3GPP TSG-RAN WG4 Meeting # 109 R4-2318182

**Chicago, US, November 13 – 17, 2023**

**Agenda item:** 8.26.9

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Topic summary for [109][226] NR\_NTN\_enh

**Document for:** Information

# Introduction

*The summary covers the contributions submitted under the following AI:*

* *8.26.6 RRM core requirements [NR\_NTN\_enh-Core]*
  + *8.26.6.1 NR-NTN RRM requirements in above 10 GHz bands [NR\_NTN\_enh-Core]*

*\* submit some general discussions if needed under this agenda. Submit the proposals for Type 1 and Type 2 UEs in the same contribution.*

* + *8.26.6.2 Network verified UE location [NR\_NTN\_enh-Core]*
  + *8.26.6.3 NTN-TN and NTN-NTN mobility and service continuity enhancements [NR\_NTN\_enh-Core]*
* *8.26.7 RRM performance requirements [NR\_NTN\_enh-Perf]*

# Topic #1: UL timing requirements in bands above 10 GHz

## Companies’ contributions summary

**Issue 1-3: Further relaxation of Te\_NTN for PRACH**

**R4-2318340 CATT**

Proposal 1: No need to define different uplink timing requirements for PRACH.

**R4-2318460 MediaTek inc.**

Proposal 2: RAN4 to further study the timing requirement of PRACH. X+Y = 80 m and Tg = 3 Ts can be a starting point.

**R4-2320004 Huawei, HiSilicon**

Proposal 2: Define same Te\_NTN requirements for all UL channels.

**Issue 1-6: Te\_NTN for 60kHz and 120kHz**

**R4-2318460 MediaTek inc.**

Proposal 1: Te\_NTN = Td + Tp + Tg. For 60kHz UL SCS, Te\_NTN = 13.5 Ts with X+Y = 55 m.

**R4-2318654 Apple**

Proposal 1: RAN4 to adopt one of following alternatives:

* Alt 1: define different UE timing requirements for different cases, i.e., case 1/2/3, or
* Alt 2: define single minimum UE timing requirement based on the worst case among case 1/2/3.

Proposal 3: RAN4 to determine the Te\_NTN requirement for eNTN above 10GHz based on the following, regardless of the UL channel type:

* For initial transmit timing requirement in NTN (Te\_NTN), Te\_NTN = Te + Tp
  + Te is the legacy timing error for FR2-1 TN.
* The Te\_NTN requirement for eNTN above 10GHz is specified as:

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals (kHz) | SCS of uplink signals (kHz) | Te\_NTN |
| 2-1 | 120 | 60 | Case 1: 9.64\*64\*Tc  Case 2/3: 12.72\*64\*Tc |
|  |  | 120 | Case 1: 9.64\*64\*Tc  Case 2/3: 12.72\*64\*Tc |
|  | 240 | 60 | Case 1: 9.14\*64\*Tc  Case 2/3: 12.22\*64\*Tc |
|  |  | 120 | Case 1: 9.14\*64\*Tc  Case 2/3: 12.22\*64\*Tc |

Proposal 4: If infra vendor cannot accept the Te requirement greater than 0.5\*CP for 120kHz UL SCS, RAN4 to adopt one of following alternatives:

* Alt 1: no timing requirement is defined for NTN with 120kHz UL SCS in above 10GHz band in Rel-18.
* Alt 2: Rel-18 UE capability is used to indicate whether UE can support Te requirement as low as 0.5\*CP in 120kHz UL case.

**R4-2318821 Ericsson**

Observation 2: For UL SCS = 120 kHz, a UE with zero implementation margin when it comes to Te requirement has to have a total round trip error allowance of 6.5 to 6.7 Ts, which corresponds to a total position error of 32 to 33 m to distribute among satellite and UE. The Te value = 7.5 Ts.

Observation 3: For UL SCS = 60 kHz, a UE with zero implementation margin when it comes to Te requirement has to have a total round trip error allowance of 13 Ts, which corresponds to a total position error of 63 m to distribute among satellite and UE. The Te value = 14 Ts.

Proposal 9: Te\_NTN Timing Error Limit

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals (kHz) | SCS of uplink signals (kHz) | Te\_NTN |
| 2-1 | 120 | 60 | 14\*64\*Tc |
| 120 | 7.5\*64\*Tc |
| 240 | 60 | 14\*64\*Tc |
| 120 | 7.5\*64\*Tc |

**R4-2318845 Xiaomi**

Observation 1: The max error budget for GNSS position error (X) and serving-satellite position error (Y) is around 56m for 60 KHz UL SCS case and around 20m for 120 KHz UL SCS case.

Proposal 1: For 60 KHz UL SCS case, the GNSS position error is assumed as 15m and the serving-satellite position error is assumed as 30m, respectively.

Observation 2: It is too challenge for UE if the GNSS position error (X) is set as 10m and serving-satellite position error (Y) is set as 10m for 120 KHz UL SCS case.

Proposal 2: RAN4 not to define UL timing requirements for 120 KHz UL SCS case.

**R4-2319062 vivo**

Observation 1: For UL SCS = 60 kHz, a UE with zero implementation margin is allowed the error 12.4 to 13 Ts, which corresponds to a total position error of 60 to 62 m to distribute among satellite and UE. The Te value = 14 Ts.

Observation 2: For UL SCS = 120 kHz, a UE with zero implementation margin is allowed the error 5.9 to 6.4 Ts, which corresponds to a total position error of 28 to 30 m to distribute among satellite and UE. The Te value = 7.5 Ts.

Proposal 1: The exact value of Te\_NTN and values assumed for X and Y is based on the following analysis result:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL=60kHz DL=120kHz | | | | | | | | |
| Component | Tcp | Td | Tr | Ta | Tf | Tp | Te |
| value | 36Ts | 1.1Ts | 2Ts | 2Ts | 0.5Ts | 12.4Ts (total pos error = 60m) | 14Ts |
| UL=120kHz DL=120kHz | | | | | | | | |
| value | 18Ts | 1.1Ts | 1Ts | 0.5Ts | 0.5Ts | 5.9Ts (total pos error = 28m) | 7.5Ts |
| UL=60kHz DL=240kHz | | | | | | | | |
| value | 36Ts | 0.55Ts | 2Ts | 2Ts | 0.5Ts | 13Ts (total pos error = 62m) | 14Ts |
| UL=120kHz DL=240kHz | | | | | | | | |
| value | 18Ts | 0.55Ts | 1Ts | 0.5Ts | 0.5Ts | 6.4Ts (total pos error = 30m) | 7.5Ts |

**R4-2319212 Samsung**

Proposal 4: For Issue 1-2, we support different UE uplink timing accuracy requirements for different cases (Case-1/2/3).

Proposal 5: For Case 1, X=15m Y=5m.

Te requirements:

|  |  |  |
| --- | --- | --- |
| SCS of SSB signals (kHz) | SCS of uplink signals (kHz) | Te |
| 120 | 60 | 7.5\*64\*Tc |
|  | 120 | 7.5\*64\*Tc |
| 240 | 60 | 7\*64\*Tc |
|  | 120 | 7\*64\*Tc |

Proposal 6: For Case 2/3

Te requirements:

|  |  |  |
| --- | --- | --- |
| SCS of SSB signals (kHz) | SCS of uplink signals (kHz) | Te |
| 120 | 60 | 13.5\*64\*Tc |
|  | 120 | - |
| 240 | 60 | 13\*64\*Tc |
|  | 120 | - |

**R4-2320004 Huawei, HiSilicon**

Proposal 1: RAN4 to define timing requirements as highlighted in Table 1.

* separately for 60kHz and 120kHz SCS
* separately for Case 2 and Case 3, FFS how to define fixed and mobile UE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 60kHz | | 120kHz | |
| Te\_NTN | Tg | Te\_NTN | Tg |
| Case 1 (X = 10m, Y= 10m) | 7.6 | 6.9 | 5.7 | 1.3 |
| Case 2 (X = 10m, Y= 15m) | 8.6 | 6.0 | 6.7 | 0.3 |
| Case 3 (X = 40m, Y= 10m) | 13.7 | 0.8 | 11.8 | -4.8 |

**R4-2320557 ZTE Corporation**

Proposal 1: Different UE uplink timing accuracy requirements shall be defined under different cases.

Proposal 2: The table can be regarded as the minimum requirements, RAN4 shall define the concrete requirements under different cases.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals (kHz) | SCS of uplink signals (kHz) | Te\_NTN |
| 2-1 | 120 | 60 | 14\*64\*Tc |
| 120(NCP) | 7.5\*64\*Tc |
| 120(ECP) |
| 240 | 60 | 14\*64\*Tc |
| 120(NCP) | 7.5\*64\*Tc |

**R4-2320736 Nokia, Nokia Shanghai Bell**

Proposal 1: Consider for Te\_NTN in the Ka-band: 12.5 for 60 kHz and 5.5 for 120 kHz

**R4-2320966 Qualcomm Incorporated**

Proposal 1: UL timing accuracy requirements for NR NTN band above 10GHz are defined as below.

* Te\_NTN for Case-1:
  + For UL SCS of 60kHz, 7\*Ts
  + For UL SCS of 120kHz, 5\*Ts
* Te\_NTN for Case-2:
  + For UL SCS of 60kHz, 11\*Ts
  + For UL SCS of 120kHz, 8\*Ts
* Te\_NTN for Case-3:
  + For UL SCS of 60kHz, 11\*Ts
  + For UL SCS of 120kHz, 8\*Ts
* No differentiation between CP types for 60kHz UL SCS.
* No different requirements for different uplink signals and channels.
* Note: GSO includes both Geostationary and Geosynchronous orbits
* Note: different UE positioning error and satellite positioning error are considered for different cases.
  + UE positioning error: 5m and 25m for stationary UE and mobile UE, respectively
  + Satellite positioning error: 5m and 20m for GSO and LEO, respectively.
  + The elevation angle is assumed to be 30 deg.

**R4-2320971 THALES**

Proposal 1: Current timing error allows 120 kHz subcarrier spacing and therefore should be used.

Proposal 2: If in some specific deployment, 120 kHz subcarrier spacing cannot be used in UL because of too high GNSS estimation errors at NTN UE side, the configuration can still be based on:

* 60 kHz in UL with normal (or extended) CP;
* 120 kHz in DL.

**Issue 1-7: NTA-offset**

**R4-2319062 vivo**

Proposal 2: For requirements on UE transmit timing for Satellite Access in above 10 GHz bands, the NTA,offset and its corresponding value shall refer to NTA-offset for TN in FR2 defined in Table 7.1.2-2.

**Issue 1-8: UE Timing Advance adjustment accuracy**

**R4-2319212 Samsung**

Proposal 1: For timing advance requirements to support VSAT UE in bands above 10GHz, reuse the legacy NTN FR requirements in 7.3C except the Table 7.3C.2.2-1.

If 60kHz and 120kHz can be accepted, UE Timing Advance adjustment accuracy is defined as:

|  |  |  |
| --- | --- | --- |
| UL Sub Carrier Spacing(kHz) | 60 | 120 |
| UE Timing Advance adjustment accuracy | ±128 Tc | ±32 Tc |

**Issue 1-9: UL timer accuracy requirements**

**R4-2319212 Samsung**

Proposal 2: For UL timer accuracy requirements to support VSAT UE in bands above 10GHz, reuse the legacy NTN FR requirements in 7.2C.

**Issue 1-10: Gradual timing adjustment requirements**

**R4-2319212 Samsung**

Proposal 3: For Gradual timing adjustment requirements to support VSAT UE in bands above 10GHz, reuse the legacy NTN FR requirements in 7.1C.2.1 except the Table 7.1C.2.1-1.

If 60kHz and 120kHz can be accepted, Tq\_NTN Maximum Autonomous Time Adjustment Step and Tp\_NTN Minimum Aggregate Adjustment rate is defined as:

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of uplink signals (kHz) | Tq\_NTN | Tp\_NTN |
| FR2-NTN | 60 | 2.5\*64\*Tc | 2.5\*64\*Tc |
|  | 120 | 2.5\*64\*Tc | 2.5\*64\*Tc |

Note: FR2-NTN is from agreements in RF session.

**Issue 1-11: Additional enhancements**

**R4-2320736 Nokia, Nokia Shanghai Bell**

Proposal 2: Ask RAN1 to introduce a mechanism to allow the NW to inform the UE that the UE pre compensation is below the required level. UEs in this situation shall not be capable of transmitting, until they fix their time pre-compensation.

Proposal 3: If the UE updates its GNSS position, and difference between the TA calculated using UE new and old positions is above the UL Transmit Timing inaccuracy, UE shall perform a new RACH.

