| 3 | Fixed NTN UE communicating with non-GSO only with electronical steering antenna. |
| 4 | Mobile NTN UE communicating with GSO with mechanical steering antenna. |
| 5 | Mobile NTN UE communicating with GSO with electronical steering antenna. |
| **Note1**: Assuming that UE has single beam towards one single satellite at a given time in Rel-18.  **Note2**: The Mobile NTN UE communicating with non-GSO is not considered in Rel-18. | |

* **Proposal 3:** We propose to clearly categorize the NTN UE for above 10GHz in following dimensions in this release: [Samsung,[R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip) ]
* **Antenna steering type**: Mechanical steering or Electronic steering
* **Mobility**: Fixed earth station or Earth station in motion
* **Satellite orbit**: GSO or non-GSO
* **Noise figure**: Class 1 or Class 2
* **Proposal 4:** We propose the following valuable categories, which were discussed or agreed in RAN4, can be postponed to future releases. [Samsung,[R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip) ]
* **Multiple connections**: Single satellite or multiple satellite
* **Multiple antennas**: Single beam/aperture or multiple beam/apreture.
* **Antenna type**: Parabolic antenna or Phased-array antenna
* **Proposal 4:** We propose to specify 5 new UE types or UE power classes, e.g. UE power classes/types 1~5, to reflect one of the each UE types defined in the above table.
* **Proposal 5:** We propose to specify new power classes, e.g. Power Class [8] and [9], to reflect the Fixed and Mobile VSAT due to its differences from RF and RRM requirements.
* Recommended WF:
  + Proposal 1 is agreed
  + Further discuss how to specify different VSAT types in the specification;
* Option 1: 5 UE power class;
* Option 2: 2 power class for fixed and mobile and each power class with different types;

**Huawei: if looking at the difference, the terminology is better to use UE class.**

**Samsung: we try to draft TS. It is better to clarify the UE class.**

**Agreement:**

* **Define the requirements based on the following UE types**

|  |  |  |
| --- | --- | --- |
| **UE class** | **UE type** | Type description |
| Fixed VSAT | 1 | Fixed VSAT supporting GSO and LEO with mechanical steering antenna. |
| 2 | Fixed VSAT supporting GSO and LEO with electronical steering antenna. |
| 3 | Fixed VSAT supporting LEO only with electronical steering antenna. |
| Mobile VSAT | 4 | Mobile VSAT supporting GSO with mechanical steering antenna. |
| 5 | Mobile VSAT supporting GSO with electronical steering antenna. |
| Note: Assuming that UE has single beam towards one single satellite at a given time. | | |

* **UE capabilities for Rel-18 NTN UE**
  + **The following new UE capabilities will be specified**
    - **Capability signalling to distinguish electronic or mechanical steering antenna**
    - **Capability signalling to distinguish fixed or mobile VSA**
  + **Reuse the capability of NTN\_ScenearioSuppot\_R17 to distinguish LEO, GSO or both**

**Issue 1-2: Mapping between NF and NTN UE power class/types**

* Proposal 1:

  Fixed VSAT:

                             Electronic steering

                                             Class 1: 2.5 dB NF  (LEO and GEO)

                                             Class 2: 6 dB NF  (LEO only)

Mechanical steering

                                             Class 1: 2.5 dB NF  (LEO and GEO)

    Mobile VSAT:

                              electronic steering

                                             Class 1: 2.5 dB NF  (~~LEO and~~ GEO)

~~Class 2: 6 dB NF  (LEO only)~~

mechanical steering

                                             Class 1: 2.5 dB NF  (~~LEO and~~ GEO)

NOTE: Mobile VSAT in the LEO is not precluded in the future release and we need to further discuss with operators.

