3GPP TSG-RAN4 Meeting #110 R4-2407460

Athens, GR, 26 Feb – 01 Mar, 2024

**Agenda item:** 7.16.9

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Topic summary for [111][219] NR\_NTN\_enh

**Document for:** Information

# Introduction

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

*7.16.6 RRM core requirements [NR\_NTN\_enh-Core]*

*7.16.6.1 NR-NTN RRM requirements in above 10 GHz bands [NR\_NTN\_enh-Core]*

*7.16.6.2 Network verified UE location [NR\_NTN\_enh-Core]*

*7.16.6.3 NTN-TN and NTN-NTN mobility and service continuity enhancements [NR\_NTN\_enh-Core]*

*7.16.7 RRM performance requirements [NR\_NTN\_enh-Perf]*

*7.16.7.1 NR-NTN RRM performance requirements in above 10 GHz bands [NR\_NTN\_enh-Perf]*

*7.16.7.2 Network verified UE location [NR\_NTN\_enh-Perf]*

*7.16.7.3 NTN-TN and NTN-NTN mobility and service continuity enhancements [NR\_NTN\_enh-Perf]*

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

## Companies’ contributions summary

**Issue 1-6A: Te\_NTN for 60kHz and 120kHz in Case2**

**R4-2408419 Samsung**

Proposal 1: Support to keep the current side condition for case 2.

**R4-2408510 Nokia**

Proposal 1: Do not use side conditions on refresh rate of satellite assistance information for the transmit timing accuracy requirements in case 3.

**R4-2408868 vivo**

Proposal 1: For the side condition on Te\_NTN for 60kHz and 120kHz in Case2, RAN4 to keep the previous agreement that ephemeris information shall be refreshed (i.e. update rate of ephemeris information in SIB19) at least every 7 seconds without further limitation on ntn-UlSyncValidityDuration

**R4-2409056 Ericsson**

Proposal 1: Remove side condition that ephemeris information be refreshed (i.e. update rate of ephemeris information in SIB19) at least every X seconds, where X= [7] s.

**R4-2409284 Huawei, HiSilicon**

Proposal 1 (Issue 1-6A): Do not define side condition on ephemeris update rate for Te requirements for Case 2.

**Issue 1-11: Additional enhancements (for Case-3)**

**R4-2409284 Huawei, HiSilicon**

Proposal 2 (Issue 1-11): RAN4 to confirm, following current requirements, that UL timing is gradually changed (subject to Tp and Tq) upon GNSS location update. If so, do not introduce additional enhancement.

## Open issues

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

**Summary of agreements:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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.

**Agreement [RAN4#109-110bis]:**

|  |  |  |
| --- | --- | --- |
| Cases | SCS of SSB | Te\_NTN [Ts] |
| 60kHz of UL SCS | 120kHz of UL SCS |
| Case-1: Stationary UE for GSO | 120kHz | 13 | 7.5 |
| 240kHz |
| Case-2: Stationary UE for LEO | 120kHz | 7.5; the requirements are applicable only if the ephemeris information be refreshed (i.e. update rate of ephemeris information in SIB19) at least every [7] seconds |
| 240kHz |
| Case-3: Mobile UE for GSO | 120kHz | [10] |
| 240kHz |

 |

**Issue 1-6A: Te\_NTN for 60kHz and 120kHz in Case2**

**Views from companies**

* (Note) Side condition for the requirement applicability (Cast-2, 120kHz of UL SCS) agreed in RAN4#109-100
	+ The requirements are applicable only if the ephemeris information be refreshed (i.e. update rate of ephemeris information in SIB19) at least every [7] seconds
* Option 1: Keep the agreed side condition
	+ Samsung, vivo
* Option 2: Remove the agreed side condition
	+ Nokia (Pleas confirm if Proposal 1 in R4-2408510 is for Case2), Ericsson, Huawei

**Moderator’s WF: Based on the technical observation presented in R4-2408510, it appears that Option 2 can be agreed.**

* In Case-2, remove the below side condition for requirement applicability.
	+ The requirements are applicable only if the ephemeris information be refreshed (i.e. update rate of ephemeris information in SIB19) at least every [7] seconds.

**Issue 1-11: Additional enhancements (for Case-3)**

**Summary of agreements:**

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| --- |
| **Agreement [RAN4#109]:****FFS:*** 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. (Nokia)
 |

**Views from companies**

* RAN4 to confirm, following current requirements, that UL timing is gradually changed (subject to Tp and Tq) upon GNSS location update. If so, do not introduce additional enhancement.
	+ Huawei

**Moderator’s Recommendation:**

* Based on the existing gradual timing adjustment UE requirement, i.e. UL timing is supposed to be gradually adjusted (subject to Tp and Tq) upon GNSS location update, the issue is closed. No further discussion.

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

## Companies’ contributions summary

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

**R4-2407305 Apple**

Proposal 1: Intra-satellite RRC re-establishment requirements are not applicable for the case that RRC re-establishment is caused by an inter-satellite HO failure, and no inter-satellite RRC re-establishment requirements will be defined for this case.

**R4-2408419 Samsung**

Proposal 2: When Type 2 UEs perform inter-satellite HO and encounter inter-satellite HO failure, intra-satellite RRC re-establishment requirements are not applicable. UEs try to search a suitable NR cell of target satellite, if T311 expiry, UEs will go to RRC\_IDLE and perform cell selection procedure.

**R4-2409284 Huawei, HiSilicon**

Proposal 3a (Issue 2-4): RAN4 not to define inter-satellite RRC re-establishment requirement.

Proposal 3b (Issue 2-4): For Type 2 UE, intra-satellite RRC re-establishment requirements do not apply when the cause for the RRC re-establishment is an inter-satellite HO failure.

## Open issues

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

**Summary of agreements:**

|  |
| --- |
| **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.

**Agreement [RAN4#109]:*** For **type 1** UE (electronical steering antenna)
	+ **Inter-satellite** RRC re-establishment:
		- **No** RRC re-establishment requirements
	+ **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). And the requirement applies when the UE is **not configured with inter-satellite measurement**.
	+ FFS whether exception case need to be considered
* For **type 2** UE (mechanical steering antenna)
	+ **Inter-satellite** RRC re-establishment
		- **No** RRC re-establishment requirements
	+ **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). And the requirement applies when the UE is **not configured with inter-satellite measurement**.
		- FFS whether exception case need to be considered

**No agreement [RAN4#110]: (no further discussion)*** Decide whether to define RRC re-establishment requirements for the case where UE fails to complete blind HO to the target satellite/cell.
 |

**Views from companies**

* For Type 2 UE, intra-satellite RRC re-establishment requirements do not apply when the cause for the RRC re-establishment is an inter-satellite HO failure.
	+ Apple, Samsung, Huawei
* Do not to define inter-satellite RRC re-establishment requirement:
	+ Apple. Huawei

**Moderator’s WF**: “No inter-satellite RRC re-establishment requirement” was already agreed in RAN4#109.

* For Type 2 UE, intra-satellite RRC re-establishment requirements do not apply when the cause for the RRC re-establishment is an inter-satellite HO failure.

# Topic #3: Network verified UE location

## Companies’ contributions summary

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

**R4-2409286 Huawei, HiSilicon**

Proposal 1 (Issue 3-2): Remove following applicability rule for UE Rx-Tx measurement requirements.

* When a serving cell change occurs during the measurement period, the UE shall continue and complete the UE Rx-Tx time difference measurement provided that the serving cell change does not impact SRS configuration for the UE Rx-Tx time difference measurement.

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

**R4-2408605 Ericsson**

Proposal 1: Not include DL timing drift reporting as condition in core requirements.

**R4-2408511 Nokia**

Proposal 3: Wait until RAN2 implements the DL Timing Drift Report in order to decide whether the report is sufficient to guarantee that UE RX-TX measurement requirements are applicable even UE applies significant changes on its timing advance within the measurement period.

**R4-2409286 Huawei, HiSilicon**

Proposal 2 (Issue 3-4): 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.

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

**R4-2408511 Nokia**

Proposal 1: For satellite switching with same PCI, select option 1a:

* UE stops the PRS measurement after t\_service and restart the UE Rx-Tx time difference measurement after switch is complete.
	+ The PRS configuration of the two satellites with the same PCI follows RAN1/2 specficiaton, and no further restriction for gNB/LMF to be defined in RAN4.
	+ The UE measurement accuracy requiremet does not apply if the PRS transmission from two satelliates overlap in time/frequency domain. Further clarify the definition of “overlapping” offline.

Proposal 2: No further agreements are needed for serving cell changes with different PCI. But a clarification note can be added to the specification for the case of different satellites.

**R4-2408605 Ericsson**

Proposal 2: We can compromise that UE shall stop the PRS measurement for the source cell and re-start PRS measurement for the target cell.

