**3GPP TSG-RAN WG4 Meeting # 109 R4-23xxxxx**

**Chicago, USA, November 13 - November 17, 2023**

**Agenda item:** 8.26.9

**Source:** Moderator (Qualcomm Incorporated)

**Title:** RRM WF

**Document for:** Approval

# Introduction

*The WF covers the contributions submitted under the following AI*

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

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

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

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

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

**No agreement**

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

**Agreement:**

* UL 60kHz SCS:
	+ 13 Ts for all cases with 120kHz/240kHz SSB
* UL 120kHz SCS:
	+ Case 1 and case 2: 7.5 Ts
		- FFS for the applicable side condition on case 2
	+ Case 3: Higher than 7.5 Ts, FFS for the exact value

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

**Tentative Agreement:**

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

Online discussion:

QC: Encourage companies to check the issue

Samsung: the existing requirement is for TDD, we need to think about for FDD.

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

**Online Agreement:**

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

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

**Online Agreement:**

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

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

**Online Agreement:**

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

**Issue 1-11: Additional enhancements**

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

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

**FFS:**

* For NTN-specific PUSCH DMRS bundling, update the applicability of the timing requirements such that the requirements apply only for the first slot within the TDW.

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

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

**Online Agreement:**

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

**Issue 2-3: RLM**

**Agreement:**

* Lmax = 64 and NRLM = 8; for both Type 1 and Type 2 UEs

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

**Agreement:**

* For type 1 UE
	+ Inter-satellite RRC re-establishment: No RRC re-establishment requirements
* For type 1 UE:
	+ Intra-satellite RRC re-establishment: Define RRC re-establishment requirement, and the requirement is the same as the existing FR1 NTN requirements (6.2C.1). 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
	+ 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
	+ Inter-satellite RRC re-establishment
		- No RRC re-establishment requirements

**Issue 2-5: L3 measurements**

**Agreement:**

* For intra-frequency intra-satellite measurements, a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:
	+ 8 identified cells, and 1 SSB per identified Cell
* For inter-frequency intra-satellite measurements, a UE shall be capable of performing SS-RSRP, SS-RSRQ, SS-SINR measurements for at least:
	+ 4 identified cells, and 1 SSB per identified Cell

**Issue 2-7: Measurement gap**

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

Online Agreement:

* Companies are encouraged to discuss the per FR and per gap pattern capability aspects.

QC: Need to discuss whether to reuse the legacy mandatory gap pattern for FR2 only UE?

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

**Agreement:**

* For type 1 UE, the additional interruption length X: 3\*Trs
* For type 2 UE: Introduce requirements based on the assumption as 22 degree/s for beam steering speed without UE capability
	+ using formula as Angle offset / UE beam steering speed
	+ UE beam steering speed as 22 degree/s

**Agreement:**

* Send an LS to RAN2 to notify that for type 2 UEs, the steering of the antenna beam is close to the maximum configurable value for T304.
* Nokia will lead the LS.

**Issue 2-12: Measurement accuracy**

**No agreement**

**Issue 2-13: UE capability**

**FFS**

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

# Topic #3: Network verified UE location

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

**Agreement:**

* 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].

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

**FFS:**

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

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

**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.

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

**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.

# Topic #4: Idle/Inactive mode mobility enhancements

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

**Online Agreement:**

* 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.

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

**Online Agreement:**

* Define requirements on NTN to TN cell reselection.

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

**Tentative Agreement:**

* For time-based NTN to NTN cell reselection in earth-moving cell, the existing RRC idle/inactive mode requirements (4.2C and 5.1C) referring to ‘t-service’ can be reused.
	+ FFS any necessary modification can be considered for the earth moving scenario. Opiton for consideration:
	+ Option A: remove the following condition:
		- UE shall start measurement of the neigbhor cells indicated by the serving cell before t-Service is reached according to the requirements
		- UE shall be able to detect, measure, and evaluate neighbour cells before the serving cell stops serving the area regardless of whether the distance condition based on serving cell reference location or the legacy Srxlev/Squal condition are met.

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

**FFS:**

* Introduce a margin for beam footprint location, [20] meters.

# Topic #5: Connected mode mobility enhancements

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

**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.

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

**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

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

**FFS:**

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

# Topic #6: Performance requirements

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

**No agreement**

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

**No agreement**

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

**No agreement**

# References

[1] R4-2318182, “Topic summary for [109][226] NR\_NTN\_enh,” 3GPP TSG-RAN WG4 Meeting #109

[2] R4-2321330, “Ad-hoc minutes for [109][226] NR\_NTN\_enh,” 3GPP TSG-RAN WG4 Meeting #109