**3GPP TSG RAN meeting #99 RP-230119**

**Rotterdam, Netherlands, March 20-23, 2023** *revised RP-222812*

## Status Report to TSG

**Title: Status report for WI NR NTN (Non-Terrestrial Networks) enhancements; rapporteur: Thales**

**Agenda item:** 9.3.2.7

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **WI / SI Name** | Rel-18 NR NTN (Non-Terrestrial Networks) enhancements | | | | |
| included in this status report | Study Item:  No | Core part:  Yes | Performance part:  Yes | | Testing part:  No |
| **Acronym** | NR-NTN-enh | | | | |
| **Unique ID** | 941006 | | | | |
| **TSG Tdoc of latest approved WI/SI description (if any)** | [*RP-223534*](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_98e/Docs/RP-223534.zip) | | | | |
| **Target Completion Date**  **(indicate if changed)** | Study Item: | Core part: 12/2023 | Performance part: 06/2024 | Testing part: | |
| **Overall Completion level** | Study Item: | Core part:  Overall: 35%  RAN1: 40%  RAN2: 30%  RAN3: 30%  RAN4: 30% | Performance Part:  Overall: 0%  RAN4: 0% | Testing part: | |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |  |
| --- | --- | --- |
| **Leading WG** | | RAN2 |
| **Rapporteur** | **Name** | Nicolas Chuberre |
| **Company** | Thales |
| **Email** | Nicolas.chuberre@thalesaleniaspace.com |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.  
 One time unit (TU) corresponds to ~ 2 hours in the meeting.  
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.  
 Note: If no Excel table is attached, then this means no time budget change.*

-

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

* **RAN WG1 #112 Athens, Greece, February 27th – March 3rd, 2023**

1. Coverage enhancement for NR NTN

**Observation**

For NTN-specific PUSCH DMRS bundling, in LEO 1200 with elevation angle 30 deg. and SCS = 15 kHz, RAN1’s understanding is the following:

* Timing error limit (Table 7.1C.2-1 in 38.133) can be satisfied within at most 13 slots if TA pre-compensation update is not assumed.
  + FFS: whether/how to consider the initial timing error at the beginning
  + FFS: TA pre-compensation update is assumed
* Frequency error limit (Section 6.4.1 in 38.101-5) can be satisfied over 32 slots if frequency pre-compensation update is not assumed.
* FFS: impact of phase difference limit

**Working assumption**

For PUCCH repetition for Msg4 HARQ-ACK, discuss the following options as container of the [repetition request or capability report] indicated by UE.

* Option A: PRACH preamble and/or occasion
  + FFS: whether PRACH resource partitioning is needed for indication of [repetition request or capability report]
  + FFS: whether or not indication of repetition factor is assumed
  + Note: the relation with R18 NR coverage enhancements for PRACH may need to be considered in future meetings
* Option B: Higher layer signaling in Msg3 PUSCH
  + FFS: which signaling is used
  + Note: if higher layer signaling is preferred in RAN1, the feasibility will be asked to RAN2.
* Option C: Physical layer signaling in Msg3 PUSCH
  + FFS: which signaling is used, e.g. DMRS ports

**Agreement**

For PUCCH repetition for Msg4 HARQ-ACK, discuss the following alternatives for dynamic indication of repetition factor from gNB.

* Alt 1: Field in DCI scheduling the Msg4 PDSCH
  + Alt 1-1: One or two bits of the existing field
    - Alt 1-1a: MCS field
    - Alt 1-1b: PUCCH resource indicator field (e.g., with repetition factor configuration per PUCCH resource)
    - Alt 1-1c: HARQ process number filed
    - Alt 1-1d: DAI field
    - Alt 1-1e: PDSCH-to-HARQ\_feedback timing indicator field
  + Alt 1-2: New field with one or two bits
* Alt 2: Field in DCI scheduling Msg3 PUSCH
  + PUCCH repetition factor is indicated jointly with Msg3 repetition factor by using a pre-defined/configured relationship between PUCCH repetition factor and Msg3 repetition factor
  + Note: it is assumed that there is impact on DCI design
* Alt 3: CRC scrambling of DCI scheduling the Msg4 PDSCH
  + One or two CRC bits other than bits scrambled by TC-RNTI is used for the dynamic indication, etc.
* Alt 4: Implicit mapping between Msg4 HARQ ACK repetition factor and indication of Msg3 PUSCH repetition with no re-interpreted field / new field (i.e. no change to DCI design)

**Working assumption**

For PUCCH repetition for Msg4 HARQ-ACK,

* A RSRP threshold can be configured via SIB at least when the number of repetitions is configured by SIB.
  + If the RSRP threshold is configured and the configured RSRP threshold is smaller than X,
    - UE capable of PUCCH repetition for Msg4 HARQ-ACK transmits repetition request if measured RSRP is lower than a RSRP threshold.
  + If the configured RSRP threshold is X,
    - UE capable of PUCCH repetition for Msg4 HARQ-ACK reports the capability of PUCCH repetition for Msg4 HARQ-ACK
  + FFS: value of X (the maximum configurable value of the RSRP threshold)
  + FFS: the exact UE behavior if the RSRP threshold is not configured
  + Down-select one from the following alternatives for the RSRP threshold.
    - Alt A: The same RSRP threshold as R17 Msg3 repetition (i.e., *rsrp-ThresholdMsg3-r17*) is used.
    - Alt B: New RSRP threshold is introduced.
* Note: UE incapable of PUCCH repetition for Msg4 HARQ-ACK transmits neither repetition request nor capability report

1. “Network verified UE location for NR NTN ”

**Agreement**

Existing DL/UL reference signals for positioning are used for supporting Network verified UE location in NTN.

FFS: Whether some enhancements on these reference signals are needed for NTN

**Agreement**

In NTN, for the position of the reference point for definition of gNB Rx – Tx time difference measurement, consider the following options:

* Option 1: Onboard the satellite
* Option 2: The uplink time synchronization reference point
* Option 3: on the gNB

**Agreement**

Select one (or more) of the following options for enhancing UE Rx-Tx time difference in NTN

* Option 1: The UE Rx – Tx time difference is defined as TUE-RX –TUE-TX

Where:

* + UE Rx-Tx time difference is defined with respect to the Rx and Tx subframe timing associated with the TRP.

For a Transmission Point

* + TUE-RX is the UE received timing of downlink subframe #*i* from this Transmission Point (TP), defined by the first detected path in time.
  + TUE-TX is the UE transmit timing of the uplink subframe corresponding to subframe #*i* received from the TP
  + One or multiple DL RS for positioning, as instructed by higher layers, can be used to determine the start of one subframe of the first arrival path of the TP.

FFS: For a Transmission Point different from the serving cell (e.g. a DL-PRS-only TP)

* Option 2*:*
  + For RTT measurement in NTN, support UE report that indicates the time difference between the arrival time of a DL RS for positioning and the transmit time of an SRS.
  + FFS: details of report and the definition of UE Rx-Tx time difference
* Option 3: The legacy R17 definition of UE Rx-Tx time difference is adopted for NTN with an offset that is determined based on one of the following options:
  + Option 3-1: This offset is reported as the nearest integer value in the unit of milliseconds by rounding the time difference of transmit timing of uplink subframe #i and receive timing of downlink subframe#i
  + Option 3-2: UE report the index of the subframe j that is closest in time to the subframe #i received from the TP and LMF can derive the offset
  + Option 3-3: TA report which corresponds to the time difference of received timing of downlink subframe #i and transmit timing of uplink subframe#i rounding up to slot granularity.
* Option 4:
  + UE Rx – Tx time difference TUE-RX – TUE-TX  can be directly derived from timing advance TTA
    - FFS: the granularity and the reporting range of TA.
    - Note: This implies that the existing framework for Multi-RTT positioning report can be used without need to specify a new TA report.