**R4-2408869 vivo**

Proposal 1: When UE switches to a new satellite switch with same PCI (soft satellite switch), UE stops the PRS measurement after *t-servicestart* and restart the UE Rx-Tx time difference measurement after switch is complete.

Proposal 2: When UE switches to a new satellite switch with same PCI (hard satellite switch), UE stops the PRS measurement after *t-service* and restart the UE Rx-Tx time difference measurement after switch is complete.

Proposal 3: When UE switches to a new satellite switch with different PCI, UE shall restart the UE Rx-Tx time difference measurement after the SRS (re)configuration is complete.

**R4-2409286 Huawei, HiSilicon**

Proposal 3 (for Issue 3-5): For UE Rx-Tx measurement for NW verified location,

* when UE switches to a new cell with different PCI (through HO or CHO), UE stops the PRS measurement for the source cell and start PRS measurement for the target cell after SRS reconfiguration on the target cell is complete
* when UE switches to a new cell with same PCI (through HO, CHO or satellite switch with re-sync), UE stops the PRS measurement after t-start and restart the UE Rx-Tx time difference measurement after switch is complete.

## Open issues

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

**Summary of agreements:**

|  |
| --- |
| **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.

**Agreement [RAN4#109]:*** For **UE Rx-Tx measurement period requirement**, as baseline, the scope does **not** include measurements **across different frequency layers**.
* For the core part CR, **Nsample = [1]**.

**Agreement [RAN4#110]:*** Nsample = 1 for UE Rx-Tx measurement period requirements
* Define additionally the single satellite based RTT requirement without MG based on the existing RTT requirements, given that the RTT requirement with MG was already agreed as baseline.

**No agreement [RAN4#110]: (not essential for Core Completion)*** In the existing formula for measurement period requirements in TS 38.133, not relevant factors for single satellite-based RTT measurements, e.g. multiple frequency layers, multiple RX TEG, etc., are to be removed for the scope of this Release
	+ [Strive to simplify the measurement period requirement as similar as PDC]
* Add detailed requirement applicability rules such that the UE RTT positioning capability for TN is not too much overloaded.

**Agreement [RAN4#110]:*** For network verified UE location,
* For accuracy requirement, re-use the TN accuracy requirements, including both baseband estimation accuracy and RF calibration margin, and side conditions with Nsample = 1
* Existing report mapping for UE and gNB Rx-Tx are re-used for NW verified location

**Agreement [RAN4#110b]:*** Remove factors related to multiple positioning frequency layers, multiple RX TEGs and Rx beam sweeping from the Rx-Tx requirements.
* Remove the below applicability rules from UE RX-TX time difference measurements:
	+ FFS: When a serving cell change occurs during the measurement period, the UE shall continue and complete the UE Rx-Tx time difference measurement provided that the serving cell change does not impact SRS configuration for the UE Rx-Tx time difference measurement.
	+ If UE uplink transmission timing changes due to the UE autonomous timing adjustment defined in clause 7.1C.2 during the UE Rx-Tx measurement period, then:
		- UE Rx-Tx measurement period requirements in this clause shall not apply for a cell, which is not the downlink reference cell (defined in section 7.1C.1) for SRS transmission. The UE Rx-Tx time difference measurement period may be restarted in such case.
* Supporting Nsample = 1 is a component of NW verified location (FG 44-2), and it does not require UE to support reduced sample number for TN positioning measurement (FG 27-3-1).
 |

**Views from companies**

* Huawei: Remove following applicability rule for UE Rx-Tx measurement requirements:
	+ When a serving cell change occurs during the measurement period, the UE shall continue and complete the UE Rx-Tx time difference measurement provided that the serving cell change does not impact SRS configuration for the UE Rx-Tx time difference measurement.

**Moderator’s WF: The below is technically well justified in R4-2409286.**

* Remove following applicability rule for UE Rx-Tx measurement requirements:
	+ When a serving cell change occurs during the measurement period, the UE shall continue and complete the UE Rx-Tx time difference measurement provided that the serving cell change does not impact SRS configuration for the UE Rx-Tx time difference measurement.

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

**Summary of agreements:**

|  |
| --- |
| **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)

**Agreement [RAN4#109]:****FFS:*** No new applicability condition for UE Rx-Tx measurement requirements related to amount of variation in the applied TA during measurement period.
* If the UE autonomous adjustments in the service link component, $N\_{TA,adj}^{UE}$, are inferior to Tq\_NTN the UE is not required to send the reporting of the service link delay variation.
* When the total autonomous variation applied by the UE in the timing advance during a measurement period (variation of $N\_{TA,adj}^{common}$ + $N\_{TA,adj}^{UE}$) exceeds [5]\*Tp the accuracy requirements might be further relaxed.

**Agreement [RAN4#110]:*** Further discussion in maintenance phase is not precluded based on contribution driven.
	+ No new applicability condition for UE Rx-Tx measurement requirements related to amount of variation in the applied TA during measurement period.

**FFS (ad-hoc) [RAN4#110b]:*** No new applicability condition for UE Rx-Tx measurement requirements related to amount of variation in the applied TA during measurement period.
	+ Including DL timing drift reporting as condition
 |

**Views from companies**

* 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
	+ Ericsson, Huawei
* Wait until RAN2 implements the DL Timing Drift Report in order to decide whether the report is sufficient to guarantee that UE RX-TX measurement requirements are applicable even UE applies significant changes on its timing advance within the measurement period
	+ Nokia

**Moderator’s Recommendation:**

* No new applicability condition for UE Rx-Tx measurement requirements related to amount of variation in the applied TA during measurement period.

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

**Summary of agreements:**

|  |
| --- |
| **Agreement [RAN4#109]:****FFS:*** 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.
* Discuss how to handle UE measurements across both satellites when there is a soft satellite switch.

**Agreement [RAN4#110]:*** When UE switches to a new satellite switch with same PCI, and no UE requirement applies. RAN4 can further discuss whether to stop or re-start the measurement in maintenance phase based on contribution driven.

**Agreement (online) [RAN4#110b]:*** When UE switches to a new satellite switch with same PCI (through HO, CHO or satellite switch with re-sync for both hard and soft satellite switch), select one option from:
	+ Option 1a: UE stops the PRS measurement after t\_service and restart the UE Rx-Tx time difference measurement after switch is complete.
		- The PRS configuration of the two satellites with the same PCI follows RAN1/2 specficiaton, and no further restriction for gNB/LMF to be defined in RAN4.
		- The UE measurement accuracy requiremet does not apply if the PRS transmission from two satelliates overlap in time/frequency domain. Further clarify the definition of “overlapping” offline.
	+ Option 1b: UE stops the PRS measurement after t\_servicestart and restart the UE Rx-Tx time difference measurement after switch is complete.
		- The PRS configuration of the two satellites with the same PCI follows RAN1/2 specficiaton, and no further restriction for gNB/LMF to be defined in RAN4.
	+ Option 2: UE stops the PRS measurement after t\_service and until LMF triggers new measurement.

**FFS (online) [RAN4#110b]:*** When UE switches to a new satellite switch with different PCI (through HO or CHO),
	+ UE stops the PRS measurement for the source cell and re-start PRS measurement for the target cell after SRS (re)configuration on the target cell is complete.
 |

**Views from companies**

* When UE switches to a new cell with **different PCI**, UE stops the PRS measurement for the source cell and start PRS measurement for the target cell after SRS reconfiguration on the target cell is complete.
	+ Nokia, vivo, Huawei
* When UE switches to a new cell with **same PCI** through **hard** satellite switch with re-sync, UE stops the PRS measurement after X and restarts the UE Rx-Tx time difference measurement after switch is complete.
	+ X = t-Service
		- Vivo, Nokia
	+ X = t-ServiceStart
		- Huawei
* When UE switches to a new cell with **same PCI** through **soft** satellite switch with re-sync, UE stops the PRS measurement after Y and restarts the UE Rx-Tx time difference measurement after switch is complete.
	+ Y = t-Service
		- Nokia
		- Nokia: The UE measurement accuracy requiremet does not apply if the PRS transmission from two satelliates overlap in time/frequency domain. Further clarify the definition of “overlapping” offline.
	+ Y = t-ServiceStart
		- Vivo, Huawei

**Moderator’s WF**: **To prevent a situation where the UE might receive two sets of PRSs from source and target satellites, it is advisable to halt PRS measurements at whichever point occurs earlier between t-Service and t-ServiceStart during satellite switch with re-sync.**

* When UE switches to a new cell with different PCI, UE stops the PRS measurement for the source cell and start PRS measurement for the target cell after SRS reconfiguration on the target cell is complete.
* When UE switches to a new cell with same PCI through hard and soft satellite switch with re-sync, UE halts the PRS measurement at whichever point occurs earlier between t-Service and t-ServiceStart and restarts the UE Rx-Tx time difference measurement after switch is complete.

