**3GPP TSG-RAN WG4 Meeting # 111 draftR4-2410137**

**Fukuoka, Japan, May 20 – May 24, 2024**

**Source:** Ad-hoc chair (Samsung)

**Title:** Ad-hoc agenda for [111][219] NR\_NTN\_enh

**Agenda item:** 7.16.9

**Document for:** Discussion and Approval

# 1 Introduction

This t-doc captures the ad-hoc discussion outcome on [111][219] NR\_NTN\_enh covering below topics:

* Topic #6 performance requirements
  + Issue 6-2-2: (FR2-NTN) Rx beam gain
  + Issue 6-2-3: (FR2-NTN) UL timing accuracy
  + Issue 6-3-2: (FR1-NTN) Idle mode mobility, NTN-TN inter-frequency cell reselection
  + Issue 6-3-3: (FR1-NTN) Connected mode mobility, Satellite switch
  + Issue 6-3-5: (FR1-NTN) Connected mode mobility, NTN to NTN RACH-less HO
  + Issue 6-3-6: (FR1-NTN) Measurement procedure and accuracy, Network verified UE location

Ad-hoc place and time:

* Monday @RAN4 RRM room from 18:00 to 19:30

# 2 Open issues from moderator summary

## 2.1 Topic #6: Performance requirements

**Issue 6-2-2: (FR2-NTN) Rx beam gain**

**Summary of agreements:**

|  |
| --- |
| **Agreement [RAN4#109]:**   * No agreement   **No agreement [RAN4#110]: (no further discussion)**   * Decide whether to remove an RF margin for different RX beams in the relative accuracy and tighten relative accuracy requirements.   **Agreement (ad-hoc) [RAN4#110b]:**   * FFS whether the RF margin for different RX beams in existing TN FR2-1 intra-frequency relative accuracy requirements can be removed or not * Existing absolute measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz. * Further discuss the minimum SSB\_RP condition on accuracy requirements |

**Views from companies**

* Remove an RF margin for different RX beams in the relative accuracy.
  + Apple, vivo (intra-frequency relative accuracy requirement), Huawei
* Define the minimum SSB\_RP condition for accuracy requirement of five UE types specified in table 9.2.1.0-1 of TS38.101-5.
  + Apple: Minimum SSB\_RP\_NTN\_FR2 = Reference sensitivity UE type, n512, 50MHz +Y -10Log10(PRBRefsens x 12) – SNRRefsens + SSB Ês/Iot + ∆MBP,n, where,
    - Reference sensitivity UE type, n512, 50MHz is the reference sensitivity value in dBm specified for a specific UE type in Band n512 for 50 MHz Channel bandwidth in Table 10.3.2-1 and section 10.3.3-1 of TS 38.101-5.
    - PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-5 Table 5.3.2-2, and is 32;
    - SNRRefsens is the SNR used for simulation of Refsens and EIS spherical coverage, and is -1 dB;
    - SSB Ês/Iot is the minimum value required by the UE to perform measurements, and is -6 dB for intra-frequency measurements and -4 dB for inter-frequency measurements. The only contribution to Iot is the UE internal noise;
    - ∆MBP,n is 0 for NTN above 10GHz since CA/DC is not considered.
  + Huawei: Do not define separate Min SSB\_RP for peak and spherical coverage unless spherical coverage is introduced in RF session in future
* For the minimum SSB\_RP condition,
  + The gain difference between fine and rough beams is YdB:
    - For mechanical steering antenna:
      * Y=FFS: Apple
      * Y=0: Samsung, Huawei
    - For electronic steering antenna:
      * Y=FFS: Apple, Samsung
      * Y=0: Huawei
* The existing absolute measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with 1dB relaxation. (i.e., revert the last meeting agreement in issue 6-2-2) since a single polarization is assumed for FR2-1 NTN.
  + Apple
* The upper bound of Rx beam gains are defined as below:
  + For Mobile VSAT communication with GSO, and for fixed VSAT communication with GSO and LEO, the upper bound of Rx beam gain is 41dB.
    - Apple
  + For fixed VSAT communication with LEO only, the upper bound of Rx beam gain is 30dB.
    - Apple
* Gmin and Gmax
  + RAN4 to further discuss Gmin and Gmax for FR2-NTN
    - Huawei
* Check if SNR values for RLM-RS test to NTN FR2 UE shall be updated from legacy FR2 and how to determine the values
  + Ericsson

**Moderator’s WF:**

* The existing absolute measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with [1]dB relaxation. (i.e., revert the last meeting agreement in issue 6-2-2).