**Issue 1-12: Applicability of UL timing requirements for PUSCH DMRS bundling**

**R4-2320003 Huawei, HiSilicon**

Proposal 1: For NTN-specific PUSCH DMRS bundling, update the applicability of the timing requirements such that the requirements apply only for the first transmission in the TDW.

## Open issues

**Issue 1-3: Further relaxation of Te\_NTN for PRACH**

**Agreement [RAN4#108b]:**

* Define Te\_NTN requirements for uplink signals/channels except for PRACH first, and come back to the issue to decide whether to introduce a different set of requirements for PRACH.

**Views from companies**

* Option 1: Define same Te\_NTN requirements for all UL channels
  + CATT, Huawei
* Option 2: Further study (e.g. X+Y = 80 m and Tg = 3 Ts)
  + MTK

**Moderator’s suggestion**

* No separate discussion. The issue can be discussed under Issue 1-6 as needed.

**Issue 1-6: Te\_NTN for 60kHz and 120kHz**

**Agreement [RAN4#108b]:**

Companies should provide ‘the exact value of Te\_NTN and values assumed for X and Y’ and ‘the analysis result based on the following criterion.’ Otherwise, the values/proposals won’t be captured in the list of options.

* Tg = 0.5\*Tcp – (Td + Tp + Tr + Ta + Tf + Tm): an effective guard period in CP
  + Tcp: a length of CP for the given SCS of UL channel/signal
  + Td: UE downlink synchronization error for the given SCS of SSB (BW of PBCH DMRS, i.e. 20 PRBs)
  + Tp = Tp,ue + Tp,sat: a round trip propagation delay estimation error due to UE position and satellite position estimation errors
    - Tp,ue: a round trip propagation delay estimation error due to [X]m of UE position error
    - Tp,sat: a round trip propagation delay estimation error due to [Y]m of satellite position estimation error
  + Tr: TAC resolution error (from TS38.213)
  + Ta: TA adjustment accuracy error (from Table 7.3.2.2-1 of TS38.133)
  + Tf: an accumulated timing drift over 160ms due to a frequency offset of 0.1ppm
  + Tm: a margin needed at gNB receiver to accommodate any additional impairments if needed.
    - If a non-zero value is assumed in the proposal for Tm, the source of the impairments shall be provided too.
* Technical analysis is required if any number will be provided for each of the components in the next meeting.
* Whether the same or different values for different channels is contribution driven.

**Views from companies**

|  |  |  |  |
| --- | --- | --- | --- |
| Cases | SCS of SSB | Te\_NTN [Ts] for 60kHz of UL SCS | Te\_NTN [Ts] for 120kHz of UL SCS |
| Case-1: Stationary UE for GSO | 120kHz | Option 1: 7-7.6 (QC, Samsung, HW)  Option 2: 9.64 (Apple)  Option 3: 12.5-13.5 (MTK, Nokia)  Option 2: 14 (Ericsson, vivo, ZTE) | Option 1: 5-5.7 (Nokia, QC, Huawei)  Option 2: 9.64 (Apple)  Option 3: 7.5 (Ericsson, vivo, Samsung, ZTE)  Option 4: No requirement or UE capability (Xiaomi, Apple) |
| 240kHz | Option 1: 7-7.6 (Samsung, Huawei, Qualcomm)  Option 2: 9.14 (Apple)  Option 3: 12.5 (Nokia)  Option 3: 13.5-14 (MTK, Ericsson, vivo, ZTE) | Option 1: 5-5.7 (Huawei, Nokia, Qualcomm)  Option 2: 7-7.5 (Ericsson, vivo, Samsung, ZTE)  Option 3: 9.14 (Apple)  Option 4: No requirement or UE capability (Xiaomi, Apple) |
| Case-2: Stationary UE for LEO | 120kHz | Option 1: 8.6 (Huawei)  Option 2: 11 (QC)  Option 3: 12.5-12.72 (Apple, Nokia)  Option 4: 13.5-14 (MTK, Ericsson, vivo, Samsung, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 6.7 (Huawei)  Option 3: 7.5-8 (Ericsson, vivo, ZTE, QC)  Option 4: 12.72 (Apple)  Option 4: No requirement or UE capability (Xiaomi, Apple) |
| 240kHz | Option 1: 8.6 (Huawei)  Option 2: 11 (QC)  Option 3: 12.22-13 (Apple, Nokia, Samsung)  Option 4: 13.5-14 (MTK, Ericsson, vivo, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 6.7-7.5 (Ericsson, vivo, Huawei, ZTE)  Option 3: 8 (QC)  Option 4: 12.22 (Apple)  Option 5: No requirement or UE capability (Xiaomi, Apple) |
| Case-3: Mobile UE for GSO | 120kHz | Option 1: 11 (QC)  Option 2: 12.5-13.5 (MTK, Apple, Samsung, Nokia)  Option 3: 13.7-14 (Ericsson, vivo, Huawei, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 7.5-8 (Ericsson, vivo, ZTE, QC)  Option 3: 12.72(Apple)  Option 4: 11.8 (Huawei)  Option 5: No requirement or UE capability (Xiaomi, Apple) |
| 240kHz | Option 1: 11 (QC)  Option 2: 12.22-13 (Apple, Samsung, Nokia)  Option 3: 13.5-14 (MTK, Ericsson, vivo, Huawei, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 7.5-8 (Ericsson, vivo, ZTE, QC)  Option 3: 11.8-12.22 (Apple, Huawei)  Option 4: No requirement or UE capability (Xiaomi, Apple) |
| Note:   * X = UE position estimation error in meters * Y = serving-satellite position estimation error in meters   Assumptions:   * MTK: X+Y=55, Tm=0 * Apple: no 2x oversampling for Td, Tm=0; X+Y =30 for case 1 and X+Y=45 for case 2/3 * Ericsson: X+Y=63 and 32-33 for 60 kHz UL SCS and 120 kHz UL SCS, respectively . * Xiaomi: X+Y=45 for 60kHz UL SCS * vivo: X+Y=60-62 and 28-30 for for 60 kHz UL SCS and 120 kHz UL SCS, respectively. * Samsung: X+Y=20 for case 1. * Huawei: X+Y=20, 25 and 50 for Case 1, Case 2 and Case 3, respectively. * Nokia: X+Y=57.5, 60.1, 20.4 and 22.9 for (120kHz DL SCS, 60kHz UL SCS), (240kHz DL SCS, 60kHz UL SCS), (120kHz DL SCS, 120kHz UL SCS) and (240kHz DL SCS, 120kHz UL SCS), respectively. * Qualcomm: X+Y=10, 25 and 30 for Case 1, Case2, and Case 3, respectively. Tm=10% of half UL CP length. | | | |

**Moderator’s WF**

* RAN4 to introduce UE capability on the support of UL SCS of 120kHz, or on the support of certain Te values for UL SCS of 120kHz.
* Down select Te\_NTN from the options highlighted in yellow in the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| Cases | SCS of SSB | Te\_NTN [Ts] for 60kHz of UL SCS | Te\_NTN [Ts] for 120kHz of UL SCS |
| Case-1: Stationary UE for GSO | 120kHz | Option 1: 7-7.6 (QC, Samsung, HW)  Option 2: 9.64 (Apple)  Option 3: 12.5-13.5 (MTK, Nokia)  Option 2: 14 (Ericsson, vivo, ZTE) | Option 1: 5-5.7 (Nokia, QC, Huawei)  Option 2: 7.5 (Ericsson, vivo, Samsung, ZTE)  Option 2: 9.64 (Apple) |
| 240kHz | Option 1: 7-7.6 (Samsung, Huawei, Qualcomm)  Option 2: 9.14 (Apple)  Option 3: 12.5 (Nokia)  Option 3: 13.5-14 (MTK, Ericsson, vivo, ZTE) | Option 1: 5-5.7 (Huawei, Nokia, Qualcomm)  Option 2: 7-7.5 (Ericsson, vivo, Samsung, ZTE)  Option 3: 9.14 (Apple) |
| Case-2: Stationary UE for LEO | 120kHz | Option 1: 8.6 (Huawei)  Option 2: 11 (QC)  Option 3: 12.5-12.72 (Apple, Nokia)  Option 4: 13.5-14 (MTK, Ericsson, vivo, Samsung, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 6.7 (Huawei)  Option 3: 7.5-8 (Ericsson, vivo, ZTE, QC)  Option 4: 12.72 (Apple) |
| 240kHz | Option 1: 8.6 (Huawei)  Option 2: 11 (QC)  Option 3: 12.22-13 (Apple, Nokia, Samsung)  Option 4: 13.5-14 (MTK, Ericsson, vivo, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 6.7-7.5 (Ericsson, vivo, Huawei, ZTE)  Option 3: 8 (QC)  Option 4: 12.22 (Apple) |
| Case-3: Mobile UE for GSO | 120kHz | Option 1: 11 (QC)  Option 2: 12.5-13.5 (MTK, Apple, Samsung, Nokia)  Option 3: 13.7-14 (Ericsson, vivo, Huawei, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 7.5-8 (Ericsson, vivo, ZTE, QC)  Option 3: 12.72 (Apple)  Option 4: 11.8 (Huawei) |
| 240kHz | Option 1: 11 (QC)  Option 2: 12.22-13 (Apple, Samsung, Nokia)  Option 3: 13.5-14 (MTK, Ericsson, vivo, Huawei, ZTE) | Option 1: 5.5 (Nokia)  Option 2: 7.5-8 (Ericsson, vivo, ZTE, QC)  Option 3: 11.8-12.22 (Apple, Huawei) |

**Issue 1-7: NTA-offset**

**Views from companies**

* (vivo) For requirements on UE transmit timing for Satellite Access in above 10 GHz bands, the NTA,offset and its corresponding value shall refer to NTA-offset for TN in FR2 defined in Table 7.1.2-2.

**Moderator’s WF**

* RAN4 to define the exact value of NTA,offset for NR NTN band above 10 GHz.
  + Option 1: the value of NTA-offset defined in Table 7.1.2-2 for FR2
  + Other options are not precluded.

**Issue 1-8: UE Timing Advance adjustment accuracy**

**Views from companies**

* (Samsung) For timing advance requirements to support VSAT UE in bands above 10GHz, reuse the legacy NTN FR requirements in 7.3C except the Table 7.3C.2.2-1.
  + If 60kHz and 120kHz can be accepted, UE Timing Advance adjustment accuracy is defined as:

|  |  |  |
| --- | --- | --- |
| UL Sub Carrier Spacing(kHz) | 60 | 120 |
| UE Timing Advance adjustment accuracy | ±128 Tc | ±32 Tc |

**Moderator’s WF**

* RAN4 to define the timing advance adjustment accuracy requirement for NR NTN band above 10 GHz. The values for 60kHz and 120kHz UL SCSs are the same as those defined in Table 7.3A.2.2-1.

**Issue 1-9: UL timer accuracy requirements**

**Views from companies**

* (Samsung) For UL timer accuracy requirements to support VSAT UE in bands above 10GHz, reuse the legacy NTN FR requirements in 7.2C.

**Moderator’s WF**

* RAN4 to define the UL timer accuracy requirements for NR NTN band above 10 GHz. The values are the same as those defined in Table 7.2C.2-1.

**Issue 1-10: Gradual timing adjustment requirements**

**Views from companies**

* (Samsung) For Gradual timing adjustment requirements to support VSAT UE in bands above 10GHz, reuse the legacy NTN FR requirements in 7.1C.2.1 except the Table 7.1C.2.1-1.
  + If 60kHz and 120kHz can be accepted, Tq\_NTN Maximum Autonomous Time Adjustment Step and Tp\_NTN Minimum Aggregate Adjustment rate is defined as:

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of uplink signals (kHz) | Tq\_NTN | Tp\_NTN |
| FR2-NTN | 60 | 2.5\*64\*Tc | 2.5\*64\*Tc |
|  | 120 | 2.5\*64\*Tc | 2.5\*64\*Tc |

* + Note: FR2-NTN is from agreements in RF session.

**Moderator’s WF**

* RAN4 to define the gradual timing adjustment requirements for NR NTN band above 10 GHz. The values are the same as those defined in Table 7.1.2.1-1.

**Issue 1-11: Additional enhancements**

**Views from companies**

* (Nokia) Ask RAN1 to introduce a mechanism to allow the NW to inform the UE that the UE pre compensation is below the required level. UEs in this situation shall not be capable of transmitting, until they fix their time pre-compensation.
* (Nokia) If the UE updates its GNSS position, and difference between the TA calculated using UE new and old positions is above the UL Transmit Timing inaccuracy, UE shall perform a new RACH.

**Moderator’s suggestion**

* Further discuss the above issue.

**Issue 1-12: Applicability of UL timing requirements for PUSCH DMRS bundling**

**Views from companies**

* (Huawei) For NTN-specific PUSCH DMRS bundling, update the applicability of the timing requirements such that the requirements apply only for the first transmission in the TDW.