# Topic #4: Idle/Inactive mode mobility enhancements

## Companies’ contributions summary

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

**R4-2407306 Apple**

Proposal 1: If both TN and NTN carriers are broadcasted to NTN capable UE for neighbour cells measurement in IDLE/Inactive mode, we propose following alternatives:

* Alt1: Cell reselection delay requirement is defined such that the UE may measure both TN and NTN cells/carriers.
* Alt2: If UE GNSS has been switched ON, cell reselection delay requirement is defined such that the UE may measure both TN and NTN cells/carriers; otherwise, cell reselection delay requirement is defined such that TN inter-frequency cell measurement is not extended.

Proposal 2: if UE is configured by network to have at least one high priority carrier which contains NTN cells, UE shall keep GNSS ON during such high priority frequency layer measurement even the UE is in TN coverage.

**R4-2407840 Xiaomi**

Proposal 1: Location-based measurement triggering parts are not applicable for cell reselection from TN to NTN

**R4-2407932 CMCC**

Proposal 1: The location-based measurement triggering is not applicable for cell re-selection from TN to NTN.

Proposal 2: Define an applicability rule for the new subclause for TN to NTN cell reselection requirements, that the requirements are only applicable when the UE is NTN capable and NTN neighbor cell(s) has been configured for measurements.

**R4-2408606 Ericsson**

Proposal 1: The agreement ‘the above requirement does not assume UE always performs NTN cell detection/measurement as well as TN cells.’ is vague. RAN4 shall clarify it. To our understanding, the legacy requirements on measurements of TN only inter-frequency cells anyway shall not be impacted, i.e., not delay the existing legacy TN requirements even for a TN+NTN capable UE.

Proposal 2: Split the condition of searching for and measuring TN only inter-frequency layers and the condition of searching for and measuring TN+NTN inter-frequency layers. One example of solutions is adding an offset to SnonIntraSearchP and SnonIntraSearchQ, e.g., in Clause 4.2.2.4.

* If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ then the UE shall search for and measure inter-frequency layers belonging to TN of higher, equal or lower priority in preparation for possible reselection.
* If Srxlev ≤ (SnonIntraSearchP – [ONTN] or Squal ≤ SnonIntraSearchQ – [ONTN] then the UE shall search for and measure inter-frequency layers belonging to TN and NTN of higher, equal or lower priority in preparation for possible reselection, provided UE has valid satellite information.

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

**R4-2407840 Xiaomi**

Proposal 2: Clarify that the requirements for NR NTN to LTE TN inter-RAT cell re-selection is defined as NEUTRA\_carrier \* Tdetect/measure/evaluate,EUTRAN, where

* The parameter NEUTRA\_carrier is the number of configured E-UTRA carriers indicated in the neighbour frequency list by serving cell, except for the frequency carrier where there is no coverage of that frequency based on the provide TN cell coverage information and UE GNSS position information.
* Tdetect/measure/evaluate,EUTRAN is the inter-RAT E-UTRAN TN cell re-selection requirement defined in Table 4.2.2.5-1 in TS 38.133

Proposal 3: It is proposed to define maximum paging interruption requirement for NR NTN to LTE TN inter-RAT cell re-selection.

**R4-2409288 Huawei, HiSilicon**

Proposal 1: (for Issue 4-2) RAN4 to clarify the requirements related to TN measurement skipping as:

“UE shall perform TN measurement if its estimated distance to tn-ReferenceLocation is smaller than tn-DistanceRadius. The requirements apply provided that the actual distance between UE to tn-ReferenceLocation is smaller than tn-DistanceRadius – 50m.”

## Open issues

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

**Summary of agreements:**

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| --- |
| **Agreement [RAN4#108b]:*** FFS: whether/how to define TN to NTN cell reselection.

**Agreement [RAN4#109]:*** Define requirements on TN to NTN cell reselection.
	+ Define core requirements for GNSS ON and GNSS switch OFF to ON, no test case.
	+ No specific value for the GNSS time to first fix to be define for the case of GNSS switch OFF to ON.

**Agreement [RAN4#110]:*** Requirement applicability
	+ Only inter-frequency cell reselection from TN to NTN only in FR1-NTN
	+ Timer-based measurement triggering parts not applicable for cell reselection from TN to NTN
	+ The requirements apply provided that UE has valid SIB19
	+ UE is not required to ensure having a valid version of SIB19 and the exact time of reacquiring SIB19 is up to UE implementation.

**Agreement [RAN4#110]:*** Measurement requirements on inter-frequency cell reselection from NR TN to NTN
	+ - * Kcarrier\_TN \* Tdetect/measure/evaluate,NR\_Inter\_TN + $\sum\_{i=1}^{K\_{carrier\\_NTN}}K\_{multi\\_SMTC,i}\*T\_{detect/measure/evaluate,NR\\_Inter\\_NTN}$ + T\_GNSS if the UE does not support the feature for enhanced RRM requirements defined in TS38.306 [14] or if the enhancedMeasurementLEO-r17 is not enabled, or within Kcarrier\_TN \* Tdetect/measure/evaluate,NR\_Inter\_TN + $\sum\_{i=1}^{K\_{carrier\\_NTN}}K\_{multi\\_SMTC,i}\*T\_{detect/measure/evaluate,NR\\_Inter\\_enh} + T\\_GNSS$ if the UE supports the feature for enhanced RRM requirements defined in TS38.306 [14] and the enhancedMeasurementLEO-r17 is enabled.
				+ The parameter Kcarrier\_TN is the number of NR TN inter-frequency carriers indicated by the serving cell.
				+ The parameter Kcarrier\_NTN is the number of NR NTN inter-frequency carriers indicated by the serving cell.
				+ Tdetect/measure/evaluate,NR\_Inter\_TN is the NR TN inter-frequency cell re-selection requirement defined in Table 4.2.2.4-1 in TS38.133
				+ Tdetect/measure/evaluate,NR\_Inter\_NTN is the NR NTN inter-frequency cell re-selection requirement defined in Table 4.2C.2.4-1 in TS38.133
	+ T\_GNSS is TTFF (Time To First Fix) of which value is left undefined in RRM spec. If UE GNSS has been switched ON, T\_GNSS can be assumed zero.
		- The note below is to be implemented in RRM requirement spec:
			* the above requirement does not assume UE always performs NTN cell detection/measurement as well as TN cells.
* Implement the requirements for TN-to-NTN cell reselection in IDLE mode in a new subclause under clause 4.2.
* FFS how to implement in CR the impact to the TN-to-TN requirement under this scenario in the maintenance phase.

**Agreement [RAN4#110]: Updated agreement on top of adhoc agreement:*** The requirements apply provided that network provides SIB19. UE is not required to ensure having a valid version of SIB19 and the exact time of reacquiring SIB19 is up to UE implementation.
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**Views from companies**

* Apple: If both TN and NTN carriers are broadcasted to NTN capable UE for neighbour cells measurement in IDLE/Inactive mode, we propose following alternatives:
	+ Alt1: Cell reselection delay requirement is defined such that the UE may measure both TN and NTN cells/carriers.
	+ Alt2: If UE GNSS has been switched ON, cell reselection delay requirement is defined such that the UE may measure both TN and NTN cells/carriers; otherwise, cell reselection delay requirement is defined such that TN inter-frequency cell measurement is not extended.
* Ericsson: Split the condition of searching for and measuring TN only inter-frequency layers and the condition of searching for and measuring TN+NTN inter-frequency layers. One example of solutions is adding an offset to SnonIntraSearchP and SnonIntraSearchQ, e.g., in Clause 4.2.2.4.
	+ If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ then the UE shall search for and measure inter-frequency layers belonging to TN of higher, equal or lower priority in preparation for possible reselection.
	+ If Srxlev ≤ (SnonIntraSearchP – [ONTN] or Squal ≤ SnonIntraSearchQ – [ONTN] then the UE shall search for and measure inter-frequency layers belonging to TN and NTN of higher, equal or lower priority in preparation for possible reselection, provided UE has valid satellite information.
* Define an applicability rule for the new subclause for TN to NTN cell reselection requirements that the requirements are only applicable when the UE is NTN capable and NTN neighbor cell(s) has been configured for measurements.
	+ CMCC
* Location-based measurement triggering parts are not applicable for cell reselection from TN to NTN
	+ Xiaomi, CMCC
* The agreement ‘the above requirement does not assume UE always performs NTN cell detection/measurement as well as TN cells.’ is vague. RAN4 shall clarify it. To our understanding, the legacy requirements on measurements of TN only inter-frequency cells anyway shall not be impacted, i.e., not delay the existing legacy TN requirements even for a TN+NTN capable UE
	+ Ericsson
* If UE is configured by network to have at least one high priority carrier which contains NTN cells, UE shall keep GNSS ON during such high priority frequency layer measurement even the UE is in TN coverage
	+ Apple

**Moderator’s WF: The central debate revolves around avoiding an unreasonably extended TN-to-TN cell reselection delay. Properly splitting the UE requirements for TN-only capable UE and NTN-only capable UE can mitigate this issue, although there are still cases where the exact UE requirements remain unclear. New proposals that may potentially impact UE implementation or other working groups are not considered in the moderator’s WF.**

* It is a common understanding that location-based measurement triggering parts are not applicable for cell reselection from TN to NTN. Whether/How to implement this in RAN4 spec is left to CR.
* If both TN and NTN carriers are broadcasted for neighbour cells measurement in IDLE/Inactive mode,
	+ For NTN capable UE, the cell reselection requirements are applied assuming UE may measure both TN and NTN cells/carriers.
	+ For NTN incapable UE, the existing TN-to-TN cell reselection requirements are applied.