**Discussion:**

* Apple: In Redcap with 1Rx antenna under FR1, 1dB relaxation. In FR2 NTN case, VSAT UE only single polarization considered. The side condition is different under FR1 and FR2.
* Huawei: We are ok to consider 1dB relaxation. How about relative accuracy requirements?
* Apple: Do we still need relative accuracy requirements for FR2 VSAT with inter-satellite measurement?
* Apple: We further check with RF session, and agree with other companies Y can be 0 or deleted.
* Samsung: We agree existing UE RF requirements only peak direction considered. We have different UE types mechanical vs electronic beam steering capability.
* MTK: We think only single beam configured for FR2 VSAT UE. No need to consider different UE capability.
* HW: This calculation is for lowest bound?
* Apple: REFSENS is minimum value

**Agreement:**

* The existing absolute measurement accuracy requirement and [relative measurement accuracy requirement] of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with [1]dB relaxation.
  + Note: Companies are encouraged to further evaluate the performance loss due to single polarization assumption on FR2 Ka band VSAT UE. It’s not precluded to further update the tentative relaxation value in future RAN4 meeting.
* Remove an RF margin for different RX beams in the relative accuracy.
* Define the minimum SSB\_RP condition for accuracy requirement of five UE types specified in table 9.2.1.0-1 of TS38.101-5. Minimum SSB\_RP\_NTN\_FR2 for Rx Beam Peak angle of arrival = Reference sensitivity UE type, n512, 50MHz +Y -10Log10(PRBRefsens x 12) – SNRRefsens + SSB Ês/Iot + ∆MBP,n, where,
  + Reference sensitivity UE type, n512, 50MHz is the reference sensitivity value in dBm specified for a specific UE type in Band n512 for 50 MHz Channel bandwidth in Table 10.3.2-1 and section 10.3.3-1 of TS 38.101-5.
  + PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-5 Table 5.3.2-2, and is 32;
  + SNRRefsens is the SNR used for simulation of Refsens and EIS spherical coverage, and is -1 dB;
  + SSB Ês/Iot is the minimum value required by the UE to perform measurements, and is -6 dB for intra-frequency measurements and -4 dB for inter-frequency measurements. The only contribution to Iot is the UE internal noise;
  + ∆MBP,n is 0.
* For the minimum SSB\_RP condition,
  + The gain difference between fine and rough beams is YdB:
    - For mechanical steering antenna, Y=0
    - For electronic steering antenna, FFS Y
* Do not define separate spherical coverage unless spherical coverage is introduced in RF session.
* FFS: Gmin and Gmax
* Note: If anything above inconsistent with RF requirement is identified, RAN4 to make updates to those aspects accordingly.

**Issue 6-2-3: (FR2-NTN) UL timing accuracy**

**Summary of agreements:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Agreement (ad-hoc) [RAN4#110b]:**   * Define UL timing test cases at least for following configuration:   + UL SCS 120kHz with DL SSB SCS: 120kHz * FFS whether any other configuration need to be considered or not * For UL SCS is 120kHz,   + Transmit Timing Test covering     - Case 1,2,3   + Timing advance adjustment accuracy covering     - Case 1,2,3 * Note:   + Case-1: Stationary UE for GSO   + Case-2: Stationary UE for LEO   + Case-3: Mobile UE for GSO   **Agreement (online) [RAN4#110b]:**   |  |  |  |  | | --- | --- | --- | --- | | **Band** | **Category** | **Test case** | **Configuration** | | Above 10 GHz | UL transmission timing | 1. Transmit Timing  2. Timing advance adjustment accuracy | UL SCS: 120kHz  DL SSB SCS: 120kHz  Case 1,2,3 | |

