3GPP TSG-RAN WG4 Meeting #112 R4-24xxxxx

Maastricht, Netherlands, 19th – 23rd August, 2024

**Agenda item:** 5.23.9

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Topic summary for [112][206] NR\_NTN\_enh

**Document for:** Information

# Introduction

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

* *5.23.6 RRM core requirements [NR\_NTN\_enh-Core]*
* *5.23.7 RRM performance requirements [NR\_NTN\_enh-Perf]*

# Topic #3: Network verified UE location

## Companies’ contributions summary

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

**R4-2412661 Huawei**

Proposal 1: RAN4 to clarify that UE is only required to measure PRS from the serving cell for PRS measurement for NW verified location.

## Open issues

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

**Views from companies**

* RAN4 to clarify that UE is only required to measure PRS from the serving cell for PRS measurement for NW verified location.
	+ Huawei

**Moderator’s WF**:

* RAN4 to clarify that UE is only required to measure PRS from the serving cell for PRS measurement for NW verified location.

# Topic #4: Idle/Inactive mode mobility enhancements

## Companies’ contributions summary

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

**R4-2411446 Apple**

*Proposal 1: For NTN incapable UE,* *if both TN and NTN carriers are broadcasted for neighbour cells measurement in IDLE/Inactive mode and the target NTN carriers include the ones on band n255 or n254, the existing TN-to-TN cell reselection requirements are not applied.*

* *In the future release, if more overlapped bands between TN and NTN are introduced besides n254/255, this applicability requirement shall be revisited.*

*Proposal 2: For TN to NTN cell re-selection requirement when Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, if UE is configured by network to have at least one high priority carrier which contains NTN cells, the requirements for GNSS ON shall be applied.*

**R4-2412661 Huawei**

Proposal 2: RAN4 to confirm that for NTN incapable UE, the existing TN-to-TN cell reselection requirements apply even NTN carriers are configured for measurement.

## Open issues

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

**Views from companies**

* For NTN incapable UE, if both TN and NTN carriers are broadcasted for neighbour cells measurement in IDLE/Inactive mode
	+ Option 1 (Apple): If the target NTN carriers include the ones on band n255 or n254, the existing TN-to-TN cell reselection requirements are not applied. In the future release, if more overlapped bands between TN and NTN are introduced besides n254/255, this applicability requirement shall be revisited.
	+ Option 2 (Huawei): the existing TN-to-TN cell reselection requirements apply
* (Apple) For TN to NTN cell re-selection requirement when Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, if UE is configured by network to have at least one high priority carrier which contains NTN cells, the requirements for GNSS ON shall be applied.

**Moderator’s WF: Based on the observation provided in R4-2412661 (Huawei), Moderator suggests Option 2 as WF.**

* For NTN incapable UE, if both TN and NTN carriers are broadcasted for neighbour cells measurement in IDLE/Inactive mode, the existing TN-to-TN cell reselection requirements apply.

**Moderator’s WF: Further discussion**

* For TN to NTN cell re-selection requirement when Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, if UE is configured by network to have at least one high priority carrier which contains NTN cells, the requirements for GNSS ON shall be applied

**Summary of previous 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.

**Agreement [RAN4#111]*** 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 (i.e., the TN to NTN reselection requirement agreed in RAN4 #110) are applied to both TN and NTN target cells/carriers.
	+ FFS: For NTN incapable UE, the existing TN-to-TN cell reselection requirements are applied.
		- Further check does UE know whether it is a TN carrier or NTN carrier
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**Issue 4-2: NTN to TN cell reselection**

**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.

**Summary of previous agreements:**

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| **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.
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# Topic #5: Connected mode mobility enhancements

## Companies’ contributions summary

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

**R4-2412661 Huawei**

Proposal 3: RAN4 to clarify that the ending point of satellite switch with re-sync is the time point when UE is ready to receive DL channels/signals or transmit UL channels/signals from/to the target satellite, and to remove TIU in the delay/interruption time.