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

**Summary of agreements:**

|  |
| --- |
| **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.

**Agreement [RAN4#109]:*** Define requirements on NTN to TN cell reselection.

**Agreement [RAN4#110]:*** Requirement applicability
	+ Only inter-frequency cell reselection from NTN in FR1-NTN to TN
	+ FFS inter-RAT cell resection
* Measurement requirements on cell reselection from NTN to NR TN (inter-frequency)
	+ Remove HST components.
	+ Remove HST components if inter-RAT considered in Rel-18

**Agreement [RAN4#110]:*** Measurement requirements on cell reselection from NTN to NR TN (inter-frequency intra-RAT)
	+ - Kcarrier\_TN \* Tdetect/measure/evaluate,NR\_Inter\_TN + $\sum\_{i=1}^{K\_{carrier\\_NTN}}K\_{multi\\_SMTC,i}\*T\_{detect/measure/evaluate,NR\\_Inter\\_NTN}$ if the UE does not support the feature for enhanced RRM requirements defined in TS38.306 [14] or if the enhancedMeasurementLEO-r17 is not enabled, or within Kcarrier\_TN \* Tdetect/measure/evaluate,NR\_Inter\_TN ~~+ K~~~~carrier\_HST~~ ~~\* T~~~~detect/measure/evaluate,NR\_Inter\_HST~~ + $\sum\_{i=1}^{K\_{carrier\\_NTN}}K\_{multi\\_SMTC,i}\*T\_{detect/measure/evaluate,NR\\_Inter\\_enh}$ if the UE supports the feature for enhanced RRM requirements defined in TS38.306 [14] and the enhancedMeasurementLEO-r17 is enabled.
			* The parameter Kcarrier\_TN is the number of NR TN inter-frequency carriers indicated by the serving cell, except for the frequency carrier where there is no coverage of that frequency based on the provide TN cell coverage information and UE GNSS position information.
			* The parameter Kcarrier\_HST is the number of NR TN inter-frequency carriers which are configured with highSpeedMeasInterFreq-r17 indicated by the serving cell, except for the frequency carrier where there is no coverage of that frequency based on the provide TN cell coverage information and UE GNSS position information.
			* The parameter Kcarrier\_NTN is the number of NR NTN inter-frequency carriers indicated by the serving cell.
			* Tdetect/measure/evaluate,NR\_Inter\_TN is the NR TN inter-frequency cell re-selection requirement defined in Table 4.2.2.4-1 in TS38.133
			* Tdetect/measure/evaluate,NR\_Inter\_NTN is the NR NTN inter-frequency cell re-selection requirement defined in Table 4.2C.2.4-1 in TS38.133
		- When the distance between the UE and tn-ReferenceLocation is larger than tn-DistanceRadius +50m, the UE is allowed to not perform measurements on the TN frequency in the corresponding area.
* Measurement requirements on cell reselection from NTN to LTE TN (inter-RAT)
	+ - NEUTRA\_carrier \* Tdetect/measure/evaluate,EUTRAN
			* The parameter NEUTRA\_carrier\_HST is the total number of configured E-UTRA carriers indicated to meet high speed requirements in the neighbour frequency list, except for the frequency carrier where there is no coverage of that frequency based on the provide TN cell coverage information and UE GNSS position information.
			* The parameter NEUTRA\_carrier is the number of EUTRA TN carriers indicated by the serving cell, except for the frequency carrier where there is no coverage of that frequency based on the provide TN cell coverage information and UE GNSS position information.
		- When the distance between the UE and tn-ReferenceLocation is larger than tn-DistanceRadius +50m, the UE is allowed to not perform measurements on the TN frequency in the corresponding area.
 |

**Views from companies**

* Xiaomi: Clarify that the requirements for NR NTN to LTE TN inter-RAT cell re-selection is defined as NEUTRA\_carrier \* Tdetect/measure/evaluate,EUTRAN, where
	+ The parameter NEUTRA\_carrier is the number of configured E-UTRA carriers indicated in the neighbour frequency list by serving cell, except for the frequency carrier where there is no coverage of that frequency based on the provide TN cell coverage information and UE GNSS position information.
	+ Tdetect/measure/evaluate,EUTRAN is the inter-RAT E-UTRAN TN cell re-selection requirement defined in Table 4.2.2.5-1 in TS 38.133
* Define maximum paging interruption requirement for NR NTN to LTE TN inter-RAT cell re-selection.
	+ Xiaomi
* Huawei: Clarify the requirements related to TN measurement skipping as follows:
	+ UE shall perform TN measurement if its estimated distance to tn-ReferenceLocation is smaller than tn-DistanceRadius. The requirements apply provided that the actual distance between UE to tn-ReferenceLocation is smaller than tn-DistanceRadius – 50m.

**Moderator’s WF: The TN coverage information is to allow UE to skip unnecessary TN cell measurements rather than forcing them. In other words, RRM requirement impact due to the assistant information should be minimal. With this understanding, the moderator’s WF is prepared.**

* Clarify the requirements related to TN measurement skipping as follows:
	+ UE shall perform TN measurement if its estimated distance to tn-ReferenceLocation is smaller than tn-DistanceRadius. The requirements apply provided that the actual distance between UE to tn-ReferenceLocation is smaller than tn-DistanceRadius – 50m.

# Topic #5: Connected mode mobility enhancements

## Companies’ contributions summary

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

**R4-2409288 Huawei, HiSilicon**

Proposal 2 (Issue 5-1): For RACH-less HO/CHO, align TIU definition as

TIU is the interruption uncertainty in acquiring the first UL transmission resource, which can be a configured grant based PUSCH or dynamic grant based PUSCH according to NW configuration and scheduling.

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

**R4-2409059 Ericsson**

Replay LS to R4-2407009\_R2-2403771 (LS on reference point for SSB-TimeOffset) from RAN2:

* The conclusion is that existing rel-18 specification supports the special case of UL the uplink time synchronization reference at the GW/gNB.
* Draft LS is presented in Appendix of R4-2409059

**R4-2407306 Apple**

Proposal 3: in reply LS, RAN4 to acknowledge RAN2’s consideration of adopting the gNB as the reference point of ssb-TimeOffset. Accordingly, RAN4 shall clarify the propagation delay difference in both hard and soft satellite switching requirements.

* Draft LS is presented in R4-2407307

**R4-2407840 Xiaomi**

Proposal 4: RAN4 to confirm that it is acceptable to adopt the gNB as the reference point of ssb-TimeOffset.

**R4-2407932 CMCC**

Proposal 3: Check whether exists strong motivation of this ssb-TimeOffset reference point changing. If no, we prefer to keep the current spec as it is, which leaves more space for NW implementation.

**R4-2408514 Nokia**

Proposal 1: When soft satellite switching is implemented by the network and the UE supports only hard satellite switching, the UE performs hard satellite switching and the corresponding requirements are applicable to this .

Proposal 8: Confirm to RAN2 that it is acceptable moving the reference point of ssb-TimeOffset from UL synchronization point to the gNB.

**R4-2408867 vivo**

Proposal 1: For soft satellite switch with resync procedure, RAN4 to confirm that it is feasible to adopt the gNB as the reference point of *ssb-TimeOffset*

* Draft LS is presented in Appendix of R4-2408867

**R4-2409288 Huawei, HiSilicon**

Proposal 3 (Issue 5-2): For both hard and soft satellite switch, update Tfirst\_SSB definition as

Tfirst\_SSB is the time to the end of the first complete SSB burst of the target satellite, the location of which is determined by the periodicity and offset of SSB of the source satellite, the ssb-TimeOffset and the propagation delay difference between the serving satellite and the target satellite.