Note: The impact of UE autonomous adjustment of TA (when applied) should be taken into account

**Agreement**

Select one (or more) of the following options for the enhancement of gNB Rx-Tx time difference in NTN

* Option 1: The gNB Rx – Tx time difference is defined as TgNB-RX –TgNB-TX

Where:

For a Transmission Point

* + TgNB-RX is the Transmission and Reception Point (TRP) received timing of uplink subframe #*i* containing SRS associated with UE, defined by the first detected path in time.
  + TgNB-TX is the TRP transmit timing of the downlink subframe corresponding to uplink subframe #i received from the UE
  + Multiple SRS resources can be used to determine the start of one subframe containing SRS.

FFS: For a Transmission Point different from the serving cell (e.g. a DL-PRS-only TP)

* Option 2:
  + For RTT measurement in NTN, support gNB report of gNB Rx-Tx time as defined in 38.215 with the following change:
    - Only the SRS resource starting within a subframe can be used to determine the start of the subframe.
* Option 3:
  + Keep the current gNB Rx-Tx definition, and report an offset which can covers the time duration corresponds to kmac if needed.
* Option 4:
  + For RTT measurement in NTN, support gNB report that indicates the time difference between the transmit time of a DL RS for positioning and the arrival time of an SRS.
  + FFS: details of report.

Note: The impact of UE autonomous adjustment of TA (when applied) should be taken into account

**Agreement**

Study the following options to resolve the mirror positions ambiguity for multi-RTT positioning:

* Option 1: gNB or LMF implementation to solve the mirror error issue.
  + FFS: whether there is spec impact
* Option 2: Reuse existing ECID method (e.g. combine UE neighbor measurements to solve the ambiguity between mirror positions), with potential enhancements
* Option 3: NR NTN UE should report the Doppler calculated on the service link
* Option 4: a VSAT UE should report its beam pointing in respect to satellite beam line of sight
* Option 5: Reporting of cell coverage information (e.g. cell footprint and reference point, or antenna pattern) to the LMF
* Option 6: Support and potentially enhance the optional Rel-17 UL-AoA measurements defined for multi-RTT positioningOther solutions are not precluded

**Conclusion**

Geometry relating the UE and the TRPs (satellites) affects positioning accuracy for network verified UE location based on Multi-RTT.

Email discussions

* R1-2302230 Summary EOM on 9.11.1 Coverage enhancement for NR NTN Moderator (NTT DOCOMO, INC.)
* R1-2302223 FL Summary #5: Network verified UE location for NR NTN THALES

#### 2.1.2 Remaining Open issues

Coverage enhancements

Normative is on going

Network verified UE location

Normative is on going

## 2.2 RAN2

#### 2.2.1 Agreements

The agreeable Work plan can be found in R2-2301344 R18 WI NR-NTN-enh work plan at RAN1, 2 and 3

* **RAN2#121, Athens, Greece, February 27th – March 3rd, 2023**

a) Coverage enhancements

Agreements:

TBC

b) Network verified UE location

Agreements:

RAN2 will work on a solution that ensures that location verification can be completed within a period of approximately 1 minute maximum and 30 seconds preferably.

Agreements:

1. For network verified UE location, the verification procedure can only be triggered by the CN.

2. Network initiated verification procedure can be triggered by the NW when the UE is in RRC Connected. FFS whether the NTN UE can perform/report measurements also when in Inactive state.

3. RAN2 will not specify an AS mechanism to prevent UEs not supporting the required RAT dependent positioning methods to access the network

Agreement:

1. RAN2 assumes that, as a baseline, legacy signalling procedure of location service can be reused for the purpose of network verified UE location in NTN.

Agreement:

1. RAN2 assumes that in general the mirror point issue can be resolved by properly configuring neighbor cell measurement to UE, for example, measurement of two neighbor cells in the opposite side of a satellite beam. FFS if there are any cases that require anything in the specs

c) Mobility enhancements

Agreements:

1. TN coverage area information will be associated to the frequency information.

2. RAN2 adopts explicit description of geographical TN area, and focuses on the following options for further discussion, taking the signalling overhead into account (FFS on the accuracy of the information):

Option 1: The corresponding geographical area information is provided by network with location coordinates of area center and radius.

Option 2: a boundary line is provided by network in the format of a list of location coordinates, additionally an indication can be used to indicate which side is the TN side

Option 6: for each TN area, a list of locations is provided by network, and the corresponding close shape could be illustrated by a polygon connecting these points within the list.

Agreements:

1. As a baseline, broadcast signalling is used to provide the information on the TN coverage area for UEs supporting NTN.

2. Also based on the signalling overhead of the broadcast solution, RAN2 will further consider the option that UE-specific update can be optionally be provided via dedicated signalling, overriding the broadcast configuration (FFS if via RRC or higher layers. FFS on the validity time, if provided by RRC)

Agreements:

1. We don’t introduce additional cell reselection prioritization rules for NTN vs TN in Rel-18 (e.g. per service type, per mobility state, or per UE type) on top of what specified in Rel-17

Agreements:

1. In R18, for earth-moving system, satellite with steerable beam is not considered as part of mobility enhancement in NTN.

2. A serving cell reference location and a distance threshold/radius will be broadcast for earth-moving cell. FFS on whether the R17 IEs are reused or not. FFS on whether additional information needs to be broadcast to inform the UE how the reference location moves over time or if this can be derived from other information (e.g. Epoch time and ephemeris).

3. For cell selection/reselection, location-based measurement initiation is supported in earth-moving cell

Agreements:

1. For earth-moving cell, the location-based cell measurement rules of quasi-fixed cell is reused, i.e., for cell reselection in earth-moving cell, UE initiates measurements when its location to serving cell reference location is larger than the configured distance threshold.

Agreements:

1. Continue in the next meeting, to show the possible signalling gain of the proposal to have some common (C)HO configuration. FFS the number of cells that could be signalled. FFS whether broadcast or groupcast signalling could be used.

2. For location-based CHO for earth-moving cells we follow the solution being investigated for cell reselection to allow the UE to derive the serving cell’s reference locations as the cells move. FFS whether the same mechanism can also be used for the candidate cell’s reference location

Agreements:

1. Support RACH-less Handover in Rel-18.

2. RACH-less Handover in NR NTN is a L3 mobility procedure (FFS if this is combined with the unchanged PCI approach, if supported) and uses the LTE’s RACH-less Handover procedure as a baseline. FFS on TA acquisition

3. In NTN RACH-less handover, network indicates (implicitly or explicitly) whether NTA in the target cell is identical to the source cell or explicitly provided by the NW.

4. Support dynamic grant from the target cell for RACH-less PUSCH transmission to reduce random access congestion in the target cell. FFS whether to limit the solution to same feeder link/gateway scenario

Working Assumption:

1. In quasi-earth fixed cell case, for hard satellite switch in the same SSB frequency and same gNB (no key change), satellite switching without PCI changing (not requiring L3 mobility) is supported.