**Moderator’s suggestion**

* Further discuss the above issue.

# Topic #2: RRM requirements in bands above 10 GHz

## Companies’ contributions summary

**Issue 2-1: RRC Idle and Inactive mobility**

**R4-2320004 Huawei, HiSilicon**

Proposal 3: RAN4 not to define RRC Idle and Inactive mobility requirements for inter-sat scenario for Type 1 UE.

**Issue 2-3: RLM**

**R4-2318821 Ericsson**

Proposal 3: The type 2 UE shall suspend or cancel any RLF triggered during handover to a neigboring satellite.

**R4-2320736 Nokia, Nokia Shanghai Bell**

Proposal 4: In Table 8.1C.1-2, include a row for FR2-NTN, with Lmax = 64 and NRLM = 8; for both Type 1 and Type 2 UEs.

[Proposal 5: Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.](#_Toc149941158)

**Issue 2-4: RRC Re-establishment**

**R4-2318340 CATT**

Proposal 2: The RRC Re-establishment requirements for both type 1UE and type 2 UE can be defined by using existing FR1 NTN requirements.

**R4-2318654 Apple**

Proposal 5: Not to specify RRC Re-establishment for inter-satellite scenario in Rel-18 for both type 1 and type 2 UEs.

**R4-2318821 Ericsson**

Proposal 2: Deprioritize defining RRC Re-establishment requirement to Type 1 UE for inter-satellite scenario in Rel-18.

Proposal 4: The type 2 UE shall suspend or cancel any RRC connection re-establishment triggered during handover to a neigboring satellite.

**R4-2320004 Huawei, HiSilicon**

Proposal 4: For RRC Re-establishment requirements, for both UE types,

* Intra-sat: existing FR1 NTN requirements in clause 6.2C.1 apply without inter-satellite measurement configuration
* Inter-sat: no requirements are defined

**Issue 2-5: L3 measurements**

**R4-2318654 Apple**

Proposal 6: RAN4 to adopt one of following alternatives:

* Alt 1: Existing UE capabilities of “*maxNumber-NGSO-SatellitesWithinOneSMTC-r17*” and “*parallelMeasurementWithoutRestriction-r17*” shall not be expanded to NTN UE in Ka band.
* Alt 2: If Existing UE capabilities of “*maxNumber-NGSO-SatellitesWithinOneSMTC-r17*” and “*parallelMeasurementWithoutRestriction-r17*”are expanded to NTN UE in Ka band,
  + n1 shall be assumed in maxNumber-NGSO-SatellitesWithinOneSMTC-r17 for Rel-18 NTN UE
  + scheduling restriction shall be always applied in parallelMeasurementWithoutRestriction-r17” for Rel-18 NTN UE

**R4-2318841 LG Electronics Inc.**

Proposal 1: No need maxNumber-NGSO-SatellitesWithinOneSMTC and parallelMeasurementWithoutRestriction for FR2 NTN UE

**R4-2320004 Huawei, HiSilicon**

Proposal 6: RAN4 to define UE capability to differentiate Type 1 and Type 2 UE.

**R4-2320736 Nokia, Nokia Shanghai Bell**

Proposal 9: For intra-frequency measurements (in FR2-NTN), a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:

* 8 identified cells, and
* 24 SSBs with different SSB index and/or PCI on the intra-frequency layer

Proposal 10: For inter-frequency measurements (in FR2-NTN) a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:

* 4 identified cells, and
* 10 SSBs with different SSB index and/or PCI on the inter-frequency layer
* 1 SSB per identified Cell

**Issue 2-7: Measurement gap**

**R4-2318340 CATT**

Proposal 3: Introduce FR2 MG patterns in section 9.1C.2 and introduce UE capability for supported gap patterns for NTN.

**Issue 2-10: Inter-satellite Handover**

**R4-2318654 Apple**

Proposal 9: for type 1 UE, the “additional interruption component for UE beam refinement to address a concern about beam mis-alignment at the handover period due to the target satellite position error and/or UE beam steering error” can be decided once RF session has conclusion on this typical value for electronic beam steering.

**R4-2318821 Ericsson**

Proposal 5: For type 1 UE, the beam refinement procedure for handover which is raised in last meeting, together with side condition and refinement target shall be exploited and clarified before directly going to determine the exact time of the beam refinement.

**R4-2318841 LG Electronics Inc.**

Proposal 2: Consider additional interruption component for beam refinement during handover with less beam sweeping factor such as N=4 (Type 1 UE).

**R4-2319212 Samsung**

Proposal 7: For Type 1 UE handover requirements, the additional interruption length can be 2 \* Trs for intra-frequency cell and 2 \* 3 \* Trs for unknown inter-frequency cell.

**R4-2320004 Huawei, HiSilicon**

Proposal 5: For Inter-satellite Handover requirements

* Type 1 UE: the additional interruption length is [4]\*Trs
* Type 2 UE: the additional interruption length is [8]s

**Issue 2-11: Mechanical beam steering for Type 2 UE**

**R4-2318340 CATT**

Proposal 4: Introduce UE capability for type 2 UE to indicate the beam switching time from one satellite to another.

**R4-2318460 MediaTek inc.**

Proposal 3: For inter-sat and mechanical-steered beam UE (Type 2) HO, the beam switching delay or the total HO interruption time can be reported as a UE capability.

**R4-2318654 Apple**

Proposal 7: for inter-SAT blind HO for type 2 UE on Ka band, the Tmechanical\_beam\_steering shall be added on top of Rel-17 FR1 NTN blind HO interruption time, where,

* Tmechanical\_beam\_steering = (Angle difference between source and target satellite)/(mechanical beam steering speed), which is the extra time delay margin for UE to switch its mechanical beam steering from serving satellite to target satellite.

Proposal 8: introduce a new UE capability of mechanical beam steering speed for type 2 UE, and 22 degree/sec could be one of the candidate values.

**R4-2318821 Ericsson**

Proposal 1: RAN4 shall check if a mobile type 2 UE for GSO can continually steer the antenna direction to the serving satellite and no extra delay requirements due to the UE’s mobility, such as moving or rotating.

**R4-2318821 Ericsson**

Proposal 6: For type 2 UE, introduce Tsteering (interruption time for redirecting antenna orientation) in inter-satellite handover, which is scaled with the practically needed time for redirecting antenna orientation, i.e., Tsteering = the angular distance (between the sourcing satellite and target satellite in handover) / the sweeping speed (indicated by the UE capability).

Proposal 7: In blind handover for type 2 UE, the UE may spend plenty of time but fail to detect (including redirecting and refining the antenna orientation to the target satellite with respect to the ephemeris data) the target satellite. RAN4 shall check the necessity to limit the maximal time delay for detecting the target satellite.

Proposal 8: Introduce UE capability indicating the sweeping speed, it can be an exact sweeping speed (x degree/second) or index of a sweeping speed range (Index1: (x1 degree/second, y1 degree/second); Index2: (x2 degree/second, y2 degree/second )).

**R4-2318841 LG Electronics Inc.**

Proposal 3: Consider 6s and 8s for additional interruption length for the retuning of the mechanical beam direction during handover with explicit UE capability (Type 2 UE)

**R4-2319212 Samsung**

Proposal 8: For Type 2 UE handover requirements, the additional interruption length can be 5.5s for GSO scenario. For LEO, the angular separation depends on the deployments. We think it can be a shorter interruption length than GSO scenario.

|  |  |
| --- | --- |
| |  | | --- | | **Issue 2-5: Beam switching requirement**  Agreement/WF:  Take following information as working assumption for beam switching time:  Ø  For mechanical steering: the typical values can be 22 degree/second, 6~8 seconds (if 120 degrees steering is assumed) for inter-satellite beam switching.  Ø  For electronic steering: A typical value is FFS for beam steering. |   If using 22 degree/second, the additional interruption length depends on the angular separation between the two satellites. For GSO/GEO, the angular separation is 120 degrees. The additional interruption length is 5.5s for GSO scenario. For LEO, the angular separation depends on the deployments. In practice, the typical angle is less than that is GSO. We think it can be a shorter interruption length than GSO scenario. |

**R4-2320736 Nokia, Nokia Shanghai Bell**

Proposal 5: Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.

Proposal 6: Type 2 UEs shall indicate via capability signalling that they are a type 2 UE.

Proposal 7: Discuss whether different values can be used for the Type 2 UE capability signalling to indicate how fast the UE can steer its antenna.

**Issue 2-12: Measurement accuracy**

**R4-2318340 CATT**

Proposal 5: RAN4 to decide in this meeting whether to perform simulation for measurement accuracy requirements in Ka band.

**Issue 2-13: UE capability**

**R4-2320736 Nokia, Nokia Shanghai Bell**

Proposal 8: Do not expand the following measurement related capabilities from Rel-17 for the operation above 10 GHz:

* parallelMeasurementGap-r17
* parallelSMTC-r17
* maxNumber-LEO-SatellitesPerCarrier-r17
* maxNumber-NGSO-SatellitesWithinOneSMTC-r17
* parallelMeasurementWithoutRestriction-r17

**R4-2319212 Samsung**

Proposal 9: Define a static capability for UE steering types, which can be electronica-steered or mechanical-steered.

**R4-2318654 Apple**

Proposal 10: introduce new UE capability for Rel-18 eNTN as in Annex, including:

* UE architectures for beam steering for band above 10GHz
* Beam steering speed for fully mechanically-steered beam UEs (Type 2 UE)
* NTN communication with SCS of 120kHz for band above 10GHz

**R4-2318654 Apple**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Consequence if the feature is not supported by the UE** | **Type** | **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 | UE architectures for beam steering for band above 10GHz | Support of UE architectures for beam steering in above 10 GHz bands, either fully electronically-steered beam UEs (Type 1 UE) or fully mechanically-steered beam UEs (Type 2 UE) |  | Yes | UE does not support NTN communication on above 10GHz bands. | Per band | FDD only | [FR2 only] | N/A | UE to indicate which architecture is used to support NTN above 10GHz:  (1)Type 1: fully electronically-steered beam UE, or  (2)Type 2: fully mechanically-steered beam UE.  [Agreed in R4-2314447] | Optional with capability signaling |
| 40.  NR\_NTN\_enh | 40-2 | [Beam steering speed for fully mechanically-steered beam UEs (Type 2 UE)] | Support of indicating the beam steering adjustment speed during mobility based measurement in inter-satellite Handover. | 40-x (Type 2 UE) | Yes | Type 2 UE cannot complete the inter-satellite handover within a time delay requirement in TS38.133 [section 6.x.y] | Per band | FDD only | FR2 only | N/A | UE to indicate which the beam steering adjustment speed during mobility based measurement in inter-satellite Handover, i.e., X degrees/sec.  The candidate values for X can be {22, etc} | Optional with capability signaling |
| 40.  NR\_NTN\_enh | [40-3] | [NTN communication with SCS of 120kHz for band above 10GHz] | [Support of NTN communication with SCS of 120kHz for band above 10GHz.] |  | [Yes] | [UE does not support NTN communication with SCS of 120kHz for band above 10GHz.] | [Per band] | FDD only | [FR2 only] | N/A | [UE is required to meet the Tx timing requirement for SCS=120kHz in TS38.133 [section 7.x.y].] | [Optional with capability signaling] |

**R4-2319062 vivo**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (Sidelink 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  *parallelMeasurementWithoutRestriction-fr2-r18* | 40-1 | Parallel measurements on cells belonging to a different NGSO satellite than a serving satellite without scheduling restrictions on normal operations with the serving cell | Support of measurements on cells belonging to different satellite as the serving cell in parallel with normal operation (i.e. data/control transmission and/or reception, and L1 measurements) of serving cell without scheduling restrictions. [The feature is applicable only when the serving satellite is NGSO. If the serving cell belongs to GSO satellite, the scheduling restriction is not applied on the premise that a mixed type of satellites on the same frequency layer is not supported in this release (Rel-18).] |  | YES | NO | UE doesn’t support of measurements on cells belonging to different satellite as the serving cell in parallel with normal operation of serving cell without scheduling restrictions. | Per Band | FDD only | FR2 only | NO |  | Optional with capability signalling |
| 40.  NR\_NTN\_enh  *maxNumber-NGSO-SatellitesWithinOneSMTC-fr2-r18* | 40-2 | Parallel measurements on multiple NGSO satellites within a SMTC | Support of simultaneously measurements on target cells [belonging to different NGSO satellites within a SMTC] |  | YES | NO | UE doesn’t support of simultaneously measurements on target cells | Per Band | FDD only | FR2 only | NO |  | Optional with capability signalling |
| 40.  NR\_NTN\_enh  *UEType-MechanicalSteering-r18* | 40-3 | Support NTN UE capable of VSAT communicating with mechanical steering antenna | Support NTN UE capable of VSAT communicating with mechanical steering antenna |  | YES | NO | UE is not capable of VSAT communicating with mechanical steering antenna | Per UE | FDD only | FR2 only | NO |  | Optional with capability signalling |







## Open issues

**Issue 2-1: RRC Idle and Inactive mobility**

**Agreement [RAN4#108b]:**

* For Type 1 UE, UE requirements on RRC Idle and Inactive mobility in intra-satellite scenario reuse FR1 NTN requirements with Ksatellite = 1 without inter-satellite measurement configuration.
* For Type 2 UE, UE requirements on RRC Idle and Inactive mobility in intra-satellite scenario reuse FR1 NTN requirements with Ksatellite = 1 without inter-satellite measurement configuration. Note: RRC Idle and Inactive mobility in inter-satellite scenario is out of scope according to the endorsed RP-232694.