* Recommended WF:
  + Proposal 1 is agreed

Agreement:

Fixed VSAT:

                             Electronic steering

                                             Class 1: 2.5 dB NF  (LEO and GSO)

                                             Class 2: 6 dB NF  (LEO only)

Mechanical steering

                                             Class 1: 2.5 dB NF  (LEO and GSO)

    Mobile VSAT:

                              electronic steering

                                             Class 1: 2.5 dB NF  (GSO)

                              mechanical steering

                                             Class 1: 2.5 dB NF  (GSO)

**Issue 1-3: the necessity of introduction of NTN UE capable of both electronic steering and mechanical steering and how reflect in the above UE types.**

* Proposal 1: For the hybrid beam steering capable NTN UE, one clarification note is added in 38.133, hybrid steering capability UE, the requirement could follow either electronic or mechanical beam steering capability.
* Recommended WF:
  + Proposal 1 is agreed

**Samsung: add 38.101-5**

**Agreement:**

* For the hybrid beam steering capable NTN UE, one clarification note is suggested to be added in 38.133 and 38.101-5 that the requirement could follow either electronic or mechanical beam steering requirements depending on the declared UE types.

**Issue 1-4: network signalling for barring certain VAST access**

* Proposal 1: To specify a UE capability and **a network IE to distinguish a mobile VSAT or a fixed VSAT** in Ka band. [Huawei, [R4-2319892](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip)]
* Recommended WF:
  + Need further discussions

Agreement: Specify **a network IE to signal that network supports either a mobile VSAT UE, a fixed VSAT UE or both** in Ka band.

**Issue 1-5: UE capability**

* Proposal 1: To specify a UE capability and a network IE to distinguish a mobile VSAT or a fixed VSAT in Ka band. [Huawei, [R4-2319892](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip)]
* Proposal 2: To specify a UE capability to distinguish electronically-steered beam UEs (Type 1) and mechanically-steered beam UEs (Type 2) due to the potential different off-axis EIRP requirements. [Huawei, [R4-2319892](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip)]
* Proposal 3: We propose to specify a UE capability to reflect the UE differences in antenna steering types, which is electronic-steered or mechanical-steered. [Samsung, [R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip)]
* Proposal 4: From above discussions and proposals, we proposed the following UE feature list: see Table-3 [Samsung, [R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip)]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 40.  NR\_NTN\_enh | 40-1 | **VSAT antenna steering type** | 1. **Mechanical steering** 2. **Electronic steering** 3. **[Hybrid steering]** | **34-1** | **yes** | **N/A** | **The network cannot distinguish the UE steering times from different steering types.** | **Per UE** | **N/A** | **FR2 only** | **N/A** |  | **Conditionally mandatory with capability signalling, at least report one steering type for UE supporting NTN and operating in FR2-NTN bands.** |
|  |  | **[VSAT operating orbit type** | 1. **GEO and LEO** 2. **LEO only** 3. **[GEO only]** | **34-1** | **yes** | **N/A** | **The network does not know whether it’s legitimate to handover a UE to a target satellite cell** | **Per UE** | **N/A** | **FR2 only** | **N/A** |  | **Conditionally mandatory with capability signalling, at least report one operating orbit type for UE supporting NTN and FR2-NTN bands.]** |
|  |  | **[VSAT mobility type** | 1. **Fixed** 2. **Mobile** | **34-1** | **yes** | **N/A** | **The network does not know whether it’s legitimate to handover a UE to a target satellite cell.** | **Per UE** | **N/A** | **FR2 only** | **N/A** |  | **Conditionally mandatory with capability signalling, at least report one mobility type for UE supporting NTN and FR2-NTN bands.]** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

* Recommended WF:
  + Need further discussions
* Option 1: use the power class as UE capability to differentiate the different VSAT (e.g. mobile, fixed, electronic or mechanical steering)
* Option 2: use the power class to differentiate the fixed or fixed VSAT and use the separate UE capability to differentiate electronic and mechanical steering capability
* Other options

### Sub-topic 2 Tx requirement

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1: How to define the on-axis EIRP limit**