LS out

Email discussions

* [AT121][104][NR NTN enh] NTN-NTN cell reselection (ZTE)
* [POST121][106][NR NTN Enh] NTN-NTN cell reselection (ZTE)

#### 2.2.2 Remaining Open issues

a) Coverage enhancements

* Specify signalling and procedures to support UL coverage enhancements

b) Network verified UE location

* specification of necessary enhancements to multi-RTT to support the network verified UE location in NTN assuming a single satellite in view. DL-TDoA methods for verification may be considered as lower priority and if time permits and condition in Note is satisfied

c) NTN-TN and NTN-NTN mobility and service continuity enhancements

* Specify NTN-TN and NTN-NTN measurement/mobility and service continuity enhancements

## 2.3 RAN3

#### 2.3.1 Agreements

* **RAN3#119, Athens, Greece, February 27th – March 3rd, 2023**

1. Mobility enhancements

Agreements

**Turn WA to agreement: The Uu cell ID is used as target Cell ID in both NG and Xn handover signaling.**

**Introducing time-based parameters for NG HO follows legacy CHO configuration over Uu interface without any RAN2 impact**

Documents agreed

* R3-231033 Clarification on Cell Identifier used for handover signalling and XN Interface (Qualcomm Incorporated, Nokia, ZTE, Deutsche Telekom, Verizon Wireless, CATT, NEC)

Email discussions

* R3-230937 # 38\_NRNTN\_ServiceContinuity, Nokia

1. Network verified UE location

Agreements

* -

Documents agreed

* -

Email discussions

* -

#### 2.3.2 Remaining Open issues

To be further discussed as part of NTN-TN and NTN-NTN mobility and service continuity enhancements

* **Whether to use Uu cell ID or mapped cell ID over Xn configuration update procedure?**

## 2.4 RAN4

#### 2.4.1 Agreements

* **RAN4#106, February 27th – March 3rd 2023, Athens**

1. NR-NTN deployment in above 10 GHz

[UERF aspects]

**Issue 2-1: Beam correspondence requirement**

**Agreement:**

* Discuss whether and how to define the requirements for beam tracking for NTN UE.

**Issue 3-1: conductive or radiated RF requirement for NTN UE**

**Agreement:**

* Define the radiated requirement as the first priority.

[BSRF Test Demod aspects]

SAN RF requirements

**Issue 2-1-1:** OBUE requirement for SAN above 10 GHz

* Agreement: As starting point, RAN4 should consider specifying OBUE requirement for SAN above 10 GHz based on ITU SM.1541-6 / OoB masks

**Issue 2-1-2:** SAN power flux density requirements

* Agreement: FFS whether need to consider SAN power flux density requirements in RAN4 specification.

**Issue 2-2-1:** Impact of insertion loss and link budget

* Agreement:
  + Prioirtize the work on radiated requirements for Ka band, FFS whether conductive requirements needed or not
    - if the conductive requirements to be defined for Ka-band NTN SAN, the impact of insertion loss and link budget should be further clarified.

**Issue 2-3-1:** SAN OTA Tx Requirements

* Agreement:

|  |  |
| --- | --- |
| **OTA Tx requirements** | **Applicability notes** |
| Radiated transmit power (EIRP) | define the requirement based on EIRP manufacturer declaration, with the accuracy of the declared output power value reusing the [± 3.4 dB] from the BS type 2-O specification in TS 38.104 (Normal test conditions). |
| Radiated transmit power (EIRP) | no requirement for Extreme test conditions. |
| OTA Satellite Access Node output power (TRP) | define the requirement based on TRP manufacturer declaration, with the accuracy of the declared output power value reusing the [± 3 dB] from the BS type 2-O specification in TS 38.104 (Normal test conditions). |
| **OTA Output power dynamics** |  |
| OTA RE power control dynamic range | Align the approach with the BS type 2-O and **no requirement to be defined.** |
| OTA Total power dynamic range | define the requirement following the approach in TS 38.104 section 9.4.3.3 for the Minimum requirement for BS type 2-O total power dynamic range derivation in FR2-1. |
| OTA Transmit ON/OFF power | N/A for NTN SAN, since the Ka-band is FDD band. |
| **OTA Transmitted signal quality** |  |
| OTA Frequency error | define the OTA Frequency error requirement for SAN as 0.05 ppm observed over 1 ms. |
| OTA Modulation quality | Reuse QPSK and 16QAM requirements of 17.5% and 12.5%, respectively.  FFS whether 64QAM can be considered for 2-0 |
| OTA Time alignment error | N/A for NTN SAN (no support for MIMO due to NTN specific channel characteristics, similar as Rel-17 NTN 5G NR). |
| **Unwanted emissions** |  |
| OTA Occupied bandwidth | define the requirement of OTA occupied bandwidth for each NR carrier shall be less than the SAN channel bandwidth. |
| OTA relative ACLR (Adjacent Channel Leakage Ratio) | FFS pending on co-existecne study conclusion |
| OTA absolute ACLR | align the requirement with SAN type 1-O **no requirement to be defined.** |
| OTA OBUE (Operating band unwanted emissions) | reuse the approach from SAN type 1-O and define the requirement based on related ITU recommendation SM.1541-6 as starting point. |
| OTA TX spurious emissions | General requirement: defined the requirement based on ITU-R SM.329.  Protection of the SAN receiver: Align the approach with SAN type 1-O based on NTN deployment specific conditions, i.e. **no requirement to be defined.** |
| OTA TX intermodulation | Align the approach with SAN type 1-O based on NTN deployment specific conditions, i.e. **no requirement to be defined.** |

**Issue 2-3-2:** SAN OTA Rx Requirements

* Agreement:

|  |  |
| --- | --- |
| **OTA Rx requirement** | **Applicability notes** |
| OTA sensitivity | Align the approach with BS type 2-O, i.e. no OTA sensitivity requirement for FR2, the OTA sensitivity is the same as the OTA reference sensitivity (see next proposal). |
| OTA Reference sensitivity level | While the overall requirement framework can be reused from the BS type 2-O in TS 38.104, the range of EIS values applicable to the NTN SAN deployment in FR2 requires further study. |
| OTA Dynamic range | FFS pending further evaluation |
| OTA ACS | FFS pending on co-existence study conclusion |
| OTA In-band blocking | Align the approach with the SAN type 1-O, i.e. **no requirement to be defined.** |
| OTA Out of band blocking | FFS |
| OTA Receiver spurious emission | Align the approach with the SAN type 1-O, i.e. **no requirement to be defined.** |
| OTA Receiver intermodulation | Align the approach with the SAN type 1-O, i.e. **no requirement to be defined.** |
| OTA In-channel selectivity | FFS |
| co-location requirements | to mirror the agreement from FR1, there are no co-location requirements for SAN type 2-O either. |

System parameters

**Issue 1-1-1: Above 10 GHz NTN band definition** (updated during ad-hoc meeting 18h00-19h00 on 4th Day)

Agreement:

The following bands and frequency ranges were agreed, without square bracket. Note that the DL lower frequency range was modified from 17.7 to 17.3 to reflect regional regulations.

|  |  |  |
| --- | --- | --- |
| **NTN operating band** | **UL**  **Earth-to-Space** | **DL**  **Space-to-Earth** |
| n5121 | 27.5 - 30.0 GHz | 17.3 - 20.2 GHz |
| n5112 | 28.35 - 30.0 GHz | 17.3 - 20.2 GHz |
| n5103 | 27.5 - 28.35 GHz | 17.3 - 20.2 GHz |

The notes were then treated individually:

**Note 1:** This band is applicable in the countries subject to CEPT ECC Decision(05)01 and ECC Decision (13)01.

**Note 2:** This band is applicable in the USA subject to FCC 47 CFR part 25.

**Note 3:** This band is applicable for Earth Station operations in the USA subject to FCC 47 CFR part 25. FCC rules currently do not include ESIM operations in this band (47 CFR 25.202).

**Issue 1-1-2: Channel BW**

Agreement:

* + Option 1: Not to define channel bandwidth beyond 400MHz for Ka-band.

This was agreeable since there was already a prior agreement to this from RAN4 #105.

**Issue 1-1-3: SCS**

Agreement:

* + Option 1: Wait for RRM conclusion on the feasibility of using sub-carrier spacing values 60 and 120 kHz for NTN above 10 GHz.

This was agreeable. There was no objection to this option.

**Issue 1-1-4: Spectral Utilization**

Agreement:

* + Option 1: to use the same spectral utilization requirement of FR2 TN system for NTN Ka-band as starting point.

This was agreeable due to previous agreement from RAN4 #105. “Take the same spectral utilization requirement of FR2 TN system as starting point pending on further confirmation after co-existence study.”