Proposal 4 (Issue 5-2): For both hard and soft satellite switch, confirm to RAN2 that adopting the gNB as the reference point of ssb-TimeOffset is acceptable from RAN4 perspective.

* Draft LS is presented in Appendix of R4-2409288

**Issue 5-2-S: Soft’ Satellite switch (5-2-S1 and -S2 from RAN4#110 are merged)**

**R4-2407306 Apple**

Proposal 4: not consider PDD reporting between serving and target satellites involved in the satellite switching without PCI change.

Proposal 5: to enhance scheduling restriction in soft satellite switching, consider modifying the capability rule such that: if UE indicates to support soft satellite switching without PCI change, it also means UE supports both simultaneousRxDataSSB-DiffNumerology and parallelMeasurementWithoutRestriction-r17.

**R4-2408514 Nokia**

Proposal 2: Because the UE is allowed to skip measurements in neighbor cells during soft satellite switching, the total timing to detect neighbor cells has to be extended.

Proposal 3: The UE is allowed to skip measurement gaps not associated to the satellite switching from the duration of t-serviceStart and t-service.

Proposal 5: Measurement gaps or SMTCs colliding with RLM-RS are not accounted for during soft satellite switching operation.

Proposal 6: Soft satellite switching requirements do not apply if the propagation delay difference is larger than 2 ms.

Proposal 7: A UE that supports soft satellite switching shall mandatorily support parallelMeasurementWithoutRestriction-r17

**R4-2409288 Huawei, HiSilicon**

Proposal 5 (Issue 5-2-S): Do not define known case for soft satellite switch.

## Open issues

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

**Summary of agreements:**

|  |
| --- |
| **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.

**Agreement [RAN4#109]:****FFS:*** 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.

**Agreement [RAN4#110]: (f/u can be through CRs in the future meetings)*** For RACH-less HO,
	+ on PRACH in TIU
		- Leave TIU as is. RAN4 to add back PRACH to TIU if supported by RAN2 spec in maintenance phase, e.g.
			* PRACH if TA timer is not running and there is no PUCCH SR
			* PRACH if no valid configured grant based PUSCH is found
	+ Remove SR on PUCCH from TIU
		- RAN4 to add back it to TUE if supported by RAN2 spec in maintenance phase.
* For RACH-less CHO,
	+ The requirement for time-based CHO can be the baseline, with the following modification on TIU
		- 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.
 |

**Views from companies**

* For RACH-less HO/CHO, TIU is the interruption uncertainty in acquiring the first UL transmission resource, which can be a configured grant based PUSCH or dynamic grant based PUSCH according to NW configuration and scheduling.
	+ Huawei

**Moderator’s WF**

* For RACH-less HO/CHO, TIU is the interruption uncertainty in acquiring the first UL transmission resource, which can be a configured grant based PUSCH or dynamic grant based PUSCH according to NW configuration and scheduling.

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

**Summary of agreements:**

|  |
| --- |
| **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.

**Agreement [RAN4#109]:****FFS:*** 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 agreed 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.

**FFS:*** 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

**FFS:*** 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

**FFS:*** 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

**Agreement [RAN4#110]: Common aspects for ‘Hard’ and ‘Soft’ Satellite switch*** Decide a specific value for Tprocessing time
	+ 10ms
* Side condition for the requirement applicability
	+ the target cell Es/Iot ≥ -2 dB
 |

**Views from companies**

* In response to RAN2 LS (R4-2407009\_R2-2403771), RAN4 to confirm that it is feasible to adopt the gNB as the reference point of ssb-TimeOffset for both soft and hard satellite switch scenarios.
	+ Ericsson, Apple, Xiaomi, CMCC (not preferred though), Nokia, vivo, Huawei
* Huawei: For both hard and soft satellite switch, update Tfirst\_SSB definition as
	+ Tfirst\_SSB is the time to the end of the first complete SSB burst of the target satellite, the location of which is determined by the periodicity and offset of SSB of the source satellite, the ssb-TimeOffset and the propagation delay difference between the serving satellite and the target satellite.
* When soft satellite switching is implemented by the network and the UE supports only hard satellite switching, the UE performs hard satellite switching and the corresponding requirements are applicable to this.
	+ Nokia

**Moderator’s WF: The proposal from Nokia is already confirmed by RAN2 specification/agreement.**

* In response to RAN2 LS (R4-2407009\_R2-2403771), RAN4 to confirm that it is feasible to adopt the gNB as the reference point of ssb-TimeOffset for both soft and hard satellite switch scenarios.
	+ [Apple takes the lead on the reply LS, based on the draft presented in R4-2407307]
* For both hard and soft satellite switch, update Tfirst\_SSB definition as
	+ Tfirst\_SSB is the time to the end of the first complete SSB burst of the target satellite, the location of which is determined by the periodicity and offset of SSB of the source satellite, the ssb-TimeOffset and the propagation delay difference between the serving satellite and the target satellite. If the gNB is adopted as the reference point of ssb-TimeOffset, additional changes will be made, if any, e.g. kmac.

**Issue 5-2-S: Soft’ Satellite switch (5-2-S1 and -S2 from RAN4#110 are merged)**

**Summary of agreements:**

|  |
| --- |
| **Agreement [RAN4#110]:*** It is feasible that a soft satellite switch capable UE can perform downlink synchronization with the target NGSO satellite and keep the connection (DL and UL) with the source NGSO satellite simultaneously under the following conditions.
	+ Only if SSBs from the two satellites are spaced apart from each other at least by [1 OFDM symbol] in the time domain at UE Rx side.
* [If the UE not capable of parallelMeasurementWithoutRestriction-r17 then scheduling restriction shall be expected within the duration from Tstart to T service.]

**Agreement [RAN4#110]:*** Further discuss on the solutions of alleviating the scheduling restriction problem can be further discussed in maintenance phase.

**Agreement [RAN4#110]:*** The starting point of the downlink synchronization time~~/interruption time~~.
	+ Between t-serviceStart and t-Service, the exact starting time is up to UE implementation
* The starting point of the interruption time.
	+ t-Service

**Agreement [RAN4#110]: Satellite switch latency Requirement*** If t-Service – t-serviceStart >= Tsearch + T∆ + Tmargin and UE is able to perform downlink synchronization with the target NGSO satellite and keep the connection (DL and UL) with the source NGSO satellite simultaneously
	+ Satellite switch **ending pint** is **no later than** is Tprocessing + TIU from t-Service
* Otherwise
	+ Satellite switch ~~latency~~ **ending pint** is **no later than** Tsearch + T∆ + Tmargin + Tprocessing + TIU from t-serviceStart
* Interruption is allowed only after t-Service

**Agreement [RAN4#110]:*** Satellite switch delay (Tsoft-switch), from t-serviceStart to the time instance for the first UL transmission to the target satellite, is defined as below:
	+ Tsoft-switch = max(t-Service - t-serviceStart, Tsearch + T∆ + Tmargin) + Tprocessing + TIU
* ‘The time instance for the first UL transmission to the target satellite’ is no earlier than t-Service.

**Agreement [RAN4#110]:*** Tsearch
	+ Tfirst\_SSB [ms], where Tfirst\_SSB is the time to the end of the first complete SSB burst indicated by
		- SMTC of serving cell + ssb-TimeOffset + PDD propagation difference
* TIU (ending point of interruption is at TIU)
	+ 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 TA timer is not running and there is no PUCCH SR
	+ Note: Anything not compliant with RAN2 spec, if identified, will be removed.
* T∆: Same as the existing requirements
* Tmargin: Same as the existing requirements
* Further discuss whether UE is allowed to skip or deprioritize measurements on the serving cell and neighbor cells from T-Start in maintenance phase

**Agreement (online) [RAN4#110]:*** Scheduling restrictions over [t-ServiceStart ~ t-Service] for UE incapable of parallelMeasurementWithoutRestriction-r17 and/or [differentSCS between SSB and data]
	+ Define scheduling restriction during soft satellite switch from UE perspective, i.e. scheduling restriction are allowed only during SSB occasions of the target satellite (same as 9.2C.5.3)
		- For the scheduling restriction: For RSRP measurement, 1 additional symbol before and after SSB block. For RSRQ measurement, 1 additional symbol before and after RSSI symbols.

**Agreement (online) [RAN4#110]:*** Optimization on measurements
	+ UE is allowed to skip measurements other cells and satellites than the target satellite and source satellite from T-serviceStart to the satellite switch completion.