**Views from companies**

* Samsung: For different cases (Case-1, -2, and -3), consider the following aspects:
  + For Configuration 1 and 3, the only difference is the propagation condition. In configuration 1, AWGN is used. In configuration 3, AWGN with a constant doppler shift is used.
  + For fixed UE only supports GSO, the UE is only required to pass the test of config 1.
  + For fixed UE support both GSO and NGSO, the test config 1 can be sipped if the UE passes test config 2.
  + For mobile UE only supports GSO, the UE is only required to pass the test of config 1.
* Nokia:
  + For FR2-NTN, adopt equal to , when AT commands are used in the test case in scenarios 1 and 2.
  + For case 3, adopt the transmit timing accuracy equal to cases 1 and 2, when UE is tested with fixed position in a simplified test setup.
* Vivo: Define additional test cases as below:
  + UL SCS 60kHz with DL SSB SCS: 120kHz
  + UL SCS 60kHz with DL SSB SCS: 240kHz
  + UL SCS 120kHz with DL SSB SCS: 240kHz
* Huawei: RAN4 to discuss the value for for mobile and fixed UEs

**Moderator’s WF: Moderator does not find a reason to consider UE mobility for Case-3 in Rel-18 or to define additional test cases for other SCSs that 120kHz. Furthermore, test applicability rule based on UE capability or VSAT class need not be separately agreed, as it is evident.**

* The value for for mobile and fixed UEs is reduced to X in Rel-18.
  + X = []
* In the test case of UE transmission timing accuracy for Case-3 (Mobile UE for GSO):
  + UE mobility is not considered unless the testability issue is resolved.
  + UE requirement for Case-3 is set to the same value as that of Case-1 (Stationary UE for GSO).

**Discussion:**

* MTK: value for Te?
* QC: During test cases, no GNSS performance verified, that’s the reason to tighten the value.
* Huawei: Te consists of Satellite position error and UE position error. UE still need to estimate satellite position even during the agreed simplified test set-up.
* Nokia: With simple snap shot with constant delay, we believe we can tighten the margin as proposed.
* MTK: We prefer keeping original margin value 5Ts, we need to understand the reason to further tighten.
* Nokia: Can we agree we need a margin on this case, and keep the value for further discussion.
* Apple: The values of this margin need to specified case by case.
* HW: With AT command, we still can emulate velocity.
* QC: We cannot emulate delay aspect with existing test set-up. And we will further discuss this issue during Rel-19.
* Nokia: In existing test set-up, AT command used but details rely on RAN5 design if RAN5 can accommodate with mobility then still possible to model UE mobility. We would like to ensure test case design aligned with core requirements as much as possible.
* Thales: During test, delay, doppler value and UE location; all the parameters need to be considered together. Static values now considered during existing test set-up. Considering mobility, more work required.
* Samsung: Case 3 specific to mobile VSAT regarding less of VSAT mobility state; mobile VSAT UE shall pass case 3 requirements instead of case 1 requirements.
* ZTE: We have similar concern as Samsung.
* HW: Similar question as ZTE/Samsung. Requirement applicable rule on core requirements pending on UE type or UE mobility state?
* MTK: For 60kHz SCS, we have same requirements for all UE types. Now we focus on 120 kHz SCS case.
* Apple: Core requirements shall not be changed. During test cases, test requirement can follow case 1.
* QC: UE performance can be varied pending on mobility condition with same implementation.
* Nokia: Mobile VSAT UE shall have better implementation than static UE and achieve better performance under same condition.
* MTK: Can we further discuss the margin similar as previous discussion.

**Agreement:**

* The value for for mobile and fixed UEs shall be introduced for uplink timing error requirements for FR2 NTN (Ka band introduced in Rel-18 )
  + Further discuss the exact values:
    - Option 1: X = []
    - Other options not precluded
* In the test case of UE transmission timing accuracy for Case-3 (120kHz SCS) (Mobile UE for GSO):
  + UE mobility is not considered before the testability issue is resolved. And without consideration of UE mobility during test, UE test requirement for Case-3 will be further discussed considering necessary margin.
  + It’s not precluded to further update test case including test requirements for case -3 if testability issue on UE mobility resolved in future release.