* Proposal 1:
* maximum EIRP limit is 76.2dBm.
* The maximum TRP limit for NTN UE follow the ITU recommendation.
* Proposal 2: We propose to consider 76.2 dBm as maximum EIRP limit for VSAT considering the co-ex study assumptions including 33dBm Tx power and 43.2dBi maximum Tx antenna gain. [Samsung, [R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip)]
* Proposal 3: Add the following note in TS 38.101-5 NTN UE maximum output power sub-clause: [Ericsson,[R4-2319568](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319568.zip)]
* Note: Additional regulatory power flux density requirements have been specified for a certain type of mobile VSAT operating in band n512 (ECC Decision(13)01 Annex 2).
* Recommended WF:
  + Proposal 1 is agreed
  + FFS for proposal 3

**Huawei: there is no specific values corresponding to “the maximum TRP…” Do we need put the general text for it?**

**Moderator: we do not have concrete values.**

**Agreement:**

* maximum EIRP limit is 76.2dBm.
* The maximum TRP limit for NTN UE follows the regulatory requirements, including both ECC and FCC requirements.

**Issue 2-2: Transmit power assumption for each UE types**

* Proposal 1:
* for each UE type, single value for minimum EIRP limit for certain elevation angle and FFS for the exact value;
* If UE is capable of communicating with both GSO and LEO, to follow the minimum EIRP for worse case.
* Proposal 2: The minimum EIRP requirement of NTN UE (VSAT) should consider both network link budget and implementation budget. [Samsung, [R4-2319179](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319179.zip)]

**Table 2 Minimum required EIRP from implementation budget**

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | VSAT on 27GHz |
| P\_out per element | dBm |  |
| # of antennas in array |  |  |
| Total conducted power per polarization | dBm |  |
| Avg. antenna element gain | dBi |  |
| Antenna roll-off loss vs frequency | dB |  |
| Realized antenna array gain | dBi |  |
| Polarization gain | dB |  |
| Mismatch and transmission line loss  including load pull | dB |  |
| Beam forming loss (phase shifter and amplitude error) | dB |  |
| Finite beam table | dB |  |
| Beam forming loss (one beam table fits all) | dB |  |
| Form-factor integration losses | dB |  |
| Total implementation loss for peak EIRP(worst-case) | dB |  |
| Total implementation loss for TRP(best-case) | dB |  |
| TRP | dBm |  |
| Peak EIRP (Minimum) | dBm |  |

* Proposal 3. Companies to provide missing information for the second class of terminals using 6dB NF. [Thales,[R4-2320900](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320900.zip)]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Tx Power [W]** | **Antenna Gain [dBi]** | **NF [dB]** | **UE types** |
| **VSAT UE Class 1** | **2W (33 dBm)** | **Tx: 43.2 dBi**  **Rx: 39.7 dBi** | **2.5 dB** | **Type 1, Type 2** |
| **VSAT UE Class 2** | **TBD**  **[38 dBm?]** | **TBD**  **Tx: [20.2 dBi?]**  **Rx: [17 dBi?]** | **6 dB** | **Type 1 only** |

* Proposal 4. It might be useful to differentiate in terms of EIRP and EIS between the previous 2 classes of terminals. [Thales,[R4-2320900](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320900.zip)]
* Proposal 5: For fixed VSAT communicating with LEO only with electronical steering antenna, it’s proposed to specify the minimum EIRP as 60dBm. [Huawei,[R4-2319892](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip)]
* Proposal 6: for VSAT with phase antenna array antenna if introduced, antenna array size should be limited as 1024 in the UL direction. [ZTE,R4-2320332]
* Recommended WF:
  + Proposal 1 is agreed
  + Further discuss the following minimum EIRPP limit:
* For VSAT capable of connecting with both GSO and LEO, TBD value
* For VSAT only capable of connecting with LEO, [60dBm]

**Huawei: we have concrete proposal for values, i.e., 60dBm.**

**Inmarsat: disagree. It conflicts with the agreement.**

**Thales: the first bullet to UE type 1, 2, 4, 5 and the second to UE type 3. We can associated those types with different EIRPs.**

**Agreement:**

* for each UE type, single value for minimum EIRP limit for certain elevation angle and FFS for the exact value;
* If UE is capable of communicating with both GSO and LEO, to follow the minimum EIRP for worse case.

**The following was discussed:**

* for each UE type, single value for minimum EIRP limit for certain elevation angle
* [60]dBm
* If UE is capable of communicating with both GSO and LEO, to follow the minimum EIRP for worse case.