**Issue 5-2-S: Soft’ Satellite switch**

**R4-2411446 Apple**

*Proposal 3: Not consider PDD reporting between serving and target satellites involved in the satellite switching without PCI change.*

*Proposal 4: 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.*

## Open issues

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

**Views from companies**

* (Huawei) RAN4 to clarify that the ending point of satellite switch with re-sync is the time point when UE is ready to receive DL channels/signals or transmit UL channels/signals from/to the target satellite, and to remove TIU in the delay/interruption time.

**Moderator’s WF:**

* RAN4 to clarify that the ending point of satellite switch with re-sync is the time point when UE is ready to receive DL channels/signals or transmit UL channels/signals from/to the target satellite, and to remove TIU in the delay/interruption time.

**Summary of previous agreements:**

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| **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

**Agreement [RAN4#111]:*** 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.
 |

**Issue 5-2-S: Soft’ Satellite switch**

**Views from companies**

* (Apple) 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

**Moderator’s WF: The below seems to be already confirmed/agreed by RAN2**

* RAN4 to not consider PDD reporting between serving and target satellites involved in the satellite switching without PCI change.

**Moderator’s WF: Further discussion**

* 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.

**Summary of previous agreements:**

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| **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
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# Topic #6: Performance requirements

## Companies’ contributions summary

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

**R4-2411447 Apple**

Proposal 1: remove the bracket for the following 1dB relaxation:

* The existing absolute measurement accuracy requirement and relative measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with 1dB relaxation.

Proposal 2: For the minimum SSB\_RP condition, only single type of beam is assumed, i.e., the gain difference between fine and rough beams is YdB:

* Y=0, for both mechanical steering antenna and electronic steering antenna

Proposal 3: For Mobile VSAT communication with GSO, and for fixed VSAT communication with GSO and LEO, the lower bound of Rx beam gain is 41dB.

Proposal 4: For fixed VSAT communication with LEO only, the lower bound of Rx beam gain is 30dB.

Proposal 5: VSAT vendor to claim the upper bound of the Rx beam gain.

**R4-2412115 Samsung**

Proposal 1: For electronic steering antenna, Y is 0.

Proposal 2: Gmin can be 33.7dBi for NTN VSAT type 1, 2, 4, 5 while 27.3dBi for NTN VSAT type 3.

Proposal 3: Gmax depends on typical implementation of antennas.

**R4-2412664 Huawei**

Proposal 1: RAN4 to confirm Y=0 also for electronic steering antenna.

Proposal 2: RAN4 to define

* Gmin = 25dB for VSAT type 3, and Gmin = 33dB for other VSAT types
* Gmax = 50dB for all VSAT types

Proposal 5: For RLM for FR2-NTN, RAN4 to discuss the following options.

* Option 1: update core requirements (PDCCH parameters, evaluation period) as for R17 RedCap
* Option 2: update the SNR levels in TCs with new Qout/Qin and measurement accuracy

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

**R4-2412664 Huawei**

Proposal 3: RAN4 to define $T\_{GNSS\\_margin}$ as 65.536 Tc and 196.608 Tc for fixed and mobile VSAT.

Proposal 4: For FR2-NTN UL timing test, the test requirement for Case 3 is same as that for Case 1.

## Open issues

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

**Views from companies**

* For the minimum SSB\_RP condition for electronic steering antenna,
	+ RAN4 to confirm Y (gain difference between fine and rough beams) = 0
		- Apple, Samsung, Huawei
* (Apple) Remove the bracket for the following 1dB relaxation:
	+ The existing absolute measurement accuracy requirement and relative measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with 1dB relaxation
* Gmin FR2-NTN
	+ Samsung:
		- 27.3dBi for NTN VSAT type 3
		- 33.7dBi for other VSAT types
	+ Huawei
		- 25dB for VSAT type 3
		- 33dB for other VSAT types
* Gmax FR2-NTN
	+ Samsung: depends on typical implementation of antennas
	+ Huawei: 50dB for all VSAT types
* (Apple) The lower bound of Rx beam gain
	+ 30dB for NTN VSAT type 3
	+ 41dB for other VSAT types
	+ VSAT vendor to claim the upper bound of the Rx beam gain
* (Huawei) For RLM for FR2-NTN, RAN4 to discuss the following options
	+ Option 1: update core requirements (PDCCH parameters, evaluation period) as for R17 RedCap
	+ Option 2: update the SNR levels in TCs with new Qout/Qin and measurement accuracy