**Views from companies**

* (Huawei) RAN4 not to define RRC Idle and Inactive mobility requirements for inter-sat scenario for Type 1 UE.

**Moderator’s WF**

* RAN4 not to define RRC Idle and Inactive mobility requirements for inter-sat scenario for Type 1 UE.

**Issue 2-3: RLM**

**Agreement [RAN4#108b]:**

* For Type 1 UE, RLM requirements specified based the assumption that the measurement delay without beam sweeping scaling factor.
  + RLM requirements are the same as the existing FR1 NTN requirements (8.1C).
* For Type 2 UE, RLM requirements are the same as the existing FR1 NTN requirements (8.1C).

**Views from companies**

* (Ericsson) The type 2 UE shall suspend or cancel any RLF triggered during handover to a neigboring satellite.
* (Nokia) In Table 8.1C.1-2, include a row for FR2-NTN, with Lmax = 64 and NRLM = 8; for both Type 1 and Type 2 UEs.
* (Nokia) Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.

**Moderator’s WF**

* Decide the values of Lmax and NRLM
  + Option 1: Lmax = 64 and NRLM = 8; for both Type 1 and Type 2 UEs
  + Option 2: Lmax = 1 and NRLM = 1; for both Type 1 and Type 2 UEs
    - In the draft CR R4-2320965, the above values were considered as per RP-232694 approved in RAN#101 that the number of Tx beams from satellites was reduced to 1.
* Discuss and decide whether to consider the following for type 2 UE.
  + Option 1: The type 2 UE shall suspend or cancel any RLF triggered during handover to a neigboring satellite
  + Option 2: Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.

**Issue 2-4: RRC Re-establishment**

**FFS [RAN4#108b]:**

* For Type 1 UE, whether to specify RRC Re-establishment for inter-satellite scenario.
* For Type 2 UE, whether to specify RRC Re-establishment for inter-satellite scenario.
* FFS: RRC Re-establishment requirements for intra-satellite scenario are the same as the existing FR1 NTN requirements with Ksatellite = 1.

**Views from companies**

* For type 1 UE
  + Intra-satellite RRC re-establishment
    - Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1).
      * CATT
      * Huawei (without inter-satellite measurement configuration)
    - No RRC re-establishment requirements
  + Inter-satellite RRC re-establishment
    - No RRC re-establishment requirements
      * Apple, Ericsson, Huawei
* For type 2 UE
  + Intra-satellite RRC re-establishment
    - Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1).
      * CATT
      * Huawei (without inter-satellite measurement configuration)
    - No RRC re-establishment requirements
  + Inter-satellite RRC re-establishment
    - Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1).
      * CATT
    - No RRC re-establishment requirements
      * Apple, Huawei
    - Suspend or cancel any RRC connection re-establishment triggered during handover to a neigboring satellite
      * Ericsson

**Moderator’s WF**

* For type 1 UE
  + Inter-satellite RRC re-establishment
    - No RRC re-establishment requirements
* Discuss the following cases:
  + For type 1 UE
    - Intra-satellite RRC re-establishment
      * Option 1-A: Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1).
      * Option 1-B: No RRC re-establishment requirements
  + For type 2 UE
    - Intra-satellite RRC re-establishment
      * Option 2-1A: Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1). And the requirement applies when the UE is not configured with inter-satellite measurement.
      * Option 2-1B: No RRC re-establishment requirements
    - Inter-satellite RRC re-establishment
      * Option 2-2A: Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1).
        + CATT
      * Option 2-2B: No RRC re-establishment requirements
        + Apple, Huawei, Ericsson
      * Option 2-2C: Suspend or cancel any RRC connection re-establishment triggered during handover to a neigboring satellite

**Issue 2-5: L3 measurements**

**Agreement [RAN4#108b] - Issue 2-5: L3 measurements:**

* For Type 1 UE and Type 2 UE, intra-satellite L3 measurements are the same as the existing FR1 NTN requirements defined in 9.2C and 9.3C without inter-satellite measurement configuration.
  + Existing UE capabilities need further clarification if these capabilities are expanded to NTN UE in Ka band, e.g.,
    - maxNumber-NGSO-SatellitesWithinOneSMTC-r17 and
    - parallelMeasurementWithoutRestriction-r17
  + Note: no inter-satellite L3 measurements based on the endorsed RP-232694.

**Views from companies**

* (Nokia) For intra-frequency measurements (in FR2-NTN), a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:
  + 8 identified cells, and
  + 24 SSBs with different SSB index and/or PCI on the intra-frequency layer
* (Nokia) For inter-frequency measurements (in FR2-NTN) a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:
  + 4 identified cells, and
  + 10 SSBs with different SSB index and/or PCI on the inter-frequency layer
  + 1 SSB per identified Cell

**Moderator’s WF**

* For intra-frequency measurements, a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:
  + 8 identified cells, and
  + FFS on [24 SSBs with different SSB index and/or PCI on the intra-frequency layer]
* For inter-frequency measurements a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:
  + 4 identified cells, and
  + FFS on [10 SSBs with different SSB index and/or PCI on the inter-frequency layer]
  + 1 SSB per identified Cell
* Further discuss and decide FFS points in RAN4#109. As per RP-232694 approved in RAN#101, the number of Tx beams from satellites was assumed to be 1.

**Issue 2-7: Measurement gap**

**Agreement [RAN4#108b]:**

* FR2 MG patterns are used for NTN in bands above 10 GHz.

**Views from companies**

* (CATT) Introduce FR2 MG patterns in section 9.1C.2 and introduce UE capability for supported gap patterns for NTN.

**Moderator’s WF**

* Introduce FR2 MG patterns in section 9.1C.2 and introduce UE capability for supported gap patterns for NTN.

**Issue 2-10: Inter-satellite Handover**

**Agreement [RAN4#108b]:**

* For Type 1 UE, inter-satellite HO requirements are the existing FR1 NTN HO requirements with unknown cell condition **plus an additional interruption component** for UE beam refinement to address a concern about beam mis-alignment at the handover period due to the target satellite position error and/or UE beam steering error. **TBD on the additional interruption length**.
* For Type 2 UE, inter-satellite HO requirements are the existing FR1 NTN HO requirements with unknown cell condition **plus an additional interruption component** for the retuning of the mechanical beam direction. **TBD on the additional interruption length**.
* Postpone the discussion on inter-satellite CHO requirements on above 10GHz bands in future releases.

**Agreement [RAN4#108b] - Issue 2-11: Mechanical beam steering for Type 2 UE:**

* For Type 2 UE, in RAN4#109, discuss and decide whether/how to resolve issues due to non-zero beam switching delay from one satellite to another.
  + The beam switching delay can be an implicit or explicit UE capability.
  + The capability can be static or semi-static one. RAN4 to aim to decide the details (including any procedure modification, which may be needed in RAN1/2/, to accommodate Type 2 UE beam switching latency).

**Views from companies**

* For type 1 UE, the additional interruption length X:
  + Decide the value of X once RF session has conclusion on this typical value for electronic beam steering.
    - Apple
  + X = 4\*Trs
    - LGE, Huawei
  + X = 2\*Trs and 2\*3\*Trs for intra-frequency HO and unknown inter-frequency HO, respectively
    - Samsung
* For type 2 UE, the additional interruption length Y:
  + Y = 5.5 sec and shorter than 5.5 sec for GSO and NGOS, respectively
    - Samsung
  + Y = 6 sec
    - LGE
  + Y = 8 sec
    - LGE, Huawei
  + Y = UE capability (to be introduced) on beam switching time from one satellite to another
    - CATT, MTK (or the capability on the total HO interruption time)
  + Y = ‘Angle difference between source and target satellite’/‘mechanical beam steering speed’ and introduce UE capability on ‘mechanical beam steering speed’
    - Apple, Ericsson, Nokia
* Other proposals
  + (Ericsson) RAN4 shall check if a mobile type 2 UE for GSO can continually steer the antenna direction to the serving satellite and no extra delay requirements due to the UE’s mobility, such as moving or rotating.
  + (Ericsson) In blind handover for type 2 UE, the UE may spend plenty of time but fail to detect (including redirecting and refining the antenna orientation to the target satellite with respect to the ephemeris data) the target satellite. RAN4 shall check the necessity to limit the maximal time delay for detecting the target satellite.
  + (Nokia) Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.
  + (Nokia) Type 2 UEs shall indicate via capability signalling that they are a type 2 UE.

**Moderator’s WF**

* For type 1 UE, the additional interruption length X is
  + Option 1-A: 4\*Trs
  + Option 1-B: 2\*Trs and 2\*3\*Trs for intra-frequency HO and unknown inter-frequency HO, respectively
  + Option 1-C: up to RF session discussion.
  + Option 1-D: Depends on refinement target (e.g., side condition) and outputs from RF session discussion.
* For type 2 UE, the additional interruption length Y is
  + Option 2-A: 5.5 sec and shorter than 5.5 sec for GSO and NGOS, respectively
  + Option 2-B: 6 sec
  + Option 2-C: 8 sec
  + Option 2-D: UE capability (to be introduced) on beam switching time from one satellite to another
  + Option 2-E: ‘Angle difference between source and target satellite’/‘mechanical beam steering speed’ and introduce UE capability on ‘mechanical beam steering speed’
* Discuss the following:
  + Whether and how to to limit the maximal time delay for detecting the target satellite.
  + Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.

**Issue 2-12: Measurement accuracy**

**Views from companies**

* (CATT) RAN4 to decide in this meeting whether to perform simulation for measurement accuracy requirements in Ka band.

**Moderator’s suggestion**

* No discussion in RAN4#109.

**Issue 2-13: UE capability**

**Views from companies**

* maxNumber-NGSO-SatellitesWithinOneSMTC-r17 and parallelMeasurementWithoutRestriction-r17 are not applicable for NR NTN band above 10GHz.
  + Apple, LGE, Samsung, Nokia
* parallelMeasurementGap-r17 is not applicable for NR NTN band above 10GHz.
  + Nokia
* parallelSMTC-r17 is not applicable for NR NTN band above 10GHz.
  + Nokia
* maxNumber-LEO-SatellitesPerCarrier-r17 is not applicable for NR NTN band above 10GHz.
  + Nokia
* Define UE capability to differentiate Type 1 and Type 2 UE
  + Huawei, Nokia, Apple,vivo

**Moderator’s WF**

* The following UE capabilities introduced in Rel-17 NR NTN are not applicable for NR NTN band above 10GHz:
  + maxNumber-NGSO-SatellitesWithinOneSMTC-r17
    - Note: Support of **simultaneously** measurements on target cells belonging to different NGSO satellites within a SMTC
  + parallelMeasurementWithoutRestriction-r17 are not applicable
    - Note: Support of measurements on cells belonging to different satellite as the serving cell **in parallel** with normal operation (i.e. data/control transmission and/or reception, and L1 measurements) of serving cell without scheduling restrictions. The feature is applicable only when the serving satellite is NGSO. If the serving cell belongs to GSO satellite, the scheduling restriction is not applied on the premise that a mixed type of satellites on the same frequency layer is not supported in this release (Rel-17).
  + parallelSMTC-r17
    - Note: Support of measurements on target cells belonging to 4 SMTC-s on a single frequency carrier
    - Note: As per RP-232694 approved in RAN#101, inter-satellite measurements are not assumed in Rel-18.
  + maxNumber-LEO-SatellitesPerCarrier-r17
    - Note: On serving carrier, it indicates the number of target LEO satellites the UE can monitor per carrier including serving satellite
    - Note: On non-serving carrier, it indicates the number of target LEO satellites the UE can monitor per carrier.
    - Note: As per RP-232694 approved in RAN#101, inter-satellite measurements are not assumed in Rel-18.
  + TBD on [parallelMeasurementGap-r17]
    - Note: Support of 2 measurement gaps
    - Note: the capability directly means neither ‘parallel/simultaneous measurement’ nor ‘inter-satellite measurement.’