**Issue 2-3: MPR and A-MPR requirement for VSAT**

* Proposal1: RAN4 to confirm if MPR and A-MPR (and so NS signalling) are not needed in the context of FR2-NTN. [Ericsson,[R4-2319568](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319568.zip)]
* Recommended WF:
  + Not to introduce MPR and A-MPR requirement for NTN VSAT
  + To use NS value approach to indicate the regional requirement if necessary

**Agreement:**

* Not to introduce MPR and A-MPR requirement for NTN VSAT
* To use NS value approach to indicate the regional requirement if necessary

**Issue 2-4: freq error requirement for NTN VSAT**

* Proposal 1:
* Reuse the existing FR1 NTN UE freq error requirement [+/-0.1ppm with 1ms];
* Recommended WF:
  + Proposal 1 is agreed

Agreement: Reuse the existing FR1 NTN UE freq error requirement [+/-0.1ppm with 1ms]

**Issue 2-5: EVM requirement for NTN VSAT**

* Proposal 1:
* postpone the support of Pi/2 BPSK for NTN VSAT in Rel-18 into future release. [ZTE, R4-2320332]
* Recommended WF:
  + Need further discussions

Agreement: postpone the support of Pi/2 BPSK for NTN VSAT in Rel-18 into future release

**Issue 2-6: Other transmitter signal quality requirement for NTN VSAT**

* Proposal 3: RAN4 need to further discuss the following transmitter signal quality requirement: [ZTE,R4-2320332]
* the necessity of carrier leakage requirement for NTN VSAT
* the necessity of in-band emission for NTN VSAT
* the necessity of EVM equalizer spectrum flatness requirement for NTN VSAT
* Recommended WF:
  + Need further discussions

Agreement:

* Do not define the following requirements
  + carrier leakage requirement for NTN VSAT
  + legacy TN UE in-band emission for NTN VSAT
  + EVM equalizer spectrum flatness requirement for NTN VSAT

**Issue 2-7: Transmitter dynamic range requirement for NTN VSAT**

* Proposal 1: RAN4 need to further discuss the the following requirement for NTN VSAT. [ZTE,R4-2320332]
* [The minimum output power]
* The OFF output power
* The transition period requirement
* Power control requirement,
* Recommended WF:
  + Need further discussions

Agreement: The following requirements need be specified.

* The minimum output power
* The OFF output power
* The transition period requirement
* Power control requirement,

**Issue 2-8 OBW**

* Proposal 1:
* Option 1: to follow the existing requirement of TS 38.101-2
* Recommended WF:
  + Proposal 1 is agreed

**Agreement:** follow the existing requirement of TS 38.101-2

**Issue 2-9 SEM requirement**

* Proposal 1:
* for the out-of-band emission requirement, propose to use the ITU-R SM.1541-6, Annex 5 OoB domain emission limits for space services (earth and space stations) as starting point and further discuss any modification if necessary (e.g. to keep consistency with other regional out-of-band emission requirement). [ZTE,R4-2320332]
* Recommended WF:
  + Need further discussions

Agreement:

**Issue 2-10 transmitter spurious emission requirement**

* Proposal 1:
* for the general transmitter spurious emission requirement, propose to follow the ITU-R SM.39 recommendation.[ZTE,R4-2320332]

TABLE 2 [ITU-R SM.329]

|  |  |
| --- | --- |
| Space services (mobile earth stations)(3), (4) | 43  10 log *P*, or 60 dBc, whichever is less stringent |
| Space services (fixed earth stations)(3), (4) | 43  10 log *P*, or 60 dBc, whichever is less stringent |

* Recommended WF:
  + Need further discussions

**Issue 2-11 Phase continuity requirement for DMRS bundling.**

* Proposal 1:
* NOT applicable for FR2 NTN VSAT
* Recommended WF:
  + Proposal 1 is agreed

.