**Issue 6-3-2: (FR1-NTN) Idle mode mobility, NTN-TN inter-frequency cell reselection**

**Views from companies**

* Samsung: For the test configuration of TC NTN to NR TN cell reselection,
  + The test comprises two carriers and one cell is of NTN Cell while another cell is TN cell.
  + Before the test, UE camped on NTN cell. UE received SIB25 information of Cell 1 of “tn-ReferenceLocation” and “tn-DistanceRadius”. During T1, the UE location is maintained by UE is not in the TN coverage. After the start of T2, the UE location is changed by new configuration of SIB25 to initiation to NTN-TN cell reselection.
  + At the end of T2, UE reselects to TN Cell by the best RSRP.
* Samsung: For the test configuration of TC NTN to EUTRA TN cell reselection, first check whether there is HST carrier in core requirements. In the test case, it can compromise two carriers and two cells. Cell 1 is the NTN Cell which UE camped on this cell at the beginning. Cell 2 is the EUTRA neighbor cell. Similar test procedure in TC of NTN to NR TN in proposal 1 can be reused.
* Huawei: In the TCs for NTN-TN cell reselection,
  + do not verify the TN measurement skipping
  + set the distance between the UE and tn-ReferenceLocation as tn-DistanceRadius - 50m
  + include only one neighbor cell which is a TN cell

**Moderator’s WF:**

* In NTN-TN cell reselection test case,
  + Set the distance between the UE and tn-ReferenceLocation as tn-DistanceRadius - 50m.
  + Only one TN neighbour cell is configured.
  + Note: Detailed test configurations and procedures are confirmed by the review and endorsement of relevant test case CR.
  + Note: TN measurement skipping is not verified.

**Discussion:**

* + LGE: TN skipping belongs to UE capability. This test case is not relevant to UE capability.

**Agreement:**

* In NTN-TN cell reselection test case,
  + Set the distance between the UE and tn-ReferenceLocation as tn-DistanceRadius - 50m.
  + Only one TN neighbour cell is configured.
  + Note: Detailed test configurations and procedures are confirmed by the review and endorsement of relevant test case CR.
  + Note: TN measurement skipping is not verified.

**Issue 6-3-3: (FR1-NTN) Connected mode mobility, Satellite switch**

**Views from companies**

* In the TCs for satellite switch,
  + MTK: GSO test configuration is not applicable.
  + Huawei: SSB transmit timing from TE should fit the SSB-timeOffset and the nominal PDD.
  + Samsung: t-ServiceStart-r18 is earlier than t-Service.
  + Huawei: set (t-Service - t-serviceStart) larger than (Tsearch + T∆ + Tmargin)

**Moderator’s WF:**

* In the TCs for satellite switch,
  + GSO test configuration is not applicable.
  + SSB transmit timing from TE should fit the SSB-timeOffset and the nominal PDD.
  + (t-Service - t-serviceStart) > (Tsearch + T∆ + Tmargin)

**Discussion:**

* CMCC: 1st and last bullets already be reflected into CRs. For 2nd bullet, what does mean “nominal” ?

**Agreement:**

* In the TCs for satellite switch,
  + GSO test configuration is not applicable.
  + (t-Service - t-serviceStart) > (Tsearch + T∆ + Tmargin)
* Note: Reflect above agreements into draft CRs

**Issue 6-3-5: (FR1-NTN) Connected mode mobility, NTN to NTN RACH-less HO**

**Views from companies**

* Samsung: Support to define the test case for NTN to NTN RACH-less HO. The test comprises of two Cells and three successive time periods. At the start of T1, UE camps on Cell 1. And NTN Cell send a RRC message implying RACH-less HO to cell 2 during T2. After the UE reported Event A3, the PUSCH transmission in Cell 2 is configured in the RRC message from Cell 1. The UE shall stat to transmit PUSCH to Cell 2 less than the “RRC procedure delay + Tinterrupt (Interruption time for RACH-less HO)” from the beginning of time period T3
* Ericsson: Slightly intend towards no test case for NTN to NTN RACH-less (C)HO.