**Issue 1-1-5:** FR2-0(-NTN)/FR2-1-NTN sub-frequency range specification

* Proposals
  + Option 1: Introduce extension of the lower bound of the FR2 frequency range to cover both DL and UL of NTN bands defined under the Ka band. (P1& P2/[R4-2302468](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_106/Docs/R4-2302468.zip))

NOTE: This FR2 extension does not preclude its further extensions.

|  |  |  |
| --- | --- | --- |
| Frequency range designation | | Corresponding frequency range |
| FR1 | | 410 MHz – 7125 MHz |
| FR2 | FR2-0 | [17700] MHz – 24250 MHz |
| FR2-1 | 24250 MHz – 52600 MHz |
|  | FR2-2 | 52600 MHz – 71000 MHz |

* + Option 2: FR2-1-NTN is agreed for the FR name only in NTN specifications. TN specifications are not touched at current stage. (P1/[R4-2300563](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_106/Docs/R4-2300563.zip))

Table 1: Definition of frequency ranges for NTN

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range |
| FR1 | 410 MHz – 7125 MHz |
| FR2-1-NTN | [17700]-20200 MHz, [27500]-30000 MHz |

* + Option 3: Consider one single range [17700]-30000 MHz (as for FR1 410 MHz – 7125 MHz).
* Agreement:
  + Update with 17.3 GHz lower range instead of 17.7 GHz.
  + Further discuss if introducing FR2-0 or FR2-1-NTN with respect to definition of NTN (which is FDD).
* The FR would be captured in NTN specifications, in order to not impact terrestrial definition FR1 and FR2 for TN specifications.
* At least 2 options are considered for the corresponding frequency ranges:

1.     **Option 1:** 17300-24250 MHz as extension of the existing FR2 range:

|  |  |  |
| --- | --- | --- |
| Frequency range designation | | Corresponding frequency range |
| FR1 | | 410 MHz – 7125 MHz |
| FR2 | **FR2-0-NTN** | **17300 MHz – 24250 MHz** |
| FR2-1 | 24250 MHz – 52600 MHz |
|  | FR2-2 | 52600 MHz – 71000 MHz |

2.     **Option 2:** 17300-30000 MHz;

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range |
| **FR2-NTN** | **17300-30000 MHz** |

**Note:** Bands defined within FR2-NTN can be regarded as a FR2 band.

  3.     **Option 3:** **Other options not precluded.**

Co-existence studies (scenario)

Following agreements have been made:

1. Study NTN-TN coexistence by assuming a reference frequency of 17 GHz for NTN DL cases and 27 GHz NTN UL cases, as well as the consideration of ACLR and ACS assumptions as following:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Combination | Aggressor | Victim | Scope of Coexistence Simulation |
| 1 | TN with NTN | NTN UL | TN UL | ACLR NTN UE to be varied/defined  ACS TN gNB fixed |
| 2 | TN with NTN | TN UL | NTN UL | ACLR TN UE fixed  ACS NTN SAN to be varied/defined |
| 3 | TN with NTN | NTN UL | TN DL | ACLR NTN UE to be varied/defined  ACS TN UE fixed |
| 4 | TN with NTN | TN DL | NTN UL | ACLR TN gNB fixed  ACS NTN SAN to be varied/defined |
| 5 | TN with NTN | TN DL | NTN DL | ACLR TN gNB fixed  ACS NTN UE to be varied/defined |
| 6 | TN with NTN | NTN DL | TN DL | ACLR NTN SAN to be varied/defined  ACS TN UE fixed |
| 7 | TN with NTN | NTN DL | TN UL | ACLR NTN SAN to be varied/defined  ACS TN gNB fixed |
| 8 | TN with NTN | TN UL | NTN DL | ACLR TN UE fixed  ACS NTN UE to be varied/defined |
| NOTE 1: For coexistence between Ka-Band DL and adjacent TN bands, there are no 3GPP defined/specified TN bands. | | | | |

Furthermore, for the assumption on TN ACLR/ACS for co-existence simulation, the values for 17GHz in below table are considered as starting point for co-existence simulation purpose yet other options not precluded.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency band | BS | | UE | | ACIR | |
| ACLR | ACS | ACLR | ACS | BS ACLR  UE ACS | UE ACLR  BS ACS |
| 17 GHz | [30] | [26] | [19] | [25] | [23.8] | [18.2] |
| 27 GHz | 28 | 24 | 17 | 23 | 21.8 | 16.2 |

1. RAN4 to update the NTN-TN coexistence scenarios for above 10 GHz bands with the following figures:

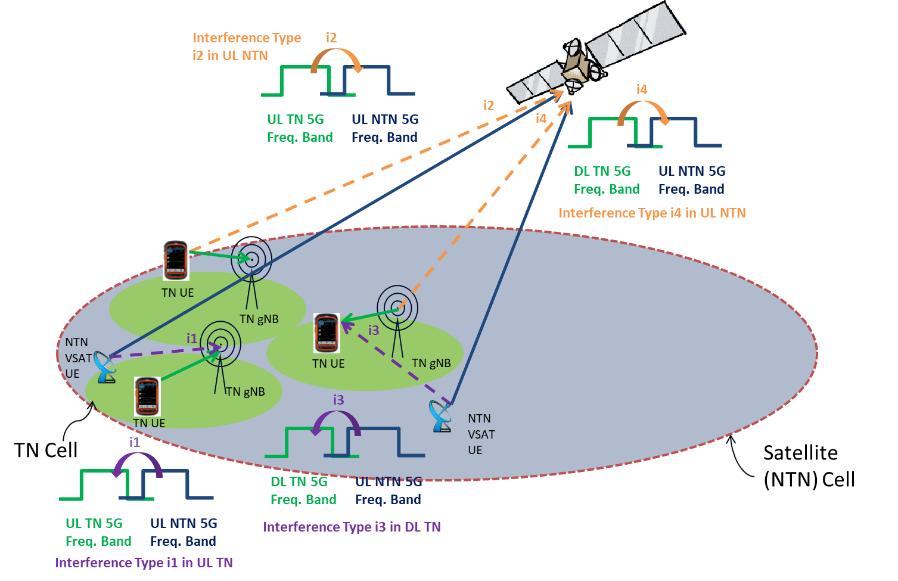


Figure 1. Coexistence scenarios for use cases 1-4 (in above 10 GHz)

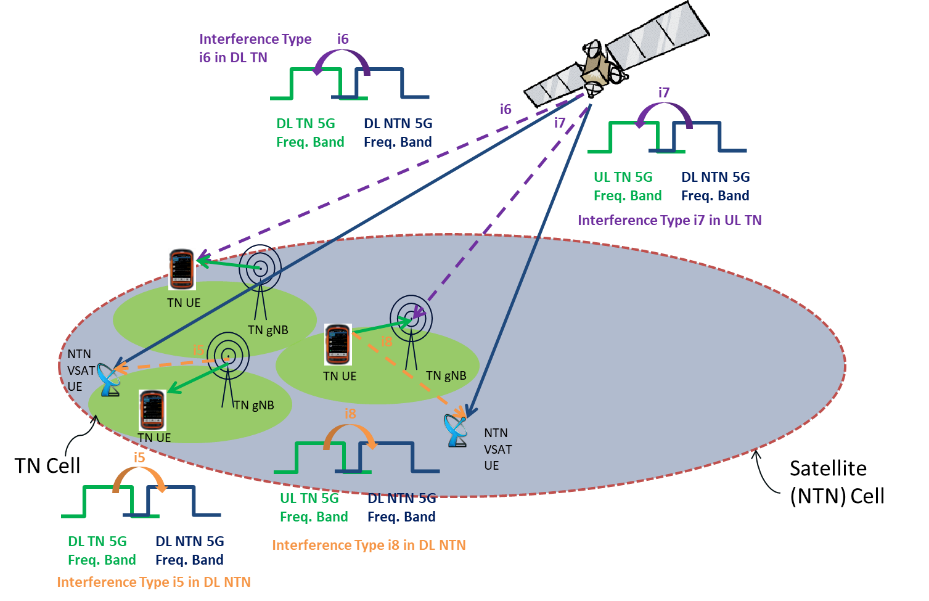


Figure 2. Coexistence scenarios for use cases 5-8 (in above 10 GHz)

Co-existence studies (Network layout)

Following agreements have been made:

1. For TN Urban area deployment, 20% active ratio can be applied to urban areas.
2. Further discuss whether NTN UEs could be dropped within TN cluster taking into account relative discussion of Issue 3-3 Number of active UE (UL).