### Sub-topic 3 Rx requirement

*Sub-topic description:*

*Open issues and candidate options before e-meeting:.*

**Issue 3-1 REFSENS requirements**

* Proposal 1: For fixed VSAT communicating with LEO only with electronical steering antenna, it’s proposed to specify the minimum EIS as -107dBm for 50MHz channel bandwidth. [Huawei,[R4-2319892](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip)]
* Observation 1: for parabolic antenna, Rx antenna gain as 39.7dBs seems to be reasonable assumption for both VSAT connecting with GEO/LEO with NF as 2.5dB and VSAT connecting with LEO with NF as 6dB;[ZTE,R4-2320332]
* Proposal 2: if typical scenario for NTN Ka-band for each beam is transmitted with single polarization, e.g. LHCP or RHCP, then polarization diversity gain. [ZTE,R4-2320332]
* Recommended WF:
  + Need further discussions

**Issue 3-2 FRC and FDD pattern in Annex.**

* Proposal 1:
* Reuse the existing DL FRC defined in TS38.101-2 with update TDD pattern configuration for FDD. FFS for UL FRC/ PRB configuration.
* Recommended WF:
  + Proposal 1 is agreed

**Issue 3-3: Maximum input power for NTN VSAT**

* Proposal 1:
* Depend on the simulation inputs/link budget [elevation angle as 90 degree] and only consider the receiver power without considering receiver array gain/aperture gain.
* If the VSAT is communicating with both GSO and LEO, the requirement will be decided by the worse case;
* Proposal 2: it’s proposed to specify -100dBm as OTA maximum input level for Ka band NTN UE. [Huawei,[R4-2319892](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319892.zip)]
* Observation 1: the OTA maximum input power is around -107dBm prior to antenna. [ZTE,R4-2320332]
* Recommended WF:
  + Proposal 1 is agreed
  + Further discuss the exact value for maximum input power requirement.

**Issue 3-4: In-band blocking requirement for**

* Proposal 1:
* for in-band blocking requirement for VSAT, propose to specify the power level of IBB to the same as power level of interfering signal of ACS requirement and reuse the freq offset of FR2 TN UE in-band blocking requirement. [ZTE,R4-2320332]
* Recommended WF:
  + Need further discussions

**Issue 3-5: Receiver spurious emission requirement for NTN VSAT.**

* Proposal 1:
* Option 1: not needed since this is FDD band and OTA conformance testing.
* Recommended WF:
  + Proposal 1 is agreed

## Companies views’ collection for 1st round

### Open issues

Sub-topic 1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

Sub-topic 2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

Sub-topic 3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

Sub-topic 4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

# Topic #2: PUSCH DMRS bundling

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2318425**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318425.zip) | Apple | CR to 38.101-5 on the introduction of NTN DMRS bundling feature |
| [**R4-2318426**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318426.zip) | Apple | On DMRS bundling with Doppler pre-compensation for NTN  Proposal 1: The requirement on phase continuity for NTN DMRS bundling is verified under zero Doppler and constant delay test conditions. The delay condition is a constant and derived from the ephemeris information (SIB-19) and UE location associated with the Doppler value under test.  Proposal 2: It is reasonable to limit the applicability of maximum DMRS bundling window length for NTN NGSO UEs to no more than [4] slots. For NTN GSO UEs the same maximum DMRS window bundling length can be reused from the terrestrial specification.  Proposal 3: The Rel-18 feature list shall capture the restriction on DMRS bundling bundling length for NTN bands.  Observation 1: RAN4 agreed to verify the phase continuity requirement for NTN DMRS bundling under zero Doppler and constant delay conditions.  Observation 2: Generally, some limit on the maximum DMRS bundling length is needed in light of variable Doppler conditions. This limit can apply to the UE supporting NGSO operation.  Observation 3: Phase rotation due to Doppler shift variation over a DMRS bundling window length of 8 slots consumes nearly the entire phase error budget of the requirement on max allowed phase difference. |
| [**R4-2319893**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319893.zip) | Huawei, HiSilicon | Discussion on DMRS bundling  **Proposal 1:**  **1) As only FDD bands are supported by NTN handheld UE, it’s proposed to only consider the Phase continuity requirements for NTN UE in FDD bands.**  **2) 25 degrees Phase difference between any slot p-1 and slot p and 30 degrees Phase difference between slot 0 and any slot p could be reused for NTN UE DMRS bundling feature. And some side conditions for TDD bands should be updated.**  **3) New UE capability for NTN UE DMRS bundling feature should be specified, e.g. “*maxDurationDMRS-Bundling-NTN-r18”*.**  **4) The RF Phase continuity requirements for Pi/2 BPSK modulation are not supported for NTN UE.**  **5) It’s suggested to specify RF Phase continuity requirements for NTN UE as proposed in Annex.**  **6) It’s assumed that Doppler conditions are set to zero and delay conditions are set to constant.** |
| [**R4-2319894**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319894.zip) | Huawei, HiSilicon | CR for 38.101-5 to introduce Phase continuity requirements for NTN UE DMRS bundling |
| [**R4-2320551**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320551.zip) | Ericsson | LS on UE capability of PUSCH DMRS bundling for NR NTN  Observation 1 The DMRS bundling enhancement feature for NGSO cannot be tested in Rel-18.  Proposal-1: Exclude the DRMS bundling for NGSO test and include it in Rel-19.  Proposal-2: The DMRS bundling test for UE only support NGSO should be excluded in Rel-18 test.  Proposal-3: Introduce new UE capability on DMRS bundling TDW for GSO and NGSO or limit the DMRS bundling capability in Rel-18 only to GSO. |
| [**R4-2320552**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320552.zip) | Ericsson | CR on DMRS bundling |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1 General