**Moderator’s WF:**

* For the minimum SSB\_RP condition for electronic steering antenna,
	+ RAN4 to confirm Y (gain difference between fine and rough beams) = 0
* Remove the bracket for the following 1dB relaxation:
	+ The existing absolute measurement accuracy requirement and relative measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with 1dB relaxation
* For RLM for FR2-NTN, RAN4 to discuss the following options
	+ Option 1: update core requirements (PDCCH parameters, evaluation period) as for R17 RedCap
	+ Option 2: update the SNR levels in TCs with new Qout/Qin and measurement accuracy
* Gmin
	+ Option 1:
		- 27.3dBi for NTN VSAT type 3
		- 33.7dBi for other VSAT types
	+ Option 2:
		- 25dB for VSAT type 3
		- 33dB for other VSAT types
	+ Option 3:
		- 30dB for NTN VSAT type 3
		- 41dB for other VSAT types
* Gmax
	+ Option 1: depends on typical implementation of antennas
	+ Option 2: 50dB for all VSAT types
* Note: If anything above inconsistent with RF requirement is identified, RAN4 to make updates to those aspects accordingly.
* Note: NTN FR2 VSAT classes specified in table 9.2.1.0-1 of TS38.101-5
	+ NTN VSAT type 1: Fixed VSAT communicating with GSO and LEO with mechanical steering antenna
	+ NTN VSAT type 2: Fixed VSAT communicating with GSO and LEO with electronic steering antenna
	+ NTN VSAT type 3: Fixed VSAT communicating only with LEO with electronic steering antenna
	+ NTN VSAT type 4: Mobile VSAT communicating with GSO with mechanical steering antenna
	+ NTN VSAT type 5: Mobile VSAT communicating with GSO with electronic steering antenna

**Summary of previous agreements:**

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| --- |
| **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

**Agreement [RAN4#111]:*** The existing absolute measurement accuracy requirement and relative measurement accuracy requirement of TN FR2 (including intra-frequency and inter-frequency) can be applied for NTN UE above 10GHz with [1]dB relaxation.
	+ Note: Companies are encouraged to further evaluate the performance loss due to single polarization assumption on FR2 Ka band VSAT UE. It’s not precluded to further update the tentative relaxation value in future RAN4 meeting.
* Remove an RF margin for different RX beams in the relative accuracy.
* Define the minimum SSB\_RP condition for accuracy requirement of five UE types specified in table 9.2.1.0-1 of TS38.101-5. Minimum SSB\_RP\_NTN\_FR2 for Rx Beam Peak angle of arrival = Reference sensitivity UE type, n512, 50MHz +Y -10Log10(PRBRefsens x 12) – SNRRefsens + SSB Ês/Iot + ∆MBP,n, where,
	+ Reference sensitivity UE type, n512, 50MHz is the reference sensitivity value in dBm specified for a specific UE type in Band n512 for 50 MHz Channel bandwidth in Table 10.3.2-1 and section 10.3.3-1 of TS 38.101-5.
	+ PRBRefsens is NRB associated with subcarrier spacing 120 kHz for 50MHz in TS 38.101-5 Table 5.3.2-2, and is 32;
	+ SNRRefsens is the SNR used for simulation of Refsens and EIS spherical coverage, and is -1 dB;
	+ SSB Ês/Iot is the minimum value required by the UE to perform measurements, and is -6 dB for intra-frequency measurements and -4 dB for inter-frequency measurements. The only contribution to Iot is the UE internal noise;
	+ ∆MBP,n is 0.
* For the minimum SSB\_RP condition,
	+ The gain difference between fine and rough beams is YdB:
		- For mechanical steering antenna, Y=0
		- For electronic steering antenna, FFS Y
* Do not define separate spherical coverage unless spherical coverage is introduced in RF session.
* FFS: Gmin and Gmax
* Note: If anything above inconsistent with RF requirement is identified, RAN4 to make updates to those aspects accordingly.
 |