# Topic #3: Network verified UE location

## Companies’ contributions summary

**Issue 3-2:** **Measurement period and accuracy requirements on RTD**

**R4-2319063 vivo**

Proposal 1: For the UE Rx-Tx time difference measurement period as specified in the definition of DL timing drift in TS38.215, it is referring to the measurement period requirements for UE Rx-Tx measurement for NTN to be defined in TS38.133.

Proposal 2: Measurement period requirements for UE Rx-Tx measurement for NTN is defined to reuse the **existing TN requirements** **with MG** as baseline and consider a **higher Es/Iot** than the existing one is needed, targeting **the same accuracy** as the existing one.

**R4-2320006 Huawei, HiSilicon**

Proposal 1: RAN4 to discuss whether Nsample = 4 is applicable for UE Rx-Tx measurement.

**R4-2320737 Nokia, Nokia Shanghai Bell**

Proposal 3: For the UE Rx-Tx difference, discuss whether the scope include measurements across different frequency layers and how to treat the case where inter-frequency MGs are to be shared between more than one satellite.

**Issue 3-3: Measurement period and accuracy requirements on DL timing drift**

**R4-2320967 Qualcomm Incorporated**

Proposal 1: **No UE requirement on DL timing drift measurement/calculation** is needed.

**R4-2320006 Huawei, HiSilicon**

we do not see the introduction of the DL timing drift will impact the UE Rx-Tx measurement requirements in RAN4.

Proposal 2: RAN4 not to further discuss “UE Rx-Tx time difference measurement period” in the definition of DL timing drift (which is RAN1 scope).

**Issue 3-4: Measurement accuracy requirements on UL timing drift**

**R4-2320006 Huawei, HiSilicon**

Proposal 3: RAN4 not to define new applicability condition for UE Rx-Tx measurement requirements related to amount of variation in the applied TA during measurement period.

**R4-2320737 Nokia, Nokia Shanghai Bell**

Proposal 1: If the UE autonomous adjustments in the service link component, , are inferior to Tq\_NTN the UE is not required to send the reporting of the service link delay variation.

Proposal 2: When the total autonomous variation applied by the UE in the timing advance during a measurement period (variation of + ) exceeds [5]\*Tp the accuracy requirements might be further relaxed.

**Issue 3-5: Other impact on RRM**

**R4-2320737 Nokia, Nokia Shanghai Bell**

Proposal 4: For the satellite switch case with same PCI, the UE shall consider the measurements collected prior to the satellite switch invalid and restart the UE Rx-Tx time difference measurement after the switch is complete.

Proposal 5: Discuss how to handle UE measurements across both satellites when there is a soft satellite switch.

## Open issues

**Issue 3-2: Measurement period and accuracy requirements on RTD**

**Agreement [RAN4#108b]:**

* Measurement period requirements for UE Rx-Tx measurement is defined to reuse the existing TN requirements with MG as baseline.
  + Option 1: a higher Es/Iot than the existing one is needed, targeting the same accuracy as the existing one.
  + Other options are not precluded.

**Views from companies**

* UE Rx-Tx measurement period requirement is the same as the existing requirement with MG
  + Vivo
* Discuss whether the scope include measurements across different frequency layers and how to treat the case where inter-frequency MGs are to be shared between more than one satellite
  + Nokia
* A higher Es/Iot than the existing Es/Iot and the same accuracy requirement
  + Vivo
* Discuss whether Nsample = 4 is applicable
  + Huawei

**Moderator’s WF**

* For UE Rx-Tx measurement period requirement, discuss and decide the following in RAN4#109:
  + Option 1-A: The scope includes measurements across different frequency layers.
    - Further discuss and decide the details, in RAN4#109, about how to treat the case where inter-frequency MGs are to be shared between more than one satellite.
  + Option 1-B: The scope does not include measurements across different frequency layers.
* For UE Rx-Tx measurement accuracy requirement, compared to the existing requirements, discuss the following in the performance requirement phase.
  + Whether and how much to increase Es/Iot
  + Whether to reuse or modify the same accuracy requirement.
  + Whether Nsample = 4 is applicable

**Issue 3-3: Measurement period and accuracy requirements on DL timing drift**

**Agreement [RAN4#108b]:**

Discuss further on the interpretation on ‘UE Rx-Tx time difference measurement period’ as specified in RAN1 following conclusion.

*RAN1 agreement in RAN1#114 meeting*

* *DL timing drift measurement is defined as the DL timing estimated to be shifted due to Doppler over the service link associated with the UE Rx-Tx time difference measurement period.*

**Views from companies**

* No UE requirement on DL timing drift measurement/calculation.
  + QC, Huawei

**Moderator’s WF**

* No UE requirement on DL timing drift measurement/calculation.

**Issue 3-4: Measurement accuracy requirements on UL timing drift**

**Agreement [RAN4#108b]:**

Discuss and decide the following in RAN4#109.

* Whether the requirements apply when the total autonomous variation applied by the UE in the timing advance during a measurement period exceeds a threshold (e.g. 5\*Tp)

**Views from companies**

* (Huawei) No new applicability condition for UE Rx-Tx measurement requirements related to amount of variation in the applied TA during measurement period.
* (Nokia) If the UE autonomous adjustments in the service link component, , are inferior to Tq\_NTN the UE is not required to send the reporting of the service link delay variation.
* (Nokia) When the total autonomous variation applied by the UE in the timing advance during a measurement period (variation of + ) exceeds [5]\*Tp the accuracy requirements might be further relaxed.

**Moderator’s WF**

* Further discuss the above.

**Issue 3-5: Other impact on RRM**

**Views from companies**

* (Nokia) For the satellite switch case with same PCI, the UE shall consider the measurements collected prior to the satellite switch invalid and restart the UE Rx-Tx time difference measurement after the switch is complete.
* (Nokia) Discuss how to handle UE measurements across both satellites when there is a soft satellite switch.

**Moderator’s WF**

* Further discuss the above.

# Topic #4: Idle/Inactive mode mobility enhancements

## Companies’ contributions summary

**Issue 4-1: TN to NTN cell reselection**

**R4-2318342 CATT**

Proposal 1: RAN4 to define TN to NTN cell reselection.

**R4-2318461 MediaTek inc.**

Proposal 1: Deprioritized or not pursue TN-to-NTN reselection requirements.

**R4-2318655 Apple**

Proposal 1: by considering symmetric mobility, RAN4 to adopt one of the following alternatives for moving forward (all alternatives are acceptable to us):

* Alt 1: define both TN-NTN and NTN-TN mobility requirement, and exception list for TN-NTN mobility is needed in next RANP meeting.
* Alt 2: define both TN-NTN and NTN-TN mobility requirement, but TN-NTN case can be postponed to R19 scope
* Alt 3: Not define either TN-NTN or NTN-TN mobility requirement

Proposal 2: if TN-NTN cell reselection requirement is to be specified in Rel-18, only SS-RSRP/SS-RSRQ based inter-frequency cell reselection case shall be considered and the Rel-17 NTN-NTN inter-frequency cell reselection requirement can be used as baseline.

**R4-2318820 Ericsson**

Proposal 1: Deprioritize defining RRM requirements for TN-to-NTN cell reselection, at the least before the procedure is carried out by RAN2.

**R4-2318897 LG Electronics Inc.**

Proposal 1: RAN4 to wait for RAN2 conclusion on TN to NTN cell reselection.

**R4-2318908 CMCC**

Proposal 1: Deprioritize the TN to NTN cell reselection scenario.

**R4-2319061 vivo**

Proposal 3: RAN4 to suspend discussion on whether/how to define TN-to-NTN cell reselection requirements until RAN2 design on TN-to-NTN mobility is stable.

**R4-2319213 Samsung**

Proposal 1: RAN4 to define RRM requirement for TN-to-NTN cell reselection as NTN-to-TN cell reselection.

**R4-2320007 Huawei, HiSilicon**

Proposal 1: RAN4 not to define RRM requirements for TN-to-NTN cell reselection.

**R4-2320558 ZTE Corporation**

Observation 4: The signal service quality of UE in the coverage range of TN is much better than that of NTN and the UE power saving shall be considered.

Observation 5: A UE camps in a TN cell and then switch to a NTN cell which is not happened frequently only when UE is at the border of the TN coverage.

Proposal 3: RAN4 shall not define the TN-NTN cell re-selection and the related requirements.

**Issue 4-2: NTN to TN cell reselection**

**R4-2318461 MediaTek inc.**

Proposal 2: (Option A) RAN4 to not update the existing UE requirements other than adding the clarification that UE is not required to perform TN cell measurement in an area where there is no TN network coverage on a given frequency layer based on the provide TN cell coverage information and UE GNSS position information.

**R4-2318655 Apple**

Proposal 3: to address the issue of “mismatch between practical TN cell coverage and TN cell coverage information provided by serving cell”, RAN4 can introduce an additional positive margin adding on top of the TN coverage radius provided by serving cell, e.g., 50 meters, to determine if UE is outside TN coverage or not.

**R4-2318897 LG Electronics Inc.**

Proposal 2: For the measurement requirement of TN frequency layer, measurement condition needs to be added as below.

* If serving cell is NTN and the TN coverage information is provided, UE shall search for and measure TN frequency layers if the distance between UE and the reference location of TN coverage is smaller than distanceThresh [+margin] for TN coverage. Otherwise, UE may not perform measurement of TN frequency.

**R4-2318908 CMCC**

Proposal 2: Define inter-frequency NTN-to-TN cell re-selection requirements and inter-RAT NTN-to-TN cell re-selection requirements.

**R4-2320007 Huawei, HiSilicon**

Proposal 2: RAN4 not to define RRM requirements for NTN-to-TN cell reselection.

**R4-2320739 Nokia, Nokia Shanghai Bell**

Proposal 1: For the NTN to TN Cell Reselection Requirements, re-use the same requirements for inter-frequency cell reselection (Tmeasure, Tdetect, Tmeasure) used for NTN to NTN, with K\_multi\_SMTC =1.

Proposal 2: Capture in specification that “When the UE is configured to measure a frequency layer associated to terrestrial cells, the measurement requirements are not applicable when the UE is provided with information about the TN coverage area and the UE is outside the coverage area”.

Proposal 3: Capture in TS 38.133 the cell reselection from NR NTN to EUTRA TN.

Proposal 4: Do not provide enhancements for the TN cell reselection to account for mismatch between the TN coverage area configured by the Network and the real coverage area.

**Issue 4-3: NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell**

**R4-2318342 CATT**

Proposal 2: For time-based cell reselection in earth-moving cell, the existing RRC idle/inactive mode requirements referring to ‘t-service’ can be reused.

**R4-2318655 Apple**

Proposal 4: For NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell, the existing RRC idle/inactive mode requirements referring to ‘t-service’ are reused.

**R4-2318820 Ericsson**

Proposal 2: In hard satellite switch, no need to enhance the time-based measurement initiation in earth-moving cell. In other cases, we don’t preclude possible enhancements however it depends on time plan of WI.

**R4-2318897 LG Electronics Inc.**

Proposal 3: Following conditions should be precluded for time-based measurement (t-service) if exsiting requirements referring to t-Service for earth-moving cell is reused

* UE shall start measurement of the neigbhor cells indicated by the serving cell before t-Service is reached according to the requirements
* UE shall be able to detect, measure, and evaluate neighbour cells before the serving cell stops serving the area regardless of whether the distance condition based on serving cell reference location or the legacy Srxlev/Squal condition are met.

**R4-2318908 CMCC**

Proposal 3: For NTN to NTN time-based measurement initiation for cell re-selection in earth-moving cell, the existing RRC idle/inactive mode requirements referring to ‘t-service’ can be reused.

**R4-2319061 vivo**

Observation 1: For the ‘t-service’ which is reused in time-based cell-resection initiation in R18, it corresponds to the stop time due to feeder link switching, which is a common value for all UEs currently camping in this cell. It is irrelevant to the stop time caused by “cell coverage sliding over the earth surface”

Observation 2: Due to “cell coverage sliding over the earth surface” for earth-moving cell, the actual stop time point at which some UE leaves the area currently covered by serving cell may be earlier than the stop time due to feeder link switching.

Observation 3: If the existing requirement on time-based cell reselection measurement is reused in earth-moving cell, it may occur that UE cannot finish measurements before leaving the area currently covered by serving cell even the applicability rule is met (i.e., expected remain service time is larger than Ttrigger).

Proposal 1: For the case that the actual stop time point for specific UE is earlier than the stop time due to feeder link switching, RAN4 to introduce coverage information of serving cell for helping UE to assess the available service time left for cell reselection measurement.

Proposal 2: RAN4 to send a LS to ask RAN2 to introduce the coverage information (i.e., a reference point of cell centre plus radius) of serving cell for time-based cell reselection measurement initiation.