**Agreement (online) [RAN4#110]:*** Impact on inter-satellite neighbour cell measurements
	+ No optimization for the scenario of ‘(both hard and soft) satellite switch with re-sync’ on inter-satellite neighbor cell measurements
 |

**Views from companies**

* Do not define known case for soft satellite switch.
	+ Huawei
* Do not consider PDD reporting between serving and target satellites involved in the satellite switching without PCI change
	+ Apple
* To enhance scheduling restriction in soft satellite switching,
	+ Consider modifying the capability rule such that: if UE indicates to support soft satellite switching without PCI change, it also means UE supports both simultaneousRxDataSSB-DiffNumerology and parallelMeasurementWithoutRestriction-r17.
		- Apple, Nokia
	+ Soft satellite switching requirements do not apply if the propagation delay difference is larger than 2ms
		- Nokia
* Because the UE is allowed to skip measurements in neighbor cells during soft satellite switching, the total timing to detect neighbor cells has to be extended
	+ Nokia
* The UE is allowed to skip measurement gaps not associated to the satellite switching from the duration of t-serviceStart and t-service
	+ Nokia
* Measurement gaps or SMTCs colliding with RLM-RS are not accounted for during soft satellite switching operation
	+ Nokia

**Moderator’s WF**

* UE capability of parallelMeasurementWithoutRestriction-r17 is mandatorily supported for a UE supporting soft satellite switching.
* Do not define known case for soft satellite switch.
* Do not consider PDD reporting between serving and target satellites involved in the satellite switching without PCI change.
* During and after soft satellite switch, the total timing to detect neighbor cells has to be extended.
* UE is allowed to skip measurement gaps not associated to the satellite switching from the duration of t-serviceStart and t-service
* Measurement gaps or SMTCs colliding with RLM-RS are not accounted for during soft satellite switching operation

# Topic #6: Performance requirements

## Companies’ contributions summary

**Issue 6-2-1: (FR2-NTN) Test set-up and applicability rule**

**R4-2409290 Huawei, HiSilicon**

Proposal 5 (Issue 6-2-1): Mobile UE does not need pass the TCs with NGSO. Fixed UE needs to pass the TCs with either GSO or NGSO depending on UE capability.

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

**R4-2407308 Apple**

Proposal 1: remove an RF margin for different RX beams in the relative accuracy and tighten relative accuracy requirements.

Proposal 2: since single polarization is assumed for FR2-1 NTN, the existing absolute measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with 1dB relaxation. (i.e., revert the last meeting agreement in issue 6-2-2)

Proposal 3: instead of using UE power class, RAN4 shall define the minimum SSB\_RP condition for accuracy requirement of five UE types specified in table 9.2.1.0-1 of TS38.101-5.

Proposal 4: RAN4 to define:

Minimum SSB\_RP\_NTN\_FR2 = Reference sensitivity UE type, n512, 50MHz +Y -10Log10(PRBRefsens x 12) – SNRRefsens + SSB Ês/Iot + ∆MBP,n, where,

* Reference sensitivity UE type, n512, 50MHz is the reference sensitivity value in dBm specified for a specific UE type in Band n512 for 50 MHz Channel bandwidth in Table 10.3.2-1 and section 10.3.3-1 of TS 38.101-5
* Y is the gain difference between fine and rough beams, which needs FFS in RAN4
* PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-5 Table 5.3.2-2, and is 32;
* 12 is the number of subcarriers in a PRB;
* SNRRefsens is the SNR used for simulation of Refsens and EIS spherical coverage, and is -1 dB;
* SSB Ês/Iot is the minimum value required by the UE to perform measurements, and is -6 dB for intra-frequency measurements and -4 dB for inter-frequency measurements. The only contribution to Iot is the UE internal noise;
* ∆MBP,n is 0 for NTN above 10GHz since CA/DC is not considered.

Proposal 5:

* For Mobile VSAT communication with GSO, and for fixed VSAT communication with GSO and LEO, the upper bound of Rx beam gain is 41dB.
* For fixed VSAT communication with LEO only, the upper bound of Rx beam gain is 30dB.

**R4-2408420 Samsung**

Proposal 1:

* For mechanical steering antenna:
	+ There is no difference between rough beam and fine beam. There is no RF margin for different directions. The RF margin for different beams can be removed. For the minimum SSB\_RP condition, Y is 0dB for mechanical steering antenna or remove Y for mechanical steering antenna.
* For electronic steering antenna:
	+ We suggest to keep the RF margin for electronic steering antenna to cover the worst case by different RX beams. There can be rough beams and fine beams as TN UEs. For the minimum SSB\_RP condition, Y is needed and the value can be FFS.

**R4-2408870 vivo**

Proposal 1: The RF margin for different RX beams in existing TN FR2-1 intra-frequency relative accuracy requirements can be removed

**R4-2409290 Huawei, HiSilicon**

Proposal 2 (Issue 6-2-2): Do not define the concept of rough beam for FR2-NTN (Y=0).

Proposal 3 (Issue 6-2-2): Do not define separate Min SSB\_RP for peak and spherical coverage unless spherical coverage is introduced in RF session in future.

Proposal 4 (Issue 6-2-2): RAN4 to further discuss Gmin and Gmax for FR2-NTN.

**R4-2408607 Ericsson**

Proposal 4: RAN4 to check if SNR values for RLM-RS test to NTN FR2 UE shall be updated from legacy FR2 and how to determine the values.

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

**R4-2408420 Samsung**

Proposal 4:

In UL timing tests, three test configurations are configured.

|  |  |
| --- | --- |
| Configuration | Description |
| 1 | GSO, NR FDD, SSB SCS [120] kHz, data SCS 120 kHz, BW [100] MHz |
| 2 | NGSO, NR FDD, SSB SCS [120] kHz, data SCS 120 kHz, BW [100] MHz |
| 3 | GSO, NR FDD, SSB SCS [120] kHz, data SCS 120 kHz, BW [100] MHz |

* For Configuration 1 and 3, the only difference is the propagation condition. In configuration 1, AWGN is used. In configuration 3, AWGN with a constant doppler shift is used.
* For fixed UE only supports GSO, the UE is only required to pass the test of config 1.
* For fixed UE support both GSO and NGSO, the test config 1 can be sipped if the UE passes test config 2.
* For mobile UE only supports GSO, the UE is only required to pass the test of config 1.

**R4-2408515 Nokia**

Proposal 1: For FR2-NTN, adopt $T\_{GNSS\\_margin}$ equal to $(T\_{e\\_NTN}-T\_{E})/2$, when AT commands are used in the test case in scenarios 1 and 2.

Proposal 2: For case 3, adopt the transmit timing accuracy equal to cases 1 and 2, when UE is tested with fixed position in a simplified test setup.

**R4-2408870 vivo**

Proposal 2: Define UL timing test cases for following configurations and UE is required to be tested in the configuration with the largest supported SCS:

* UL SCS 120kHz with DL SSB SCS: 120kHz
* UL SCS 60kHz with DL SSB SCS: 120kHz
* UL SCS 60kHz with DL SSB SCS: 240kHz
* UL SCS 120kHz with DL SSB SCS: 240kHz

**R4-2409290 Huawei, HiSilicon**

Proposal 6 (Issue 6-2-3): RAN4 to discuss the value for $T\_{GNSS\\_margin}$ for mobile and fixed UEs.

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

**R4-2408515 Nokia**

Proposal 3: For mobility test cases involving UEs with mechanically steered beams, make a note that the timing requirement for the completion of the mobility procedure depends on the setup of the test case, considering UE “minimum steering speed” of 22 degrees/s.

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

**R4-2408515 Nokia**

Proposal 4: RAN4 to discuss whether to introduce measurement accuracy requirements for FR2-NTN in the maintenance part of Rel-18.

**R4-2409290 Huawei, HiSilicon**

Proposal 1 (Issue 6-2-7): The relative accuracy requirements for FR2 TN are re-used for FR2-NTN, except that the RF margin for different Rx beams is removed for intra-frequency measurement.

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

**R4-2408420 Samsung**

Proposal 2: RAN4 to define new configurations for

* PDSCH Reference measurement channel
* RMSI CORESET Reference Channel
* Dedicated CORESET Reference Channel
* TRS configuration

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

**R4-2409290 Huawei, HiSilicon**

Proposal 3 (Issue 6-2-2): Use the following AoA setup for TCs.

* For TC for inter-satellite HO, define 2-AoA setup with details FFS
* For other TCs, use 1-AoA setup with details FFS

Proposal 7 (Issue 6-2-4B): Define separate sub-tests for Type 1 and Type 2 UEs with differences in

* [AoA setup]
* Test duration due to different HO delays
* Test requirements due to different HO delays

**R4-2408420 Samsung**

Proposal 3: In test cases such as timing, single AoA in Rx beam peak direction can be reused. For the test case of inter-satellite handover, new AoA setup should be defined.