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

**Views from companies**

* (Huawei) RAN4 to define $T\_{GNSS\\_margin}$ as 65.536 Tc and 196.608 Tc for fixed and mobile VSAT.
* (Huawei) For FR2-NTN UL timing test, the test requirement for Case 3 is same as that for Case 1.

**Moderator’s WF:**

* For FR2-NTN UL timing test, RAN4 to define $T\_{GNSS\\_margin}$ as 65.536 Tc and 196.608 Tc for Fixed VSAT and Mobile VSAT, respectively.
	+ Note:
		- In R17 TC, 327.68 Tc corresponds to 25m distance error (half of the max GNSS error that was assumed in core requirement definition)
		- 65.536 Tc corresponds to 5m distance error (half of the max GNSS error that was assumed in core requirement definition)
		- 196.608 Tc corresponds to 15m distance error (half of the max GNSS error that was assumed in core requirement definition)
* For FR2-NTN UL timing test, the test requirement for Case 3 is same as that for Case 1.
	+ Note:
		- Case-1: Stationary UE for GSO
		- Case-2: Stationary UE for LEO
		- Case-3: Mobile UE for GSO

**Summary of previous agreements:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Agreement [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 |

**Agreement [RAN4#111]:*** The value for $T\_{GNSS\\_margin}$ for mobile and fixed UEs shall be introduced for uplink timing error requirements for FR2 NTN (Ka band introduced in Rel-18 )
	+ Further discuss the exact values:
		- Option 1: X = [$(T\_{e\\_NTN}-T\_{e})/2$]
		- Other options not precluded
* In the test case of UE transmission timing accuracy for Case-3 (120kHz SCS) (Mobile UE for GSO):
	+ UE mobility is not considered before the testability issue is resolved. And without consideration of UE mobility during test, UE test requirement for Case-3 will be further discussed considering necessary margin.
	+ It’s not precluded to further update test case including test requirements for case -3 if testability issue on UE mobility resolved in future release.
* Only define test case with UL SCS 120kHz and DL SSB SCS 120kHz
 |