*Sub-topic description:\*

**Issue 4-1: the applicability of Pi/2 BPSK**

* + Proposal-1:The RF Phase continuity requirements for Pi/2 BPSK modulation are not supported for NTN UE.. [Huawei,[R4-2319893](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319893.zip)]
* Recommended for discussion
  + Agreed

**Issue 4-2: applicability of DMRS bundling for GSO and NGSO**

* + Proposal 1: Exclude the DRMS bundling for NGSO test and include it in Rel-19. [Ericsson, [R4-2320551](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320551.zip)]
  + Proposal 2: The DMRS bundling test for UE only support NGSO should be excluded in Rel-18 test. [Ericsson, [R4-2320551](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320551.zip)]
  + Proposal 3: It is reasonable to limit the applicability of maximum DMRS bundling window length for NTN NGSO UEs to no more than [4] slots. For NTN GSO UEs the same maximum DMRS window bundling length can be reused from the terrestrial specification. [Apple, [R4-2318426](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318426.zip)]
  + Proposal 4: New UE capability for NTN UE DMRS bundling feature should be specified, e.g. “maxDurationDMRS-Bundling-NTN-r18”. [Huawei, [R4-2319894](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319894.zip)]
* Recommended for discussion
  + Companies’ views are encouraged during the meeting.

**Issue 4-3: RF requirement for DMRS bundling**

* + Proposal 1:

1) As only FDD bands are supported by NTN handheld UE, it’s proposed to only consider the Phase continuity requirements for NTN UE in FDD bands.

2) 25 degrees Phase difference between any slot p-1 and slot p and 30 degrees Phase difference between slot 0 and any slot p could be reused for NTN UE DMRS bundling feature. And some side conditions for TDD bands should be updated.

5) It’s suggested to specify RF Phase continuity requirements for NTN UE as proposed in Annex.

6) It’s assumed that Doppler conditions are set to zero and delay

* Recommended for discussion
  + Companies’ views are encouraged during the meeting.

**Issue 4-4: NTN UE capability for DMRS bundling**

* + Proposal 1: New UE capability for NTN UE DMRS bundling feature should be specified, e.g. “maxDurationDMRS-Bundling-NTN-r18”. [Huawei, [R4-2319894](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319894.zip)]
* Recommended for discussion
  + Companies’ views are encouraged during the meeting.

## Companies views’ collection for 1st round

### Open issues

Sub-topic 1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

Sub-topic 2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

Sub-topic 3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

Sub-topic 4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A |  |
| Company B |  |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  | WF on … | YYY |  |
|  | LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |  |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
|  |  |  |

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)