Co-existence studies (System parameter)

Following agreements have been made

1. For calibration only, the NTN GEO and LEO SAN Noise Figure is set as 5.9dB.
2. NTN DL parameters in the table below is used with the circular aperture type antenna pattern defined in Section 6.4.1 of TR 38.811 for co-ex study as the starting point. Simulation with phased array antenna type is not excluded.

Ka-Band DownLink (i.e. ~20 GHz for DL) for different satellite orbits

|  |  |  |  |
| --- | --- | --- | --- |
| **SAN parameters** | **GEO** | **LEO-1200 km** | **LEO-600 km** |
| Equivalent satellite antenna aperture (m) | 5,0 | 0,5 | 0,5 |
| Satellite EIRP density (dBW/MHz) | 40 | 10 | 4 |
| Satellite Tx max Gain (dBi) | 58,5 | 38,5 | 38,5 |

1. For calibration, the number of active NTN UE (UL) is 10 UEs with divided RBs per UE by channel bandwidth.
2. Following assumptions of NTN UE height are used as the starting points

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NTN UE scenario | Fixed VSAT (on roof) | M-ESIM | A-ESIM | L-ESIM |
| Altitude | 22.5m | 22.5m | 3-14km | 1.5m |

1. For calibration, NTN UE antenna elevation angle is 90 degree.
2. TN parameters of Dense Urban Micro base station will be considered with second priority and the density is yet to be discussed.
3. Both parabolic antenna and phased array antenna for NTN SAN and UE are considered as the starting point of co-existence simulation.

* Parameters of above mentioned two types of antennas will be defined seperately.
* To reduce the workload of calibration, consider parabolic antenna for GEO and phased array antenna for LEO.

1. Adopt the following TN BS antenna parameters:

* Adopt 90 degree for 0.5 wavelengths Horizontal/Vertical element spacing.
* Adopt 5.5dBi for 90-degree horizontal/vertical 3dB beamwidth.

|  |  |
| --- | --- |
|  | **Macro urban** |
| **Base Station Antenna Characteristics** | |
| Antenna pattern | TR 38.803 |
| Element gain *GE,max* (dBi) | 5.5 |
| Horizontal *3dB* /vertical *3dB* 3 dB beam width of single element (degree) | 90º for H  90º for V |
| Horizontal/vertical front‑to‑back ratio *Am* (dB) | 30 for both H/V |
| Side lobe suppression *SLAv (dB)* | 30 |
| Antenna polarization | Linear ±45º |
| Antenna array configuration (Row × Column) | 16 × 8 elements |
| Horizontal/Vertical radiating element spacing | *dh* = 0.5   *dv* = 0.5  |
| Array Ohmic loss *LE* (dB) | 2 |
| Conducted power (before Ohmic loss) per antenna element (dBm) | 22 |
| Mechanical downtilt (degrees) | 10 |

1. To update the UE maximum output power from 23dBm to UE peak EIRP as 22.4dBm for both Urban and Dense Urban
2. To assume the TN ISD with 300m for the 17 GHz frequency range.

[RRM aspects]

No discussions in this meeting.

1. Coverage enhancements

[UERF aspects]

No UERF aspects discussioins are expected.

[BSRF Test Demod aspects]

No discussions in this meeting.

[RRM aspects]

No RRM aspects discussioins are expected.

1. Network verified UE location

[UERF aspects]

No UERF aspects discussioins are expected.

[BSRF Test Demod aspects]

No discussions in this meeting.

[RRM aspects]

No discussions in this meeting.

1. Mobility enhancements

[UERF aspects]

No UERF aspects discussioins are expected.

[BSRF Test Demod aspects]

No discussions in this meeting.

[RRM aspects]

**Issue 5-4: NTN-TN Handover**

**Conclusion:**

* It is a common understanding of the group that NTN-TN handover is not in the immediate scope of Rel-18 NR NTN enhancement.

**Agreement:**

* RAN4 to not define NTN-TN handover, i.e. mobility requirements between NTN and TN are applicable only when UE is in RRC Idle/Inactive mode.

**Issue 6-1: Applicable scope of this WI**

**Agreement:**

* Unless any compelling reasons are identified and agreed, RRM requirements will be defined for non-CA.
* The following aspects will be discussed under relevant items:
  + Whether/How to define RRM requirements for mobility between NTN and FR1/FR2 TN will be discussed under sub-AI of “NTN-TN and NTN-NTN mobility and service continuity enhancements” if needed. The discussion also includes whether TN is limited to NR or other RATs.
  + Whether/How to define RRM requirements for mobility within NTN-Ka bands and between FR1/FR2 and NTN-Ka bands will be discussed under sub-AI of “NR-NTN deployment in above 10 GHz bands” if needed.

**LS reply**

**Agreement**

* + RAN4 to send a reply-LS to RAN1 with the following contents:
    - For NTN-NTN FR1-FR1 handover, RAN4 to confirm that Note 1 in the LS (R1-2213001) is correct, i.e. the timing requirement specified in Table 7.1C.2-1 of TS38.133 applies to the first UL transmission, including PUCCH, PUSCH, SRS, PRACH, and msgA, in the target cell, provided that
      * at least one SSB is available at the UE during the last 160 ms.
      * UE is provided with information such that the UE has valid and upon handover execution.
      * the network and UE have a common understanding of NTA component upon HO execution.
    - RAN4 assumes the determination of the value for NTA for the different scenarios is up to RAN1
    - The timing requirement specified in Table 7.1C.2-1 of TS38.133 are applicable to FR1 only and there are no requirements for other frequency ranges
    - There are no existing RAN4 NR RRM requirements for RACH-less HO and additional RAN4 work will be required to introduce requirements and identify side conditions

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Documents approved:

* R4-2300973 Revised NR NTN enhancement workplan
* R4-2302877 WF for SAN RF requirements on above 10 GHz
* R4-2302878 WF for above 10GHz NTN-TN co-existence study
* R4-2302879 Ad-hoc minutes for system parameters of above 10GHz NTN band introduction
* R4-2302998 WF for system parameters of above 10 GHz NTN band
* R4-2303238 WF on NR NTN enhancement RRM requirements
* R4-2303239 LS reply on RACH-less handover in NTN
* R4-2303533 WF on NTN UE RF requirements for Ka band

Documents agreed:

* -

[Other documents]

Email discussion summaries:

* R4-2302783 Topic summary for [106][225] NR\_NTN\_enh
* R4-2302835 Topic summary for [106][142] NR\_NTN\_enh\_UERF
* R4-2303757 Topic summary for [106][312] NR\_NTN\_enh\_Part1
* R4-2303758 Topic summary for [106][313] NR\_NTN\_enh\_Part2

#### 2.4.2 Remaining Open issues

**NR-NTN deployment in above 10 GHz**

* Study and identify NTN example band: Analysis of regulations and adjacent channel co-existence scenarios.
* Specify Rx/Tx requirements for satellite access node and different VSAT UE class (not only 60 cm aperture) as appropriate for the identified example band
* Identify values for physical layer parameters chosen from the existing FR1 and FR2 sets.