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

**R4-2408421 Samsung**

Proposal 1: For the test configuration of TC NTN to NR TN cell reselection,

* The test comprises two carriers and one cell is of NTN Cell while another cell is TN cell.
* Before the test, UE camped on NTN cell. UE received SIB25 information of Cell 1 of “tn-ReferenceLocation” and “tn-DistanceRadius”. During T1, the UE location is maintained by UE is not in the TN coverage. After the start of T2, the UE location is changed by new configuration of SIB25 to initiation to NTN-TN cell reselection.
* At the end of T2, UE reselects to TN Cell by the best RSRP.

Proposal 2: For the test configuration of TC NTN to EUTRA TN cell reselection, first check whether there is HST carrier in core requirements. In the test case, it can compromise two carriers and two cells. Cell 1 is the NTN Cell which UE camped on this cell at the beginning. Cell 2 is the EUTRA neighbor cell. Similar test procedure in TC of NTN to NR TN in proposal 1 can be reused.

**R4-2409293 Huawei, HiSilicon**

Proposal 1 (Issue 6-3-2): In the TCs for NTN-TN cell reselection,

* do not verify the TN measurement skipping
* set the distance between the UE and tn-ReferenceLocation as tn-DistanceRadius - 50m
* include only one neighbor cell which is a TN cell

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

**R4-2407195 MediaTek inc.**

Proposal 1: GSO test configuration is not applicable for the following tests for Below 10 GHz in Connected mode mobility:

* satellite switch

**R4-2408421 Samsung**

Proposal 3: In soft satellite switch test, “t-ServiceStart-r18” should be configured in “SatSwitchWithReSync-r18” and the value is earlier than t-Service.

**R4-2409293 Huawei, HiSilicon**

Proposal 2 (Issue 6-3-3): In the TCs for satellite switch,

* the SSB transmit timing from TE should fit the SSB-timeOffset and the nominal PDD
* set (t-Service - t-serviceStart) larger than (Tsearch + T∆ + Tmargin)

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

**R4-2407195 MediaTek inc.**

Proposal 1: GSO test configuration is not applicable for the following tests for Below 10 GHz in Connected mode mobility:

* NTN to NTN time-based trigger CHO enhancements

**R4-2408421 Samsung**

Proposal 5: For test case of “NTN to NTN time-based trigger CHO enhancements”, the test configuration in the Rel-17 NTN test case of “A.14.2.1.4” can be reused. The test requirements shall be updated according to core requirements to remove Tmeasure and add Tsearch to Tinterrupt.

**R4-2408607 Ericsson**

Proposal 2: No test case for time/location- based trigger CHO enhancements.

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

**R4-2408421 Samsung**

Proposal 4: Support to define the test case for NTN to NTN RACH-less HO. The test comprises of two Cells and three successive time periods. At the start of T1, UE camps on Cell 1. And NTN Cell send a RRC message implying RACH-less HO to cell 2 during T2. After the UE reported Event A3, the PUSCH transmission in Cell 2 is configured in the RRC message from Cell 1. The UE shall stat to transmit PUSCH to Cell 2 less than the “RRC procedure delay + Tinterrupt (Interruption time for RACH-less HO)” from the beginning of time period T3.

**R4-2408607 Ericsson**

Proposal 1: Slightly intend towards no test case for NTN to NTN RACH-less (C)HO.

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

**R4-2408607 Ericsson**

Proposal 3: No test case for network verified UE location.

## Open issues

**Issue 6-2-1: (FR2-NTN) Test set-up and applicability rule**

**Views from companies**

* Mobile UE does not need to pass the TCs with NGSO. Fixed UE needs to pass the TCs with either GSO or NGSO depending on UE capability.
	+ Huawei

**Moderator’s Recommendation:**

* Based on UE capability and VSAT class defined in Table 9.2.1.0-1 of TS38.101-5, the above proposed applicability rue is evident. Therefore, no separate agreement is pursued.

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

**Summary of agreements:**

|  |
| --- |
| **Agreement [RAN4#109]:*** No agreement

**No agreement [RAN4#110]: (no further discussion)*** Decide whether to remove an RF margin for different RX beams in the relative accuracy and tighten relative accuracy requirements.

**Agreement (ad-hoc) [RAN4#110b]:*** FFS whether the RF margin for different RX beams in existing TN FR2-1 intra-frequency relative accuracy requirements can be removed or not
* Existing absolute measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz.
* Further discuss the minimum SSB\_RP condition on accuracy requirements
 |

**Views from companies**

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

**Moderator’s WF:**

* The existing absolute measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with [1]dB relaxation. (i.e., revert the last meeting agreement in issue 6-2-2).
* Remove an RF margin for different RX beams in the relative accuracy.
* Define the minimum SSB\_RP condition for accuracy requirement of five UE types specified in table 9.2.1.0-1 of TS38.101-5. Minimum SSB\_RP\_NTN\_FR2 for Rx Beam Peak angle of arrival = Reference sensitivity UE type, n512, 50MHz +Y -10Log10(PRBRefsens x 12) – SNRRefsens + SSB Ês/Iot + ∆MBP,n, where,
	+ Reference sensitivity UE type, n512, 50MHz is the reference sensitivity value in dBm specified for a specific UE type in Band n512 for 50 MHz Channel bandwidth in Table 10.3.2-1 and section 10.3.3-1 of TS 38.101-5.
	+ PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-5 Table 5.3.2-2, and is 32;
	+ SNRRefsens is the SNR used for simulation of Refsens and EIS spherical coverage, and is -1 dB;
	+ SSB Ês/Iot is the minimum value required by the UE to perform measurements, and is -6 dB for intra-frequency measurements and -4 dB for inter-frequency measurements. The only contribution to Iot is the UE internal noise;
	+ ∆MBP,n is 0.
* For the minimum SSB\_RP condition,
	+ The gain difference between fine and rough beams is YdB:
		- For mechanical steering antenna, Y=0
		- For electronic steering antenna, Y=0
* Do not define separate spherical coverage unless spherical coverage is introduced in RF session.
* FFS: Gmin and Gmax
* FFS: The upper bound of Rx beam gains are defined as below:
	+ For Mobile VSAT communication with GSO, and for fixed VSAT communication with GSO and LEO, the upper bound of Rx beam gain is [41]dB.
	+ For fixed VSAT communication with LEO only, the upper bound of Rx beam gain is [30]dB.
	+ The avoid values are tentatively derived based on the following formula:
		- Ant\_Gain = -174 dBm/Hz + 10log10(50MHz) + NF + SNR (QPSK) + IM - REFSENS\_50MHz
		- REFSENS\_50MHz is
			* -126.8 dBm for Mobile VSAT communication with GSO, and for fixed VSAT communication with GSO and LEO
			* -115.6 dBm for fixed VSAT communication with LEO only
			* NF = 10 dB
			* SNR = -1 dB
			* IM = 2 dB
* Note: If anything above inconsistent with RF requirement is identified, RAN4 to make updates to those aspects accordingly.

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

**Summary of agreements:**

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

**Agreement (online) [RAN4#110b]:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Band** | **Category** | **Test case** | **Configuration** |
| Above 10 GHz | UL transmission timing | 1. Transmit Timing2. Timing advance adjustment accuracy | UL SCS: 120kHzDL SSB SCS: 120kHzCase 1,2,3 |

 |

**Views from companies**

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

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

* The value for $T\_{GNSS\\_margin}$ for mobile and fixed UEs is reduced to X in Rel-18.
	+ X = [$(T\_{e\\_NTN}-T\_{E})/2$]
* In the test case of UE transmission timing accuracy for Case-3 (Mobile UE for GSO):
	+ UE mobility is not considered unless the testability issue is resolved.
	+ UE requirement for Case-3 is set to the same value as that of Case-1 (Stationary UE for GSO).