**R4-2319213 Samsung**

Proposal 2: For time-based measurement initiation for cell reselection in earth moving cell, the existing requirements on “4.2C Cell Re-selection for NR UE for Satellite Access” can be applied for both earth-fixed and earth-moving cell cases.

**R4-2320007 Huawei, HiSilicon**

Proposal 3: RAN4 to define requirements for time triggered cell reselection measurement for earth moving cell, and the Rel-17 requirements for earth fixed cell are used as baseline.

(support Option 1, no support Option 2 and 3)

**R4-2320558 ZTE Corporation**

Observation 1: Re-use t-Service-r17 format for the IE used to trigger UE neighbour cell measurements prior to cell replacement due to feeder link switch

Observation 2: No new time-based cell re-selection criteria will be introduced for R18 and the RRM requirements for time-based cell re-selection for quasi-earth fixed cell in R17 can be considered as the starting point for NTN-NTN cell re-selection requirements with earth moving cell.

Proposal 1: For NTN to NTN time-based measurement initiation for cell re-selection in earth-moving cell, the existing RRC idle/inactive mode requirements referring to “t-service” are reused.

Observation 3: RAN2 also agreed that time-based and location-based cell reselection criteria is not pursued in R18.

Proposal 2: RAN4 shall not introduce the additional coverage information.

**Issue 4-4: NTN to NTN location-based measurement initiation for cell reselection in earth-moving cell**

**R4-2318820 Ericsson**

Proposal 3: No need to introduce new cell reselection requirements for earth-moving cell since that referenceLocation for earth-moving cell only indicates initiating measurement but no impact current measurement delay requirements in ‘Clause 4.2C Cell Re-selection for NR UE for Satellite Access’.

Proposal 4: Extra location margin for or earth-moving cell may be implemented in performance part. Core part doesn’t need to take it into account.

**R4-2318908 CMCC**

Proposal 4: For NTN to NTN location-based measurement initiation for cell re-selection in earth-moving cell, an extra location margin 20m can be introduced due to UE deriving the practical reference location based on ephemeris information.

**Issue 4-5: NTN to NTN higher priority frequency layer in earth-moving cell**

**R4-2318908 CMCC**

Observation 1: For earth-moving cell, before discussing whether to tighten the cell re-selection requirement, the information of typical service time from real network deployment is needed.

## Open issues

**Issue 4-1: TN to NTN cell reselection**

**Agreement [RAN4#108b]:**

* FFS: whether/how to define TN to NTN cell reselection.

**Views from companies**

* Option 1: Do not define requirements on TN to NTN cell reselection.
  + CMCC, MTK, Ericsson, Huawei, ZTE, Apple (if no requirement on NTN to TN)
* Option 2: Define requirements on TN to NTN cell reselection.
  + CATT, Samsung
* Option 3: Wait for RAN2 conclusion
  + LGE, vivo

**Moderator’s WF**

Discuss during the meeting

**Issue 4-2: NTN to TN cell reselection**

**Agreement [RAN4#108b]:**

* UE is allowed to skip TN neighbour cells measurement in an area where there is no coverage of the frequency based on the provided TN cell coverage information and UE GNSS position information. FFS whether and how to implement it RAN4 CR.
* FFS on how to enhance NTN-to-TN cell reselection in case of mismatch between practical TN cell coverage and TN cell coverage information provided by serving cell.

**Views from companies**

* Whether and how to define NTN to TN cell reselection requirements
  + Option 1-A: RAN4 to not update the existing UE requirements other than adding the clarification that UE is not required to perform TN cell measurement in an area where there is no TN network coverage on a given frequency layer based on the provide TN cell coverage information and UE GNSS position information.
    - MTK
  + Option 1-B: Re-use the same requirements for inter-frequency cell reselection (Tmeasure, Tdetect, Tmeasure) used for NTN to NTN, with K\_multi\_SMTC =1.
    - Nokia
  + Option 1-C: Define inter-frequency NTN-to-TN cell re-selection requirements and inter-RAT NTN-to-TN cell re-selection requirements.
    - CMCC
  + Option 2: Do not define requirements on NTN to TN cell reselection.
    - Huawei, Apple (if no TN to NTN cell reselection requirement)
* Whether and how to account for UE GNSS error
  + Option 1: Add a margin of plus [50] meters on top of the TN coverage radius information.
    - Apple, LGE
* Whether and how to account for the mismatch between the TN coverage area configured by the Network and the real coverage area
  + Option 1: Do not provide enhancements for the TN cell reselection.
    - Nokia

**Moderator’s WF**

* Decide one of the options:
  + Option 1-A: RAN4 to not update the existing UE requirements other than adding the clarification that UE is not required to perform TN cell measurement in an area where there is no TN network coverage on a given frequency layer based on the provide TN cell coverage information and UE GNSS position information.
  + Option 1-B: Re-use the same requirements for inter-frequency cell reselection (Tmeasure, Tdetect, Tmeasure) used for NTN to NTN, with K\_multi\_SMTC =1.
  + Option 2: Do not define requirements on NTN to TN cell reselection.
* It Option 2 is not agreed,
  + add a margin of plus [50] meters on top of the TN coverage radius information to account for UE GNSS error
  + do not provide enhancements for the TN cell reselection to account for the mismatch between the TN coverage area configured by the Network and the real coverage area.

**Issue 4-3: NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell**

**Agreement [RAN4#108b]:**

Further discuss the requirements on time-based measurement initiation for cell reselection in earth-moving cell based on following Options:

* Option 1: For NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell, the existing RRC idle/inactive mode requirements referring to ‘t-service’ are reused.
* Option 2: Enhance the requirements on time-based measurement initiation for cell reselection in earth-moving cell
  + Introduce coverage information of serving cell for helping UE to assess the available time left for cell reselection measurement before UE leaves the coverage area of serving cell
* Option 3: For earth-moving cell, time-based measurement initiation may only apply to hard satellite switch in RAN2 design. (Nokia)

**Views from companies**

* Option 1: For time-based NTN to NTN cell reselection in earth-moving cell, the existing RRC idle/inactive mode requirements (4.2C and 5.1C) referring to ‘t-service’ can be reused.
  + CATT, Apple, Ericsson, CMCC, Samsung, Huawei, ZTE
  + Option 1-A: (LGE) the following conditions should be precluded:
    - UE shall start measurement of the neigbhor cells indicated by the serving cell before t-Service is reached according to the requirements
    - UE shall be able to detect, measure, and evaluate neighbour cells before the serving cell stops serving the area regardless of whether the distance condition based on serving cell reference location or the legacy Srxlev/Squal condition are met.
* Option 2: Enhance the requirements on time-based measurement initiation for cell reselection in earth-moving cell.
  + For the case that the actual stop time point for specific UE is earlier than the stop time due to feeder link switching, RAN4 to introduce coverage information of serving cell for helping UE to assess the available service time left for cell reselection measurement.
  + RAN4 to send a LS to ask RAN2 to introduce the coverage information (i.e., a reference point of cell centre plus radius) of serving cell for time-based cell reselection measurement initiation.
  + Support: vivo
  + Oppose: Huawei, ZTE

**Moderator’s WF**

* For time-based NTN to NTN cell reselection in earth-moving cell, the existing RRC idle/inactive mode requirements (4.2C and 5.1C) referring to ‘t-service’ can be reused. And discuss/decide the following details:
  + UE shall start measurement of the neigbhor cells indicated by the serving cell before t-Service is reached according to the requirements
  + UE shall be able to detect, measure, and evaluate neighbour cells before the serving cell stops serving the area regardless of whether the distance condition based on serving cell reference location or the legacy Srxlev/Squal condition are met.
* Further discuss the following:
  + Enhance the requirements on time-based measurement initiation for cell reselection in earth-moving cell.
    - For the case that the actual stop time point for specific UE is earlier than the stop time due to feeder link switching, RAN4 to introduce coverage information of serving cell for helping UE to assess the available service time left for cell reselection measurement.
    - RAN4 to send a LS to ask RAN2 to introduce the coverage information (i.e., a reference point of cell centre plus radius) of serving cell for time-based cell reselection measurement initiation.

**Issue 4-4: NTN to NTN location-based measurement initiation for cell reselection in earth-moving cell**

**Agreement [RAN4#108b]:**

* For NTN to NTN location-based measurement initiation for cell reselection in earth-moving cell, RAN4 to define the requirements based on the existing requirements on ‘4.2C Cell Re-selection for NR UE for Satellite Access,’ and introduce a new definition of reference location and an extra location margin.

**Views from companies**

* No need to introduce new cell reselection requirements for earth-moving cell since that referenceLocation for earth-moving cell only indicates initiating measurement but no impact current measurement delay requirements in ‘Clause 4.2C Cell Re-selection for NR UE for Satellite Access.’
  + Ericsson
* A margin for beam footprint location is introduced, e.g. 20 meters.
  + CMCC

**Moderator’s WF**

* Introduce a margin for beam footprint location, [20] meters.
* Note from Moderator: Please confirm if the above value is consistent with the margin assumed for satellite positioning error in defining Te\_NTN requirements.

# Topic #5: Connected mode mobility enhancements

## Companies’ contributions summary

**Issue 5-1: NTN to NTN RACH-less (C)HO**

**R4-2318820 Ericsson**

Proposal 5: regarding the TIU, keep agreement that ‘TIU can be a configured grant based PUSCH, dynamic grant based PUSCH, SR on PUCCH’, but remove ‘PRACH if no SSB mapping to pre-allocated grant has RSRP above the threshold while T304 is running’.

**R4-2319061 vivo**

Proposal 4: RAN4 to define requirements for combination of RACH-less HO with time-based CHO. Use the current requirements on time-based CHO as baseline and correspondingly add following description in the definition of TIU to adapt RACH-less based procedure:

* For combination of RACH-less handover with time-based conditional handover, TIU can be a configured grant based PUSCH, dynamic grant based PUSCH, SR on PUCCH, according to NW configuration and scheduling, or PRACH if no SSB mapping to pre-allocated grant has RSRP above the threshold while T304 is running.

**Issue 5-2: NTN to NTN Satellite switching without PCI change**

**R4-2318655 Apple**

Proposal 5: UE is not required to monitor source satellite during the interruption period for hard and soft satellite switch.

Proposal 6: For soft satellite switch without PCI change, starting and point and ending point shall be defined as following:

* Starting point of the interruption time for the soft switch is a time point between T-start and T-service, and the exact starting time is up to UE implementation.
* Ending point of the interruption time for the soft switch is same as hard switch case.

Proposal 7: Interruption time for hard switch is defined as Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin

* Tsearch = Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite
* Tprocessing = [5] ms
* T∆, Tmargin and TIU are same as existing requirements
* Soft switch has the same interruption time as hard switch case.

**R4-2318820 Ericsson**

Proposal 6: In soft switch, the start point of interruption time is the time when the UE starts searching the target satellite after T-start and it’s up to UE; the end point of interruption time is identical with that in hard switch, i.e., the first UL transmission.

Proposal 7: The interruption time definition of soft switch is same as that of hard switch, i.e., Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin.

Proposal 8: During hard switch, starting from T-service if no extra gap is provided, the UE shall skip or deprioritize measurements on serving cell and neighbor cells.

Proposal 9: During soft switch, the UE may start searching the target satellite after T-start, such that the UE shall skip or deprioritize measurements on serving cell and neighbor cells after T-start.

**R4-2318908 CMCC**

Proposal 5: For the case of hard satellite switch RACH-based, the starting point of the interruption time for the switch should still be t-Service, ending point of the interruption time for the switch is PRACH transmission. The interruption time is defined as Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin

* Tsearch = [Trs] ms
* Tprocessing = [5] ms
* T∆, Tmargin and TIU are same as existing requirements

Proposal 6: For the case of soft satellite switch RACH-based, the starting point of the interruption time for the switch should still be t-Service, ending point of the interruption time for the switch is PRACH transmission. The interruption time is defined as Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin

* Tsearch = [Trs] ms for unknown target cell, 0ms for known target cell
* Tprocessing = [5] ms
* T∆, Tmargin and TIU are same as existing requirements

**R4-2319061 vivo**

Proposal 5: For the requirement on Satellite switching without PCI change for soft switch case,

* Starting point of the interruption time for the switch is UE start synchronizing with target satellite
* Ending point of the interruption time for the switch is PRACH transmission for PRACH-based case and [first UL transmission excepting PRACH for without RACH performed solution]
* Both known and unknown cases need to be considered for soft switch case
  + Correspondingly, the known condition of cell needs to be updated as:

In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds before UE starts synchronizing with target satellite otherwise it is unknown. Relevant cell identification requirements are described in Clause 9.2.5 for intra-frequency handover ~~and Clause 9.3.4 for inter-frequency handover~~.