**Coverage enhancements**

* Specify PUCCH enhancements for Msg4 HARQ-ACK (e.g. repetition)

**Network verified UE location**

* Specify necessary enhancements to multi-RTT to support the network verified UE location in NTN assuming a single satellite in view

**NTN-TN and NTN-NTN mobility and service continuity enhancements**

* Specify NTN-TN and NTN-NTN measurement/mobility and service continuity enhancements

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SA2

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

Aspects related to Network verified UE location

## 4. References

## 4.1 RAN1

**RAN1#112 Athens, Greece, February 27th – March 3rd, 2023:**

* R1-2300324 Work Plan R18 WI NR-NTN-enh work plan at RAN1, 2 and 3 THALES
* R1-2302067 other Session notes for 9.11 (NTN (Non-Terrestrial Networks) enhancements) Ad-Hoc Chair (Huawei)
* R1-2302230 discussion Summary EOM on 9.11.1 Coverage enhancement for NR NTN Moderator (NTT DOCOMO, INC.)
* R1-2301726 discussion On coverage enhancements for NR NTN Ericsson
* R1-2301835 discussion Summary #1 on 9.11.1 Coverage enhancement for NR NTN Moderator (NTT DOCOMO, INC.)
* R1-2301836 discussion Summary #2 on 9.11.1 Coverage enhancement for NR NTN Moderator (NTT DOCOMO, INC.)
* R1-2301837 discussion Summary #3 on 9.11.1 Coverage enhancement for NR NTN Moderator (NTT DOCOMO, INC.)
* R1-2301838 discussion Summary #4 on 9.11.1 Coverage enhancement for NR NTN Moderator (NTT DOCOMO, INC.)
* R1-2301365 discussion On Coverage Enhancement for NR NTN Apple
* R1-2300905 discussion Discussion on coverage enhancement for NR-NTN Panasonic
* R1-2300939 discussion On coverage enhancement for NR NTN Intel Corporation
* R1-2301432 discussion Coverage enhancements for NR NTN Qualcomm Incorporated
* R1-2301512 discussion Discussion on coverage enhancement for NR NTN NTT DOCOMO, INC.
* R1-2301548 discussion Views on Coverage enhancement for NR NTN Sharp
* R1-2300765 discussion Coverage enhancement for NR NTN NEC
* R1-2300601 discussion Discussion on coverage enhancement for NR NTN Baicells
* R1-2300658 discussion Further discussion on UL coverage enhancement for NR NTN CATT
* R1-2300704 discussion Discussion on coverage enhancement for NTN ZTE
* R1-2300378 discussion Considerations on coverage enhancements for NR over NTN Nokia, Nokia Shanghai Bell
* R1-2300472 discussion Discussions on coverage enhancements for NR NTN vivo
* R1-2300236 discussion Discussion on coverage enhancements for NTN Spreadtrum Communications
* R1-2300553 discussion Discussion on coverage enhancement for NR-NTN xiaomi
* R1-2300148 discussion Consideration on coverage enhancement for NR NTN Lockheed Martin
* R1-2300117 discussion Discussion on coverage enhancement for NR NTN Huawei, HiSilicon
* R1-2300497 discussion Discussion on coverage enhancements for NR NTN NTPU, NYCU
* R1-2300266 discussion Discussion on coverage enhancement for NR NTN OPPO
* R1-2301021 discussion Discussion on coverage enhancement for NR NTN CMCC
* R1-2301055 discussion Coverage enhancement for NR NTN MediaTek Inc.
* R1-2301072 discussion Discussion on coverage enhancement for NR NTN LG Electronics
* R1-2301051 discussion Discussion on coverage enhancement for NR NTN ETRI
* R1-2300921 discussion Discussion on coverage enhancement for NR NTN Lenovo
* R1-2300888 discussion On coverage enhancement for NR NTN Sony
* R1-2300902 discussion Discussion on coverage enhancement for NR NTN Hyundai Motor Company
* R1-2301283 discussion On coverage enhancement for NR NTN Samsung
* R1-2301284 discussion Network verified UE location for NR NTN Samsung
* R1-2301217 discussion NTN NW verified UE location Lenovo
* R1-2300889 discussion Network verified UE location for NR NTN Sony
* R1-2301305 discussion On network verified UE location in NR NTN Ericsson Limited
* R1-2300966 discussion On network verified UE location for NR NTN Intel Corporation
* R1-2301052 discussion Discussion on Network verified UE location for NR NTN ETRI
* R1-2301073 discussion Discussion on network verified UE location for NR NTN LG Electronics
* R1-2301056 discussion Network verified UE location for NR NTN MediaTek Inc.
* R1-2300322 discussion FL Summary #3: Network verified UE location for NR NTN THALES
* R1-2300323 discussion FL Summary #4: Network verified UE location for NR NTN THALES
* R1-2300267 discussion Discussion on network verified UE location for NR NTN OPPO
* R1-2300319 discussion Discussion on network verified UE location in NR NTN THALES
* R1-2300320 discussion FL Summary #1: Network verified UE location for NR NTN THALES
* R1-2300321 discussion FL Summary #2: Network verified UE location for NR NTN THALES
* R1-2300118 discussion Discussion on network-verified UE location for NR NTN Huawei, HiSilicon
* R1-2300554 discussion Discussion on the network verified location for NR-NTN xiaomi
* R1-2300473 discussion Discussions on UE location verification in NR NTN vivo
* R1-2300379 discussion Considerations on Network Verified UE Positioning Nokia, Nokia Shanghai Bell
* R1-2300705 discussion Discussion on network verified UE location for NR NTN ZTE
* R1-2300659 discussion Discussion on Network verified UE location for NR NTN CATT
* R1-2300714 discussion Discussion on Network-verified UE location for NTN PANASONIC
* R1-2301513 discussion Discussion on Network verified UE location for NR NTN NTT DOCOMO, INC.
* R1-2301653 discussion Discussion on Network Verified Location for NR NTN TCL Communication Ltd.
* R1-2301433 discussion Network verified UE location for NR NTN Qualcomm Incorporated
* R1-2301366 discussion Discussion on Network Verified UE Location Apple
* R1-2302223 discussion FL Summary #5: Network verified UE location for NR NTN THALES

## 4.2 RAN2

**RAN2#121 Athens, Greece, February 27th – March 3rd, 2023**

Submitted TDOCs:

* R2-2300020 LS in Reply LS on RACH-less handover in NTN (R1-2213001; contact: OPPO) RAN1
* R2-2300062 LS in Reply LS on Latency impact for NTN verified UE location (S1-223539; contact: Xiaomi) SA1
* R2-2300066 LS in LS Response on Latency impact for NTN verified UE location (S2-2211199; contact: Qualcomm) SA2
* R2-2301344 Work Plan R18 WI NR-NTN-enh work plan at RAN1, 2 and 3 THALES
* R2-2300347 discussion Discussion on coverage enhancement for R18 NTN vivo
* R2-2301363 discussion Blind Msg3 retransmission in Rel-18 NTN InterDigital
* R2-2301524 discussion Modification of Msg3 for coverage enhancements NEC Telecom MODUS Ltd.
* R2-2301637 discussion Discussion on inital blind Msg3 retransmssion LG Electronics Inc.
* R2-2301661 discussion Discussion on Coverage Enhancement for NR NTN Nokia, Nokia Shanghai Bell
* R2-2300176 discussion Discussion on network verified UE location OPPO
* R2-2300207 discussion Discussion on Network Verified UE Location CATT
* R2-2300272 discussion On Network Verified UE Location in NR NTN MediaTek Inc.
* R2-2300364 discussion Discussion on the single satellite Multi-RTT positioning method in NTN Intel Corporation
* R2-2300528 discussion discussion on network verified UE location Ericsson
* R2-2300731 discussion Network Verified UE Location Apple
* R2-2300882 discussion Single satellite Multi-RTT based positioning Qualcomm Incorporated
* R2-2301069 discussion Discussion on NTN NW verified UE location Lenovo
* R2-2301119 discussion Further discussion on Network Verified UE Location in NTN Samsung Electronics Nordic AB
* R2-2301140 discussion Consideration on NW verified UE location ZTE Corporation, Sanechips
* R2-2301183 discussion Discussion on network verified UE location Xiaomi
* R2-2301211 discussion Further consideration on network verified UE location Huawei, Turkcell, HiSilicon
* R2-2301354 discussion On Network verified UE location Nokia, Nokia Shanghai Bell
* R2-2301837 discussion Discussion on Network Verified Location TCL Communication Ltd.
* R2-2300146 discussion Discussion on NTN-TN cell reselection enhancements Huawei, HiSilicon, Turkcell
* R2-2300164 discussion Discussion on NTN-TN cell reselection enhancement OPPO
* R2-2300208 discussion Discussion on Cell Reselection Enhancements in NTN-TN Scenario CATT
* R2-2300345 discussion Discussion on power saving for NTN-TN mobility vivo
* R2-2300363 discussion Discussion on TN-NTN cell reselection enhancements Intel Corporation
* R2-2300476 discussion On Enhanced Cell Reselection in Rel-18 NTN Nokia, Nokia Shanghai Bell
* R2-2300511 discussion Discussion on NTN-TN Mobility Enhancements in Idle State Google Inc.
* R2-2300732 discussion NTN-TN Cell Reselection Enhancement Apple
* R2-2300798 discussion Discussion on NTN-TN cell reselection enhancement LG Electronics France
* R2-2300883 discussion TN neighbour cell coverage information Qualcomm Incorporated
* R2-2300983 discussion IDLE mobility regarding NTN moving cells Lenovo
* R2-2300996 discussion Discussion on NTN-TN Cell re-selection ITL
* R2-2301093 discussion Cell selection/reselection enhancements in NTN-TN Sony
* R2-2301141 discussion Consideration on cell reselection enhancements for NTN-TN ZTE Corporation, Sanechips
* R2-2301184 discussion Cell reselection enhancements for NTN-TN mobility Xiaomi
* R2-2301225 discussion Discussion on NTN-TN reselection CMCC
* R2-2301365 discussion NTN-TN mobility and service continuity InterDigital
* R2-2301460 discussion NTN-TN Mobility Cell Reselection SHARP Corporation
* R2-2301479 discussion Discussion on NTN-TN cell reselection enhancements Samsung Research America
* R2-2301523 discussion Details of the TN coverage data signalling NEC Telecom MODUS Ltd.
* R2-2301604 discussion Further discussion on NTN-TN cell reselection enhancements Transsion Holdings
* R2-2301764 discussion Further discussion on NTN-TN cell reselection enhancements NTT DOCOMO, INC.
* R2-2301869 discussion TN NTN mobility enhancements Ericsson
* R2-2300147 discussion Discussion on NTN-NTN cell reselection enhancements Huawei, HiSilicon, Turkcell
* R2-2300165 discussion Discussion on NTN-NTN cell reselection enhancement OPPO
* R2-2300241 discussion Issues on NTN Mobility Lockheed Martin
* R2-2300344 discussion Discussion on cell reselection enhancements for earth-moving cell vivo
* R2-2300362 discussion Discussion on NTN-NTN cell reselection enhancements Intel Corporation
* R2-2300451 discussion Discussion on cell reselection in earth moving cell Quectel
* R2-2300466 discussion Neighbour cell signalling overhead reduction PANASONIC
* R2-2300509 discussion Discussion on NTN-NTN Mobility Enhancements in Idle State Google Inc.
* R2-2300655 discussion Discussion on NTN-NTN cell reselection enhancements Spreadtrum Communications
* R2-2300733 discussion NTN-NTN Cell Reselection Enhancement Apple
* R2-2300799 discussion Discussion on NTN-NTN cell reselection enhancement LG Electronics France
* R2-2300884 discussion Neighbor cell measurement relaxation Qualcomm Incorporated
* R2-2300984 discussion Measurement for cell reselection in NTN with TN cells involved Lenovo
* R2-2300995 discussion Discussion on NTN-NTN Cell re-selection ITL
* R2-2301142 discussion Consideration on cell reselection enhancements for NTN-NTN ZTE Corporation, Sanechips
* R2-2301185 discussion Cell reselection enhancements for NTN-NTN mobility Xiaomi
* R2-2301226 discussion Discussion on NTN-NTN reselection CMCC
* R2-2301364 discussion Cell reselection enhancements for Earth moving cell InterDigital
* R2-2301480 discussion Discussion on Cell Reselection with Earth-moving Cell Samsung Research America
* R2-2301535 discussion Discussion on reference location for moving cell ASUSTeK
* R2-2301605 discussion Further discussion on NTN-NTN cell reselection enhancements Transsion Holdings
* R2-2301627 discussion Further discussion on NTN-NTN cell reselection enhancements Transsion Holdings
* R2-2301868 discussion NTN NTN mobility enhancements Ericsson
* R2-2301953 discussion [AT121][104][NR NTN enh] NTN-NTN cell reselection (ZTE) ZTE Corporation, Sanechips
* R2-2300148 discussion Discussion on NTN handover enhancements Huawei, HiSilicon, Turkcell
* R2-2300177 discussion Discussion on NTN handover enhancements OPPO
* R2-2300209 discussion Discussion on PCI unchanged scenario CATT
* R2-2300210 discussion Discussion on NTN HO Enhancements CATT
* R2-2300274 discussion Handover Enhancement in LEO NTN with Earth-moving Cells MediaTek Inc.
* R2-2300346 discussion On handover enhancement for siganlling overhead reduction in NR NTN vivo
* R2-2300361 discussion Discussion on NTN 2-step handover Intel Corporation
* R2-2300450 discussion Discussion on NTN HO enhancnment CAICT
* R2-2300477 discussion On Enhanced NTN Connected-mode Mobility in Rel-18 Nokia, Nokia Shanghai Bell
* R2-2300514 discussion SMTC and Measurement Gap Enhancements for Connected UEs Google Inc.
* R2-2300516 discussion Discussion on NTN-TN Mobility Enhancements in Connected State Google Inc.
* R2-2300734 discussion NTN specific Handover Enhancement Apple
* R2-2300800 discussion Discussion on handover enhancement LG Electronics France
* R2-2300856 discussion Discussion of HO common signaling reduction in NTN China Telecom
* R2-2300885 discussion Further handover enhancement for NTN Qualcomm Incorporated
* R2-2300985 discussion Considerations on common signalling for CONNECTED mobility in NTN Lenovo
* R2-2301013 discussion NTN-NTN handover enhancement NEC
* R2-2301094 discussion Signaling overhead reduction and group handover during NTN-NTN HOs Sony
* R2-2301143 discussion Consideration on HO enhancements in NTN ZTE Corporation, Sanechips
* R2-2301186 discussion Discussion on handover enhancements for NTN-NTN mobility Xiaomi
* R2-2301269 discussion Service Link Switching with PCI unchanged CMCC,CATT,Huawei,HiSilicon,Lenovo,vivo
* R2-2301366 discussion NTN mobility enhancements for RRC\_CONNECTED InterDigital
* R2-2301481 discussion Discussion on NTN handover enhancements Samsung Research America
* R2-2301504 discussion Discussion on Handover enhancements for NTN Fujitsu Limited
* R2-2301536 discussion Discussion on RACH-less handover for NTN ASUSTeK
* R2-2301537 discussion Discussion on handover enhancement with common signalling ASUSTeK
* R2-2301606 discussion Further discussion on NTN-NTN handover enhancements Transsion Holdings
* R2-2301766 discussion Further discussion on NTN-NTN handover enhancements NTT DOCOMO, INC.
* R2-2301821 discussion Discussion on handover enhancements Sharp
* R2-2301864 discussion NTN-NTN handover enhancements Sequans Communications
* R2-2301866 discussion HO/CHO Signaling Overhead Reduction by NTN-config omission Sequans Communications
* R2-2301867 discussion Handover enhancements Ericsson