**Moderator’s WF:**

* NTN to NTN RACH-less HO test case is defined, and the detailed test configurations and procedures are confirmed by the review and endorsement of relevant test case CR.

**Discussion:**

* Ericsson: HO only or both HO and CHO cases?
* QC: HO only.

**Agreement:**

* NTN to NTN RACH-less HO test case is defined, and the detailed test configurations and procedures are confirmed by the review and endorsement of relevant test case CR.

**Issue 6-3-6: (FR1-NTN) Measurement procedure and accuracy, Network verified UE location**

**Views from companies**

* Ericsson: No test case for network verified UE location

**Moderator’s WF:**

* Do not define test case for network verified UE location.

**Agreement:**

* Do not define test case for network verified UE location.

## --------------------------Not treated in ad-hoc --------------------------------------

**Issue 6-2-4: (FR2-NTN) Mobility**

**Views from companies**

* Nokia: For mobility test cases involving UEs with mechanically steered beams,
  + make a note that the timing requirement for the completion of the mobility procedure depends on the setup of the test case, considering UE “minimum steering speed” of 22 degrees/s.

**Moderator’s Recommendation:**

* The above proposal is expected to be reflected in relevant test cases as per the agreed core requirements without further agreements.

**Issue 6-2-7: (FR2-NTN) Measurement accuracy**

**Views from companies**

* RAN4 to discuss whether to introduce measurement accuracy requirements for FR2-NTN in the maintenance part of Rel-18
  + Nokia
* The relative accuracy requirements for FR2 TN are re-used for FR2-NTN, except that the RF margin for different Rx beams is removed for intra-frequency measurement.
  + Huawei

**Moderator’s WF: As presented in R4-2409290, the measurement requirements are defined only for an intra-sat scenario, and it is assumed that the same Rx beam would be applied to the same satellite irrespective of serving cell or target cell.**

* The relative accuracy requirements for FR2 TN are re-used for FR2-NTN, except that the RF margin for different Rx beams is removed for intra-frequency measurement.
  + [The RF margin aspect will be separately discussed/decided in Issue 6-2-2]

**Issue 6-2-8: (FR2-NTN) Test case details**

**Views from companies**

* Samsung: RAN4 to define new configurations for
  + PDSCH Reference measurement channel
  + RMSI CORESET Reference Channel
  + Dedicated CORESET Reference Channel
  + TRS configuration

**Moderator’s Recommendation:**

* The detailed RMC configurations are going to be reviewed and decided based on CRs as needed.

**Issue 6-2-9: (FR2-NTN) AoA setup**

**Views from companies**

* In test cases such as timing, single AoA in Rx beam peak direction can be reused.
  + Samsung, Huawei
* For the test case of inter-satellite handover, 2-AoA setup with details on FFS
  + Samsung, Huawei
* The rest test cases:
  + new AoA setup should be defined
    - Samsung
  + single AoA setup with details on FFS
    - Huawei

**Moderator’s WF:**

* Use the following AoA setup for test cases:
  + Transmission timing accuracy: single AoA in Rx beam direction, if defined and applicable.
  + Inter-satellite mobility: 2-AoA setup with details on FFS
  + The rest test cases: single AoA in Rx beam direction, if defined and applicable

**Issue 6-3-4: (FR1-NTN) Connected mode mobility, NTN to NTN time-based trigger CHO enhancements**

**Views from companies**

* MTK: GSO test configuration is not applicable for NTN to NTN time-based trigger CHO enhancements
* Samsung: For test case of “NTN to NTN time-based trigger CHO enhancements”, the test configuration in the Rel-17 NTN test case of “A.14.2.1.4” can be reused. The test requirements shall be updated according to core requirements to remove Tmeasure and add Tsearch to Tinterrupt
* No test case for time/location- based trigger CHO enhancements

**Moderator’s WF:**

* In the TCs for NTN to NTN time-based trigger CHO enhancements,
  + GSO test configuration is not applicable.
  + The test configuration in the Rel-17 NTN test case of “A.14.2.1.4” can be reused.