* Interruption time for the soft switch is defined as Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin 
  + Tsearch = 0 ms if the target cell is known, and Trs ms if the target cell is an unknown cell and the target cell Es/Iot ≥ -2 dB
  + Tprocessing = 5 ms
  + T∆, Tmargin are same as existing requirements

Proposal 6: As for the solution on without RACH performed, so far there is no further progress made by RAN2, RAN4 to suspend defining corresponding requirements until RAN2 procedure is stable

Proposal 7: RAN4 to wait for more RAN2 decision on whether and how to provide the SMTC configuration of target satellite for Unchanged PCI scenario.

**R4-2320007 Huawei, HiSilicon**

Proposal 4: For defining requirements for soft satellite switching without PCI change, the starting point, ending point and interruption time of hard switch are reused.

Proposal 5: During satellite switching without PCI change, UE is not required to perform measurement for other cells than the target cell after t-Service.

Proposal 6: RAN4 not to define separate starting points for UL and DL for hard switch.

**R4-2320739 Nokia, Nokia Shanghai Bell**

Observation 1: For hard-switch the UL switch time and the DL switch time at the UE are different.

* UL information sent by UE toward source satellite is unreachable from tue\_ul\_switch = t-service – feeder link propagation delay
* DL switch time occurs at tue\_dl\_switch = t-service + feeder link propagation delay

Proposal 5: In the case of hard satellite switch with same PCI, a scheduling restriction applies to UEs that do not support parallelMeasurementWithoutRestriction-r17 starting at the UL slot to be transmitted at tue\_ul\_switch = t-service – common delay.

Proposal 6: Include in the interruption time for hard satellite switch a component associated to the DL transmission gap.

Proposal 7: Separate UL and DL interruption requirements for the case of hard satellite switch with same PCI.

**Issue 5-3: NTN to NTN time and location-based trigger CHO enhancements**

**R4-2318908 CMCC**

Proposal 7: For NTN to NTN time and location-based trigger CHO enhancements, DCHO = TRRC + Tmeasure + TEvent\_DU +Tinterrupt + TCHO\_execution

* TRRC is the RRC procedure delay
* TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until the time/location condition fulfilled.
* Tmeasure is the measurements time. Tmeasure=0 if only condEventD1 or condEventT1 is configured.
* TCHO\_execution is the conditional execution preparation time
* Tinterrupt = Tprocessing + TIU + T∆ + Tmargin+ Tsearch is the interruption time.
  + If the target cell is known, then Tsearch = 0 ms.
  + If the target cell is an unknown intra-frequency cell and the target cell Es/Iot≥-2 dB, then Tsearch = Trs ms.
  + If the target cell is an unknown inter-frequency cell and the target cell Es/Iot≥-2 dB, then Tsearch = 3\* Trs ms.

**R4-2319061 vivo**

Proposal 8:

* For NTN to NTN time-based trigger CHO enhancements, the delay components shall be modified as:
* TEvent\_DU shall be updated as:

TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until condition T1-1 is fulfilledwhich will trigger the conditional handover

* The measurement delay Tmesure is not needed
* For NTN to NTN location-based trigger CHO enhancements, the delay components shall be modified as:
* TEvent\_DU shall be updated as:

TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until both condition D1-1 and condition D1-2 are fulfilledwhich will trigger the conditional handover

* The measurement delay Tmesure is not needed

**R4-2320007 Huawei, HiSilicon**

Proposal 7: For time and location based CHO without measurement criteria,

DCHO = TRRC + TEvent\_DU + TCHO\_execution + Tinterrupt

* TRRC is the RRC procedure delay defined in clause 12 in TS 38.331
* TEvent\_DU is the is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until the time or location condition is met
* TCHO\_execution is the UE conditional execution preparation time and is same as in existing CHO requirements
* Tinterrupt is interruption time and Tinterrupt = Tprocessing + Tsearch + TIU + T∆ + Tmargin, and each term is same as in existing HO requirements.

**R4-2320739 Nokia, Nokia Shanghai Bell**

Proposal 8: Update CHO requirements for location and time based CHO triggers (independent of radio measurements) to introduce a component for the UE to search the target cell in the case of blind CHO.

## Open issues

**Issue 5-1: NTN to NTN RACH-less (C)HO**

**Agreement [RAN4#108b]:**

* RACH-less handover delay requirement consists of ‘RRC procedure delay + Interruption time,’ i.e. = TRRC + TInterrupt, where TInterrupt = Tprocessing + Tsearch + T∆ + Tmargin + TIU.
  + Tsearch: the definition and values are the same as that in 6.1C.1.2.2 in NTN HO.
  + Tprocessing: the definition and values are the same as that in 6.1C.1.2.2 in NTN HO.
  + T∆: the definition and values are the same as that in 6.1C.1.2.2 in NTN HO.
  + Tmargin: the definition and values are the same as that in 6.1C.1.2.2 in NTN HO.
  + TIU is the interruption uncertainty in acquiring the first UL transmission resource, which can be a configured grant based PUSCH, dynamic grant based PUSCH, SR on PUCCH, according to NW configuration and scheduling, or PRACH if no SSB mapping to pre-allocated grant has RSRP above the threshold while T304 is running.
* The RACH-less handover delay requirement applies to
  + both known and unknown cases
  + both intra-satellite and inter-satellite handover cases
  + both intra-frequency and inter-frequency target cell cases
* The RACH-less handover delay requirement is applicable only when the UE is provided with all essential information of the target satellite as the existing NTN handover requirement, i.e.
  + (from 6.1C.1.2 of TS38.133) The requirements apply provided that UE has the valid and applicable parameters of ephemeris information, common TA, DL and UL Polarization information, K offset , and K mac for target NR SAN cell during D handover, otherwise interruption time may be longer than the requirements in clause 6.1C.1.2.2.

**Views from companies**

* (Ericsson) Update TIU as below:
  + TIU is the interruption uncertainty in acquiring the first UL transmission resource, which can be a configured grant based PUSCH, dynamic grant based PUSCH, SR on PUCCH, according to NW configuration and scheduling~~, or PRACH if no SSB mapping to pre-allocated grant has RSRP above the threshold while T304 is running~~.
* (vivo) Define a new requirement for combination of RACH-less HO with time-based CHO. The requirement is the same as time-based CHO with the adoption of TIU defined for RACH-less HO:

**Moderator’s WF**

* Decide and decide the following:
  + Update TIU as below:
    - TIU is the interruption uncertainty in acquiring the first UL transmission resource, which can be a configured grant based PUSCH, dynamic grant based PUSCH, SR on PUCCH, according to NW configuration and scheduling~~, or PRACH if no SSB mapping to pre-allocated grant has RSRP above the threshold while T304 is running~~.
  + Define a new requirement for combination of RACH-less HO with time-based CHO. The requirement is the same as time-based CHO with the adoption of TIU defined for RACH-less HO:

**Issue 5-2: NTN to NTN Satellite switching without PCI change**

**Agreement [RAN4#108b]:**

* For satellite switching without PCI change,
  + define requirements for both hard and soft switch scenarios.
    - TBD on how to define hard/soft satellite switch without PCI change (which will be determined mostly based on further clarification expected to be made by RAN2)
  + define requirements for PRACH-based and for without RACH performed solution.
  + The above does not necessarily mean that a common requirement formula cannot be defined. e.g. requirements for each case can be represented by a common formula with different definitions of respective components.
    - Starting point of the interruption time for the switch is t-Service, FFS other starting point needs to be considered for other cases depending on RAN2 progress
    - Ending point of the interruption time for the switch is PRACH transmission for PRACH-based case and [first UL transmission excepting PRACH for without RACH performed solution]
* Interruption time for the hard switch is defined as Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin 
  + Tsearch = [Trs] ms
  + Tprocessing = [5] ms
  + T∆, Tmargin and TIU are same as existing requirements
* FFS Interruption time for soft switch
* FFS on
  + whether/how to define requirements resulting from separate link switch time instances for UL and DL.
    - Note: the starting and ending may be revisited depending outcome of discussions
  + whether/how to define UE behavior (e.g. skipping/relaxation of L1/L3 measurement and evaluation) during the switch.

**Views from companies**

* For soft and hard satellite switch without PCI change, Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin (i.e. same formula as hard satellite switch) and the values of respective components are the same.
  + Apple, Ericsson, Huawei
* For soft satellite switch without PCI change,
  + Starting point of the interruption time:
    - between t-Start and t-Service, and the exact starting time is up to UE implementation.
      * Apple, Ericsson,vivo
    - t-Service
      * CMCC, Huawei
  + Ending point of the interruption time:
    - same as hard switch case.
      * Apple, Ericsson,vivo, Huawei
  + Tsearch
    - Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite. [Note: SMTC configuration details need to be updated as RAN2 makes further progress]
      * Apple
    - Consider known condition
      * CMCC, vivo
      * Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite for unknown target cell [and the target cell Es/Iot ≥ -2 dB], and 0 for known target cell. [Note: SMTC configuration details need to be updated as RAN2 makes further progress]
        + CMCC, vivo
      * In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds before UE starts synchronizing with target satellite otherwise it is unknown. Relevant cell identification requirements are described in Clause 9.2.5 for intra-frequency handover ~~and Clause 9.3.4 for inter-frequency handover~~.
        + Vivo
  + Tprocessing = 5 ms
    - Apple, CMCC,vivo
  + T∆, Tmargin and TIU are same as existing requirements.
    - Apple, CMCC
* For hard satellite switch without PCI change,
  + Starting point of the interruption time:
    - t-Service
      * CMCC
  + Tsearch = Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite. [Note: SMTC configuration details need to be updated as RAN2 makes further progress]
    - Apple, CMCC
  + Tprocessing = 5 ms
    - Apple, CMCC
  + A scheduling restriction applies to UEs that do not support parallelMeasurementWithoutRestriction-r17 starting at the UL slot to be transmitted at tue\_ul\_switch = t-service – common delay
    - Nokia
  + Include in the interruption time a component associated to the DL transmission gap
    - Nokia
* Whether/how to define requirements resulting from separate link switch time instances for UL and DL
  + Option 1: Do not define separate starting points for UL and DL for hard switch
    - Huawei
  + Option 2: Define separate starting points for UL and DL for hard switch
    - Nokia
* During satellite switching without PCI change, UE is not required to monitor other cells than the target cell:
  + Apple, Huawei, Ericsson
  + For soft satellite switch without PCI change, UE shall skip or deprioritize measurements on serving cell and neighbor cells after t-Start
    - Ericsson
  + For hard satellite switch without PCI change, UE is not required to monitor other cells than the target cell after t-Service
    - Apple, Huawei,Ericsson

**Moderator’s WF#1**

* For soft and hard satellite switch without PCI change, Tinterrupt = Tsearch + TIU + Tprocessing + T∆ + Tmargin (i.e. same formula as hard satellite switch). The following are the same for both cases:
  + Tprocessing = 5 ms
  + TIU, T∆ and Tmargin are same as existing requirements.
  + Ending point of the interruption time: PRACH transmission for PRACH-based case and [first UL transmission excepting PRACH for without RACH performed solution, if supported by RAN2]
* For soft satellite switch without PCI change,
  + Starting point of the interruption time:
    - Option 1: between t-Start and t-Service, and the exact starting time is up to UE implementation.
    - Option 2: t-Service
  + Tsearch
    - Decide whether to consider the following known condition.
      * In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds before UE starts synchronizing with target satellite otherwise it is unknown. Relevant cell identification requirements are described in Clause 9.2.5 for intra-frequency handover ~~and Clause 9.3.4 for inter-frequency handover~~.
    - If agree to not consider known vs. unknown condition,
      * Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite.
    - Otherwise,
      * Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite for unknown target cell [and the target cell Es/Iot ≥ -2 dB], and 0 for known target cell.
* For hard satellite switch without PCI change,
  + Starting point of the interruption time: t-Service
  + Tsearch = Tfirst\_SSB ms, where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by the SMTC of target satellite.
* Note: The SMTC configuration details need to be updated as RAN2 makes further progress.

**Moderator’s WF#2**

* During satellite switching without PCI change, UE is not required to monitor other cells than the target cell:
  + For soft satellite switch without PCI change, UE [may or shall] skip measurements on other cells than the target cell after t-Start
  + For hard satellite switch without PCI change, UE is not required to monitor other cells than the target cell after t-Service

**Moderator’s WF#3**

* For hard satellite switch without PCI change, further discuss the following:
  + A scheduling restriction applies to UEs that do not support parallelMeasurementWithoutRestriction-r17 starting at the UL slot to be transmitted at tue\_ul\_switch = t-service – common delay
  + Include in the interruption time a component associated to the DL transmission gap

**Moderator’s WF#4**

* Decide whether/how to define requirements resulting from separate link switch time instances for UL and DL
  + Option 1: Do not define separate starting points for UL and DL for hard switch
  + Option 2: Define separate starting points for UL and DL for hard switch

**Issue 5-3: NTN to NTN time and location-based trigger CHO enhancements**

**Agreement [RAN4#108b]:**

* Define time and location-based NTN to NTN CHO requirements without L3 measurement criteria by modifying the current NTN to NTN CHO requirements.