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

**Views from companies**

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

**Moderator’s Recommendation:**

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

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

**Views from companies**

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

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

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

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

**Views from companies**

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

**Moderator’s Recommendation:**

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

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

**Views from companies**

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

**Moderator’s WF:**

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

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

**Views from companies**

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

**Moderator’s WF:**

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

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

**Views from companies**

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

**Moderator’s WF:**

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

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

**Views from companies**

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

**Moderator’s WF:**

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

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

**Views from companies**

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

**Moderator’s WF:**

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

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

**Views from companies**

* Ericsson: No test case for network verified UE location

**Moderator’s WF:**

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

# Draft CRs

## RRM core requirements

**R4-2407460 Qualcomm Incorporated (NR\_NTN\_enh-Core) Baseline-Big CR for RAN4#111 draft CRs to TS 38.133 on RRM requirements for NR NTN enhancement\_v0**

* To be served as a baseline big CR

**R4-2407677 Samsung Draft CR on VSAT UE timing requirements for NTN in above 10GHz**

|  |  |
| --- | --- |
| ***Reason for change:*** | Resubmit the endorsed draft CR in R4-2403496 and R4-2406478There is [TBD] in NTA\_offset table 7.1C.2-3 |
|  |  |
| ***Summary of change:*** | Includes all changed in R4-2403496 and R4-2406478Change [TBD] to 0 in NTA\_offset table 7.1C.2-3 |
|  |  |
| ***Consequences if not approved:*** | The timing requeiments of VSAT UE in NTN bands above 10GHz are missing and incompleted in spec |
|  |  |
| ***Clauses affected:*** | 7.1C 7.2C 7.3C |

**R4-2407841 Xiaomi draftCR on L3-RSRP measurement requirements maintenance in above 10 GHz scenario**

|  |  |
| --- | --- |
| ***Reason for change:*** | The scheduling overhead was introduced for the case UE configured with more than one LEO satellites on the same measurement carrier. In Rel-18 NR-NTN deployment in above 10 GHz bands, L3 measurement requirements were introduced for intra-satellite case only. So, the requirements applicability condition of scheduling restriction cap could be removed. |
|  |  |
| ***Summary of change:*** | Remove the L3 measurement requirements applicability condition of scheduling restriction cap.The correction is based on the previously endorsed big CR (R4-2403572) |
|  |  |
| ***Consequences if not approved:*** | The requirement is not align with the agreements. |
|  |  |
| ***Clauses affected:*** | 9.2C.7 |

**R4-2409058 Ericsson Draft CR to TS 38.133: Removing side condition**

|  |  |
| --- | --- |
| ***Reason for change:*** | Case 2 side condition for GSO has brackets. |
|  |  |
| ***Summary of change:*** | Remove side condition that ephemeris information be refreshed (i.e. update rate of ephemeris information in SIB19) at least every X seconds, where X= [7] s. |
|  |  |
| ***Consequences if not approved:*** | Inclompete set of NTN core requirements. |
|  |  |
| ***Clauses affected:*** | Table 7.1C.2-2, Note 2: Te\_NTN Timing Error Limit for fixed VSAT is served by GSO and fixed VSAT is served by NGSO. |

**R4-2409285 Huawei, HiSilicon draftCR on measurement requirements for NTN in Ka band**

|  |  |
| --- | --- |
| ***Reason for change:*** | Based on RAN4#111 agreements, for Type 2 UE, intra-satellite RRC re-establishment requirements do not apply when the cause for the RRC re-establishment is an inter-satellite HO failure. |
|  |  |
| ***Summary of change:*** | Clarifiy the applicability of the intra-satellite RRC re-establishment requirements based on the agreement.  |
|  |  |
| ***Consequences if not approved:*** | Requirements improperly apply in scenarios where they should not.  |
|  |  |
| ***Clauses affected:*** | 6.2C.1.2.2 |

**R4-2409287 Huawei, HiSilicon draftCR on Rx-Tx measurement requirements**

|  |  |
| --- | --- |
| ***Reason for change:*** | RAN4#110-bis agreed to remove factors related to multiple positioning frequency layers, multiple RX TEGs and Rx beam sweeping from the Rx-Tx requirements. Also, it is agreed to remove applicability rules that are related to PSCell or SCell. |
|  |  |
| ***Summary of change:*** | Remove factors related to multiple positioning frequency layers, multiple RX TEGs and Rx beam sweeping from the Rx-Tx requirements for MG based case. Also, remove applicability rules that are related to PSCell or SCell for both MG based and MG-less cases. |
|  |  |
| ***Consequences if not approved:*** | Ue Rx-Tx measurement requirements are incorrect.  |
|  |  |
| ***Clauses affected:*** | 9.9C.4.5, 9.9C.4.6 |

**R4-2408512 Nokia CR to TS 38.133 on applicability of soft satellite switching requirements**

|  |  |
| --- | --- |
| ***Reason for change:*** | It is not clear from the specification when the requirements for hard and soft satellite switching are applicable, specially when the UE supports only hard satellite switching with same PCI, and the network is configured with soft satellite switching.  |
|  |  |
| ***Summary of change:*** | Clarify the applicability of requirements |
|  |  |
| ***Consequences if not approved:*** | The applicability of requirements for this feature will remain unclear. |
|  |  |
| ***Clauses affected:*** | 6.1C.3.2 |

**R4-2408513 Nokia CR to TS 38.133 on RLM and measurements during satellite switching with resynchronization**

|  |  |
| --- | --- |
| ***Reason for change:*** | During soft satellite switching with resync the UE is allowed to skip measurements on neighbor cells, but this behavior is not captured in specification. It is also expected to focus in RLM measurements for the duration of the the soft satellite switching  |
|  |  |
| ***Summary of change:*** | Capture that UE is allowed to skip measurements on neighbor cells for the duration of the soft satellite switching with resync. Capture that the UE shall focus on RLM measurements when MG and SMTC occasions are dropped.  |
|  |  |
| ***Consequences if not approved:*** | The applicability of requirements for this feature will remain unclear.  |
|  |  |
| ***Clauses affected:*** | 8.1C.2, 8.1C.3, 9.2C, 9.3C |

**R4-2409289 Huawei, HiSilicon draftCR on requirements for satellite switch with re-sync**

|  |  |
| --- | --- |
| ***Reason for change:*** | 1. Known cell is not applicable for soft satellite switch.
2. The wording for the definition of Tfirst\_SSB is unclear.
 |
|  |  |
| ***Summary of change:*** | 1. Remove known cell case for soft satellite switch.
2. Update the wording for the definition of Tfirst\_SSB
 |
|  |  |
| ***Consequences if not approved:*** | Requirements for satellite switch with re-sync are not fully correct. |
|  |  |
| ***Clauses affected:*** | 6.1C.3.2.2, 6.1C.3.2.3 |

## RRM performance requirements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Band** | **Category** | **Test case** | **Configuration** | **Volunteer** | **Drat CR** |
| Above 10 GHz | UL transmission timing | 1. Transmit Timing2. Timing advance adjustment accuracy | UL SCS: 120kHzDL SSB SCS: 120kHzCase 1,2,3 | Samsung | R4-2407678, Samsung |
| Above 10 GHz | Connected mode mobility | 1. Intra-satellite handover2. Inter-satellite (blind mobility) | Type 1 and Type 2[Intra-frequency] | Qualcomm | R4-2407461, QualcommR4-2409291, Huawei |
| Above 10 GHz | Signaling | RLM [Out-of-sync, In-sync] | Type 1 and Type 2[Non-DRX, SSB] | vivo | R4-2408864, vivoR4-2408608, Ericsson |
| Above 10 GHz | Measurement procedure | L3-RSRP [Intra-satellite] | Type 1 and Type 2[Without gap, Intra-frequency, SSB, non-DRX, SSB index reading] | Xiaomi | R4-2407842, Xiaomi |
| Above 10 GHz | Measurement procedure | L1-RSRP | Type 1 and Type 2[SSB, non-DRX] | Apple | R4-2407364, Apple |
| Above 10 GHz | Measurement accuracy | L3-RSRP | Type 1 and Type 2[Without gap, Intra-frequency, SSB, non-DRX, SSB index reading] | Nokia |  |
| Above 10 GHz | Measurement accuracy | L1-RSRP | Type 1 and Type 2[SSB, non-DRX] | Nokia |  |
| Below 10 GHz | Idle mode mobility | 1. NTN-TN inter-frequency cell reselection (Intra-RAT to NR TN)2. NTN-TN inter-frequency cell reselection (Inter-RAT to LTE TN) | Earth fixed cell | ZTE | R4-2409691, ZTE (Idle)R4-2409692, ZTE (Inactive)R4-2409695, ZTE R4-2409696, ZTE |
| Below 10 GHz | Connected mode mobility | 1. RACH-less for soft satellite switch2. RACH-based for hard satellite switch | Earth fixed cell | CMCC | R4-2407933, CMCC |
| Below 10 GHz | Connected mode mobility | NTN to NTN RACH-less HO | Earth fixed cell[Inter-satellite, without MG] | MTK | R4-2407196, MediaTek |
| Below 10 GHz | Connected mode mobility | NTN to NTN time-based trigger CHO enhancementsNote: not test earth-moving cell |  | LGE | R4-2407964, LG |
| ~~Below 10 GHz~~ | ~~Connected mode mobility~~ | ~~[NTN to NTN location-based trigger CHO enhancements]~~~~Note: not test earth-moving cell~~ |  | N/A |  |
| ~~Below 10 GHz~~ | ~~Measurement procedure and accuracy~~ | ~~[Network verified UE location]~~ |  | N/A | R4-2409292, Huawei (not a test case) |
| Note1* Type 1: fully electronically-steered beam UEs
* Type 2: fully mechanically-steered beam UEs

Note2* Case-1: Stationary UE for GSO
* Case-2: Stationary UE for LEO
* Case-3: Mobile UE for GSO
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