## 4.3 RAN3

**RAN3#119 Athens, Greece, February 27th – March 3rd, 2023:**

Submitted TDOCs:

* R3-230435 Work Plan R18 WI NR-NTN-enh work plan at RAN1, 2 and 3 THALES
* R3-230177 discussion Discussion on the cell ID and multiple TAC issue Nokia, Nokia Shanghai Bell
* R3-230293 discussion Further discussion on mobility of NTN Huawei
* R3-230436 other NGAP Support for Time-Based HO in NTN Ericsson, Thales, Intelsat, Lockheed Martin, Hughes Network Systems, CATT, ESA
* R3-230484 discussion Discussion on NR NTN Service Continuity Enhancements Qualcomm Incorporated
* R3-230148 discussion Discussion on Mobility and Service Continuity Enhancements CATT
* R3-230168 discussion Further discussion on mobility of NR NTN China Telecommunication
* R3-230620 discussion Remaining issues on service continuity enhancement for NTN Samsung
* R3-230768 discussion Further discussion on mobility issue for NR NTN ZTE
* R3-230176 discussion Discussion on the time-based trigger condition in NR NTN Nokia, Nokia Shanghai Bell
* R3-230294 discussion Further discussion on Xn and NG interface Huawei
* R3-230441 discussion Time Margin for CHO in NR NTN Ericsson, Thales
* R3-230438 CR Time-Based HO for NTN - NGAP Impacts Ericsson, Thales, ZTE, Omnispace, TTP, CATT, Hughes Network Systems, Huawei, Lockheed Martin, Intelsat, CATT, ESA
* R3-230485 draftCR Clarification on Cell Identifier used for handover signalling and XN Interface Qualcomm Incorporated, Nokia, ZTE, Deutsche Telekom, Verizon Wireless, CATT, NEC
* R3-230933 draftCR Clarification on Cell Identifier used for handover signalling and XN Interface Qualcomm Incorporated, Nokia, ZTE, Deutsche Telekom, Verizon Wireless, CATT, NEC
* R3-231021 draftCR Clarification on Cell Identifier used for handover signalling and XN Interface Qualcomm Incorporated, Nokia, ZTE, Deutsche Telekom, Verizon Wireless, CATT, NEC
* R3-231033 other TP for BL CR 38.300 on NTN Handover Cell ID Qualcomm Incorporated, Nokia, ZTE, Deutsche Telekom, Verizon Wireless, CATT, NEC, Huawei
* R3-230488 CR XN NTN Mobility Enhancements Qualcomm Incorporated
* R3-230937 other Summary of offline discussion(CB:#38\_NRNTN\_ServiceContinuity) Nokia
* R3-230023 LS in Reply LS on Latency impact for NTN verified UE location SA1, Xiaomi
* R3-230027 LS in LS Response on Latency impact for NTN verified UE location SA2, Qualcomm
* R3-230149 discussion Discussion on UE Location Verification CATT
* R3-230444 discussion Latency Impact of Network Verified UE Location for NTN Ericsson, CATT
* R3-230784 discussion Discussion on NR NTN Network Verified UE Location TCL Communication Ltd.

## 4.4 RAN4

**RAN4#106 Athens, Greece, February 27th – March 3rd, 2023:**

Submitted TDOCs:

* R4-2300973 discussion Revised NR NTN enhancement workplan NTT DOCOMO, INC.
* R4-2302468 discussion Further discussion on SAN terminology and related frequency range definition Huawei, HiSilicon
* R4-2301465 other NTN enhancement: System parameters - Band(s) definition Ericsson
* R4-2301671 other Discussion on above 10GHz NTN band Nokia, Nokia Shanghai Bell
* R4-2301744 discussion Further discussion on system parameter for NTN in Ka band ZTE Corporation
* R4-2302711 discussion NTN Ka band definition Qualcomm Incorporated
* R4-2302643 discussion NTN Ka-band, clarifications on regulatory background Inmarsat, Hispasat, Thales
* R4-2301464 other NTN enhancement: Regulatory aspects and band discussion Ericsson
* R4-2302107 other Discussion on Rel-18 NTN regulatory information and compliance for ka band Huawei, HiSilicon
* R4-2300088 other Simulation assumptions for co-existence study for above 10GHz bands Qualcomm Incorporated
* R4-2300574 other Further discussion on remaining issues about simulation assumptions for above 10GHz NTN co-existence study CATT
* R4-2302108 other Discussion on Rel-18 NTN coexistence study assumption Huawei, HiSilicon
* R4-2301466 other NTN enhancement: coexistence simulations Ericsson
* R4-2301364 discussion Simulation assumptions for above 10GHz NTN co-existence study Samsung Electronics Nordic AB
* R4-2301745 discussion Further discussion on coexistence evaluation for NTN in Ka-band ZTE Corporation
* R4-2302535 discussion NTN Simulation Parameters for above 10 GHz Coexistence Studies THALES
* R4-2301746 discussion Further discussion on SAN RF requirements for NTN in Ka-band ZTE Corporation
* R4-2301467 other NTN enhancement: SAN RF requirements Ericsson
* R4-2302467 discussion Discussion on SAN RF requirements for NTN enhancements Huawei, HiSilicon
* R4-2300575 other Further discussion on SAN RF requirements for above 10GHz bands CATT
* R4-2301099 other Discussion on UE RF for NTN above 10GHz bands Xiaomi
* R4-2302527 discussion NTN UE Terminal Types for above 10 GHz THALES, Inmarsat, Hispasat
* R4-2302109 other Discussion on Ka band NTN UE Huawei, HiSilicon
* R4-2301468 other NTN enhancement: NTN UE RF requirements Ericsson
* R4-2301747 discussion Further discussion on UE RF requirements for NTN in Ka-band ZTE Corporation
* R4-2302714 discussion Satellite broadband user equipment HISPASAT, Hughes Network Systems, Thales, ESA, Eutelsat, Lockheed Martin, Intelsat, Inmarsat, Airbus
* R4-2301647 other Discussion on RRM core requirements in Rel-18 NTN OPPO
* R4-2301340 discussion Discussion on RRM requirements for NTN enhancement vivo
* R4-2301346 discussion Reply LS on RACH-less handover in NTN vivo
* R4-2301390 other LS on RACH-less HO ZTE Corporation
* R4-2301982 LS out Initial discussion on RRM requirements for Rel-18 NTN Huawei, HiSilicon
* R4-2302020 discussion RRM requirements for NR NTN enh Ericsson
* R4-2302339 other Discussion on LS reply for RACH-less HO Nokia, Nokia Shanghai Bell
* R4-2300946 discussion Discussion on RRM issues for NTN enhancement LG Electronics Inc.
* R4-2301007 discussion Discussion on RRM impact and LS from RAN1 on NTN enhancement Samsung
* R4-2300894 discussion Discussion on RRM requirements for Rel-18 NTN Xiaomi
* R4-2300287 discussion RRM impacts overview for eNTN Apple
* R4-2300389 discussion Discussion on RRM requirements for NTN enhancement MediaTek inc.
* R4-2300588 LS out Reply LS on RACH-less handover in NTN CATT
* R4-2300100 other Response to incoming LS on RACH-less handover in NTN Qualcomm Incorporated
* R4-2302783 other Topic summary for [106][225] NR\_NTN\_enh Moderator (Qualcomm)
* R4-2303757 other Topic summary for [106][312] NR\_NTN\_enh\_Part1 Moderator - Thales
* R4-2303758 other Topic summary for [106][313] NR\_NTN\_enh\_Part2 Moderator - Samsung
* R4-2302835 other Topic summary for [106][142] NR\_NTN\_enh\_UERF Moderator (ZTE)