**Views from companies**

* The existing conditional CHO requirement defined in 6.1C.2.2 (DCHO = TRRC + TEvent\_DU + Tmeasure + Tinterrupt + TCHO\_execution, Tinterrupt = Tprocessing + TIU + T∆ + Tmargin) is reused with the following updates:
  + TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until the time or location condition is fulfilled.
    - Vivo, Huawei
  + Remove Tmeasure
    - Vivo, Huawei, CMCC
  + Add Tsearch to Tinterrupt, i.e. Tinterrupt = Tprocessing + TIU + T∆ + Tmargin+ Tsearch, and the definition of Tseach is the same as the existing one defined in 6.1C.2.2.
    - CMCC, Huawei, Nokia

**Moderator’s WF**

* The existing conditional CHO requirement defined in 6.1C.2.2 (DCHO = TRRC + TEvent\_DU + Tmeasure + Tinterrupt + TCHO\_execution, Tinterrupt = Tprocessing + TIU + T∆ + Tmargin) is reused with the following updates:
  + TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until the time or location condition is fulfilled.
  + Remove Tmeasure
  + Add Tsearch to Tinterrupt, i.e. Tinterrupt = Tprocessing + TIU + T∆ + Tmargin+ Tsearch, and the definition of Tseach is the same as the existing one defined in 6.1C.2.2.

# Topic #6: Performance requirements

**Issue 6-1: Configuration of test cases**

**R4-2320008 Huawei, HiSilicon**

Proposal 4: Rel-17 test setup is reused for Rel-18 RRM testing.

**R4-2320740 Nokia, Nokia Shanghai Bell**

Proposal 1: For Release 18, at least for the operation above 10 GHz, RRM test cases for NGSO shall be performed with variable Doppler shift and with delay drift, emulating a satellite movement.

* FFS on GSO scenarios
* FFS on the test cases for the other objectives.

**Issue 6-2: NTN bands above 10 GHz**

**R4-2318822 Ericsson**

Proposal 1: for FR2-NTN Type 1 UE, below test cases need to be considered:

* RRC Idle and Inactive mobility in intra-satellite scenario
* UL timing accuracy
* L1-RSRP
* RLM
* L3 measurements in intra-satellite scenario
* Intra-satellite Handover
* Blind inter-satellite Handover

Proposal 2: for FR2-NTN Type 2 UE, below test cases need to be considered:

* RRC Idle and Inactive mobility in intra-satellite scenario
* UL timing accuracy
* L1-RSRP
* RLM
* L3 measurements in intra-satellite scenario
* Intra-satellite Handover
* Blind inter-satellite Handover

**R4-2320008 Huawei, HiSilicon**

Proposal 1: For NTN in Ka band, the measurement accuracy requirements for TN FR2 are reused except for relative accuracy for intra-frequency measurement.

* For relative accuracy for intra-frequency measurement, FFS whether to define requirements for intra-sat only based on the assumption of same Rx beam.

Proposal 5: RAN4 to define RRM test cases for the following requirements.

* NTN in Ka band
  + UL timing
  + Intra-sat and inter-sat HO
  + RLM
  + Intra-sat L3 measurement period and accuracy

**R4-2320740 Nokia, Nokia Shanghai Bell**

Proposal 2: For Type 2 UEs only consider test cases for UE UL timing accuracy, RLM and Blind HO. UL timing accuracy test case is the same for both Type 1 and Type 2 UE.

* FFS whether the same test cases can be used for Type 2 and Type 1 UEs for RLM and Blind HO with adaptation of the test parameters (e.g. test duration, interruption time, etc).

Proposal 3: For Type 1 UE consider test cases for : UE UL timing accuracy, RLM, CHO, HO and Measurement Procedures

**Issue 6-3: NTN bands below 10 GHz**

**R4-2318822 Ericsson**

Proposal 3: For FR1-NTN UE, below test cases shall be considered:

* Network verified UE location
* NTN-TN cell reselection
* NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell, only for satellite switch
* NTN to NTN location-based measurement initiation for cell reselection in earth-moving cell, for cell switch
* NTN to NTN RACH-less (C)HO
* NTN to NTN Satellite switching without PCI change
  + Hard switch
  + RACH based
    - RACH-less
  + soft switch
    - RACH based
    - RACH-less
* NTN to NTN time-based trigger CHO enhancements
* NTN to NTN location- based trigger CHO enhancements

**R4-2320008 Huawei, HiSilicon**

Proposal 2: RAN4 to discuss whether Nsample = 4 is applicable for UE Rx-Tx measurement.

Proposal 3: Existing report mapping for UE and gNB Rx-Tx are re-used for NW verified location.

Proposal 5: RAN4 to define RRM test cases for the following requirements.

* NW verified location
  + UE Rx-Tx measurement period and accuracy
* Mobility enhancement
  + RACH-less HO
  + Satellite switch with unchanged PCI
  + Time and location based CHO without measurement criterion

**R4-2320740 Nokia, Nokia Shanghai Bell**

Proposal 4: For FR1 objectives RAN4 to introduce test cases at least for the following feathres:

* RACH-less HO
* Satellite Switching without PCI change
* NTN to TN Cell reselection
* Measurement Initiation triggers for Earth Moving Cells

Proposal 5: For mobility enhancements, include at least test cases for RACH-less HO and Hard Satellite Switch with same PCI.

## Open issues

**Issue 6-1: Configuration of test cases**

**Views from companies**

* Rel-17 test setup is reused for Rel-18 RRM testing.
  + Huawei
* At least for the operation above 10 GHz, RRM test cases for NGSO shall be performed with variable Doppler shift and with delay drift, emulating a satellite movement. FFS on RRM test cases for GSO.
  + Nokia

**Moderator’s suggestion**

* As to whether/how to enable a more advanced test setup than Rel-17 NTN, the discussion/decision may need a bigger group discussion across RF/RRM/Demod and RAN5/RAN plenary. Please consult with RAN4 leadership to determine whether/how to proceed.

**Issue 6-2: NTN bands above 10 GHz**

**Views from companies**

* Define the following test cases for NTN bands above 10 GHz:
  + RRC Idle and Inactive mobility in intra-satellite scenario
    - for both Type 1 and Type 2 VSAT devices: Ericsson
  + UL timing accuracy
    - for both Type 1 and Type 2 VSAT devices: Ericsson, Huawei, Nokia
  + L1-RSRP
    - for both Type 1 and Type 2 VSAT devices: Ericsson
  + RLM
    - for both Type 1 and Type 2 VSAT devices: Ericsson, Huawei, Nokia
  + L3 measurements in intra-satellite scenario
    - for both Type 1 and Type 2 VSAT devices: Ericsson, Huawei
  + Intra-satellite Handover (including conditional HO)
    - for both Type 1 and Type 2 VSAT devices: Ericsson, Huawei
  + Blind inter-satellite Handover (not including conditional HO)
    - for both Type 1 and Type 2 VSAT devices: Ericsson, Huawei, Nokia
* For measurement accuracy requirements for NTN bands above 10 GHz:
  + The TN FR2 measurement accuracy requirements are reused except for relative accuracy for intra-frequency measurement.
    - Huawei
  + For relative accuracy for intra-frequency measurement, FFS whether to define requirements for intra-sat only based on the assumption of same Rx beam.
    - Huawei
* FFS whether the same test cases can be used for Type 2 and Type 1 UEs for RLM and Blind HO with adaptation of the test parameters (e.g. test duration, interruption time, etc).
  + Nokia

**Moderator’s WF**

* Define the following test cases for NTN bands above 10 GHz:
  + For both Type 1 and Type 2 VSAT devices
    - UL timing accuracy
    - for both Type 1 and Type 2 VSAT devices: Ericsson
    - RLM
    - L3 measurements in intra-satellite scenario
    - Intra-satellite Handover (including conditional HO)
    - Blind inter-satellite Handover (not including conditional HO)
  + FFS on the following test cases:
    - RRC Idle and Inactive mobility in intra-satellite scenario
    - L1-RSRP
* FFS on the following:
  + For measurement accuracy requirements for NTN bands above 10 GHz:
    - The TN FR2 measurement accuracy requirements are reused except for relative accuracy for intra-frequency measurement.
    - For relative accuracy for intra-frequency measurement, FFS whether to define requirements for intra-sat only based on the assumption of same Rx beam.
  + Whether the same test cases can be used for Type 2 and Type 1 UEs for RLM and Blind HO with adaptation of the test parameters (e.g. test duration, interruption time, etc).

**Issue 6-3: NTN bands below 10 GHz**

**Views from companies**

* Define the following test cases for NTN bands below 10 GHz:
  + Network verified UE location only for UE Rx-Tx measurement period and accuracy (not for DL timing drift)
    - Ericsson, Huawei
    - FFS: whether Nsample = 4 is applicable for UE Rx-Tx measurement
      * Huawei
      * Note: In the NT requirements,
        + 4-sample: -13dB and -3dB, for both AWGN and TDL-A/C
        + 1-sample: -6dB and 0dB, for AWGN
    - Existing report mapping for UE and gNB Rx-Tx are re-used for NW verified location
      * Huawei
  + NTN-TN cell reselection
    - Ericsson
  + NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell, only for satellite switch
    - Ericsson
  + NTN to NTN location-based measurement initiation for cell reselection in earth-moving cell, for cell switch
    - Ericsson, Nokia
  + NTN to NTN RACH-less (C)HO
    - Ericsson, Huawei, Nokia
  + NTN to NTN Satellite switching without PCI change
    - Hard switch
      * RACH based
        + Ericsson, Huawei, [Nokia]
      * RACH-less
        + Ericsson, Huawei, Nokia
    - soft switch
      * RACH based
        + Ericsson, [Huawei], [Nokia]
      * RACH-less
        + Ericsson, [Huawei], [Nokia]
  + NTN to NTN time-based trigger CHO enhancements (without measurement criterion)
    - Ericsson, Huawei
  + NTN to NTN location- based trigger CHO enhancements (without measurement criterion)
    - Ericsson, Huawei

**Moderator’s WF**

* Define the following test cases for NTN bands below 10 GHz:
  + Network verified UE location only for UE Rx-Tx measurement period and accuracy (not for DL timing drift)
    - FFS: whether Nsample = 4 is applicable for UE Rx-Tx measurement
    - Existing report mapping for UE and gNB Rx-Tx are re-used for NW verified location
  + NTN to NTN RACH-less (C)HO
  + NTN to NTN time-based trigger CHO enhancements (without measurement criterion)
  + NTN to NTN location- based trigger CHO enhancements (without measurement criterion)
  + NTN to NTN Satellite switching without PCI change
    - Hard switch
      * RACH-based and RACH-less
    - FFS: soft switch
      * RACH-based and RACH-less
  + FFS
    - NTN-TN cell reselection
    - NTN to NTN time-based measurement initiation for cell reselection in earth-moving cell, only for satellite switch
    - NTN to NTN location-based measurement initiation for cell reselection in earth-moving cell, for cell switch

# Draft CRs

|  |  |  |  |
| --- | --- | --- | --- |
| **UE type** | **Classification** | **Core requirement** | **TDoc** |
| VSAT device for NTN bands above 10GHz | UE transmit timing requirements | UE transmit timing for Satellite Access | R4-2319214, Samsung |
| UE timer accuracy for satellite access |
| Timing advance for satellite access |
| RRC\_IDLE state mobility  RRC\_INACTIVE state mobility | Cell Re-selection for NR UE for Satellite Access | R4-2318341, CATT |
| RRC\_CONNECTED state mobility | Handover | Huawei, R4-2320005  (Ericsson R4-2318819) |
| RRC Re-establishment |
| Signalling characteristics | Radio Link Monitoring | R4-2320965, Qualcomm |
| Measurement Procedure | NR intra-frequency measurements | R4-2318846, Xiaomi |
| NR inter-frequency measurements |
| L1-RSRP measurements for Reporting |
| Device for NTN bands below 10GHz | Measurement Procedure | NR measurements for network verified UE positioning | R4-2320738, Nokia |
| RRC\_IDLE state mobility  RRC\_INACTIVE state mobility | Cell Re-selection for NR UE for Satellite Access | R4-2320574, ZTE  R4-2320575, ZTE |
| RRC\_CONNECTED state mobility | Handover | R4-2319064, vivo |