# 3 Conclusion

**Issue 6-2-2: (FR2-NTN) Rx beam gain**

**Agreement:**

* The existing absolute measurement accuracy requirement and [relative measurement accuracy requirement] of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with [1]dB relaxation.
  + Note: Companies are encouraged to further evaluate the performance loss due to single polarization assumption on FR2 Ka band VSAT UE. It’s not precluded to further update the tentative relaxation value in future RAN4 meeting.
* Remove an RF margin for different RX beams in the relative accuracy.
* Define the minimum SSB\_RP condition for accuracy requirement of five UE types specified in table 9.2.1.0-1 of TS38.101-5. Minimum SSB\_RP\_NTN\_FR2 for Rx Beam Peak angle of arrival = Reference sensitivity UE type, n512, 50MHz +Y -10Log10(PRBRefsens x 12) – SNRRefsens + SSB Ês/Iot + ∆MBP,n, where,
  + Reference sensitivity UE type, n512, 50MHz is the reference sensitivity value in dBm specified for a specific UE type in Band n512 for 50 MHz Channel bandwidth in Table 10.3.2-1 and section 10.3.3-1 of TS 38.101-5.
  + PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-5 Table 5.3.2-2, and is 32;
  + SNRRefsens is the SNR used for simulation of Refsens and EIS spherical coverage, and is -1 dB;
  + SSB Ês/Iot is the minimum value required by the UE to perform measurements, and is -6 dB for intra-frequency measurements and -4 dB for inter-frequency measurements. The only contribution to Iot is the UE internal noise;
  + ∆MBP,n is 0.
* For the minimum SSB\_RP condition,
  + The gain difference between fine and rough beams is YdB:
    - For mechanical steering antenna, Y=0
    - For electronic steering antenna, FFS Y
* Do not define separate spherical coverage unless spherical coverage is introduced in RF session.
* FFS: Gmin and Gmax
* Note: If anything above inconsistent with RF requirement is identified, RAN4 to make updates to those aspects accordingly.

**Issue 6-2-3: (FR2-NTN) UL timing accuracy**

**Agreement:**

* The value for for mobile and fixed UEs shall be introduced for uplink timing error requirements for FR2 NTN (Ka band introduced in Rel-18 )
  + Further discuss the exact values:
    - Option 1: X = []
    - Other options not precluded
* In the test case of UE transmission timing accuracy for Case-3 (120kHz SCS) (Mobile UE for GSO):
  + UE mobility is not considered before the testability issue is resolved. And without consideration of UE mobility during test, UE test requirement for Case-3 will be further discussed considering necessary margin.
  + It’s not precluded to further update test case including test requirements for case -3 if testability issue on UE mobility resolved in future release.

**Issue 6-3-2: (FR1-NTN) Idle mode mobility, NTN-TN inter-frequency cell reselection**

**Agreement:**

* In NTN-TN cell reselection test case,
  + Set the distance between the UE and tn-ReferenceLocation as tn-DistanceRadius - 50m.
  + Only one TN neighbour cell is configured.
  + Note: Detailed test configurations and procedures are confirmed by the review and endorsement of relevant test case CR.
  + Note: TN measurement skipping is not verified.

**Issue 6-3-3: (FR1-NTN) Connected mode mobility, Satellite switch**

**Agreement:**

* In the TCs for satellite switch,
  + GSO test configuration is not applicable.
  + (t-Service - t-serviceStart) > (Tsearch + T∆ + Tmargin)
* Note: Reflect above agreements into draft CRs

**Issue 6-3-5: (FR1-NTN) Connected mode mobility, NTN to NTN RACH-less HO**

**Agreement:**

* NTN to NTN RACH-less HO test case is defined, and the detailed test configurations and procedures are confirmed by the review and endorsement of relevant test case CR.

**Issue 6-3-6: (FR1-NTN) Measurement procedure and accuracy, Network verified UE location**

**Agreement:**

* Do not define test case for network verified UE location.

# Reference

[1] R4-2408016 Topic summary for [111][219] NR\_NTN\_enh, Moderator (Qualcomm)