# CRs

## RRM core requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | **Affected clauses** | **Status** |
| **R4-2411377** | **CATT** | **CR on Rel-18 NR NTN core requirements** | 4.2.2.12, 4.2C.3, 4.2C.45.1C.3, 5.1C.49.3C.8, 9.3C.9, 9.3C.10 |  |
| **R4-2411614** | **Xiaomi** | **draftCR on L3-RSRP measurement requirements maintenance in above 10 GHz scenario** | 9.2C.7 | Draft CR |
| **R4-2411756** | **CMCC** | **(NR\_NTN\_enh-Core) CR to TS 38.133 specification corrections of for NR NTN enh** | 4.2C.2.2, 4.2C.2.3, 4.2C.2.46.1C.3, 6.1C.3.1, 6.1C.3.29.2C.6.1 |  |
| **R4-2412238** | **Ericsson** | **( NR\_NTN\_enh-Core) Formal CR on interruption time in handover delay for NR SAN FR2-NTN – NR SAN FR2-NTN Handover** | 6.1C.1.3.2 |  |
| **R4-2412239** | **Ericsson** | **( NR\_NTN\_enh-Core) Formal CR on measurements of inter-frequency NR cells with NTN carrier NTN** | 4.2.2.12 |  |
| **R4-2412662** | **Huawei** | **CR on Rx-Tx measurement requirements for NTN** | 9.9C.4 |  |
| **R4-2412663** | **Huawei** | **CR on requirements for satellite switch with re-sync** | 6.1C.3.2 |  |
| **R4-2412862** | **Nokia** | **CR to 38.133 for introducing Measurement Accuracy Requirements for FR2-NTN** | All new 10.1.3C, 10.1.5C |  |
| **R4-2412863** | **Nokia** | **CR to 38.133 on Measurement Procedures Requirements** | 9.2C.2, 9.2C.4 |  |
| **R4-2412864** | **Nokia** | **CR to 38.133 on applicability rules for hard satellite switching** | 6.1C.3 |  |
| **R4-2413047** | **ZTE** | **Modify NR NTN cell re-selection measurement in RRC CONNECTED state** | 8.1C.2.2 |  |
| **R4-2413048** | **ZTE** | **Modify NR NTN cell re-selection measurement in RRC IDLEINACTIVE state** | 4.2C.2.4, 4.2C.2.10, 4.2C.2.11, 4.2C.3, 4.2C.4 |  |
| **R4-2413049** | **ZTE** | **Supplement the NR NTN cell re-selection requirements in RRC IDLE state** | 24.2C.1 |  |
| **R4-2413050** | **ZTE** | **Supplement the NR NTN cell re-selection requirements in RRC INACTIVE state** | 5.1C.1, 5.1C.3, 5.1C.4 |  |
| **R4-2413051** | **ZTE** | **Modify the NR NTN RRC Re-establishment requirements\_R17** | 6.2C.1.1, 6.2C.1.2.1 |  |
| **R4-2413052** | **ZTE** | **Modify the NR NTN RRC Re-establishment requirements\_R18** |  | Not available |
| **R4-2413204** | **Ericsson** | **( NR\_NTN\_enh-Core) Formal CR on measurements of inter-frequency NR cells with NTN carrier** | 4.2.2.12 |  |
| **R4-2413218** | **Ericsson** | **(NR\_NTN\_enh-Core) Formal CR on measurements of inter-frequency NR cells with NTN carrier** |  | Duplication of R4-2413204 |
| **R4-2411685** | **LGE** | **(NR\_NTN\_enh-Core) CR to remove redundant sub-clauses in NTN IDLE/INACTIVE mode** | 4.2C.3, 4.2C.45.1C.3, 5.1C.4 | Duplication of R4-2411377 |

## RRM performance requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | **Affected clauses** | **Status** |
| **R4-2411378** | **CATT** | **CR on Rel-18 NR NTN performance requirements** | All new 10.1.3C, 10.1.8C, 10.1.13C, 10.1.5C, 10.1.10C and 10.1.15CB.2.17, B.2.18 |  |
|  |  |  |  |  |
| **R4-2412410** | **Samsung** | **Correction on test cases for Rel-18 NTN** | A.14.3.1.2, A.14.3.2.3 |  |
| **R4-2412665** | **Huawei** | **CR on measurement accuracy requirements for FR2-NTN** | All new 10.1.3C, 10.1.5C, 10.1.8C, 10.1.10C, 10.1.13C, 10.1.15C |  |
| **R4-2412666** | **Huawei** | **CR on AoA setup for FR2-NTN test** | New A.3.15C |  |
| **R4-2412858** | **Nokia** | **CR to 38.133 on test cases for L3-RSRP Measurement Accuracy in FR2-NTN** | New A.14.6.1.3 |  |
| **R4-2412859** | **Nokia** | **CR to 38.133 on test case for L1-RSRP measurement procedures on FR2-NTN** | New A.14.5.3.5 |  |
| **R4-2412860** | **Nokia** | **CR to 38.133 on correction of parameters test cases for L1-RSRP Measurement Accuracy in FR2-NTN** | A.14.6.4.3 |  |
| **R4-2412861** | **Nokia** | **CR to 38.133 on Derivation of Side conditions for NTN measurement performance on FR2-NTN** | 2B.2.1.7, B.2.17, B.2.18 |  |