3GPP TSG-RAN WG4 Meeting # 112 R4-2414037

**Maastricht, NL, Aug 19 – 23, 2024**

**Agenda Item:** 8.25.5

**Source:** CATT

**Title:** The WF on RRM requirements for Rel-19 NR NTN phase3

**Document for:** Approval

# 0 Notes:

In this document,

* **< Agreement >** represents the decisions made by in this meeting
* **< Way forward >** represents the next step in later meetings
	+ “FFS” does not mean RAN4 will make a down-selection for the item. More other options can be proposed.
* **< Tentative Agreement >** will be changed to < Agreement > if no comments are received.

# Topic #1: Work plan

### Sub-topic 1-1 Work plan

#### Issue 1-1-1: Work plan

* The work plan R4-2411355 is treated in [112][310] NR\_NTN\_Ph3\_General\_SAN\_RF.

# Topic #2: Downlink coverage enhancements

### Sub-topic 2-1 SSB periodicity enhancement

#### Issue 2-1-1: RRM impact of SSB periodicity enhancement

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (CATT, Apple, Xiaomi, Samsung, HW, QC):
	+ RAN4 to wait for more progress from RAN1/2 on SSB periodicity extension and other possible system level enhancements to discuss the RRM impacts of DL coverage enhancement.
	+ Proposal 1a (Samsung):
		- If SSB periodicity is extended, almost all RRM requirements should be impacted including idle mode/inactive mode and connected mode such as: cell (re)-selection, L3 measurement/L1 measurement and so on. Need further RAN1 conclusion on whether SSB periodicity is changed.
	+ Proposal 1b (Ericsson): RAN4 to check if RRM requirements could be impacted by scaled measurement time delay due to extension of SSB/SMTC periodicity.
		- RAN4 to check if RRM requirements could be impacted by SSB periodicity extension to a value larger than 20ms during cell search, including the remaining physical channels and signals (e.g., SIB, paging, etc.).

### Sub-topic 2-2 Network energy saving

#### Issue 2-2-1: RRM impact of DTX/DRX

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (Apple):
	+ RAN4 to wait more conclusions from RAN1 to decide whether and how NTN RRM can be impacted by DTX/DRX from NES.
* Proposal 2 (Samsung):
	+ All the measurements related to DL-RS should be impacts in “off” state. RAN4 to discuss and define new RRM requirements to enhance DL coverage. Need further progress from other WGs.
* Proposal 3 (Ericsson):
	+ RAN4 to check if RRM requirements could be impacted by scaled measurement time delay due to extension of DRX periodicity.

### Sub-topic 2-3 Dynamic and flexible power sharing

#### Issue 2-3-1: RRM impact of dynamic and flexible power sharing

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (LG):
	+ After RAN1 concludes the solution for dynamic and flexible power sharing among satellite beams or different satellite beam patterns/size, RAN4 should check whether the outcome from RAN1 is affect RRM requirements.
* Proposal 2 (Xiaomi):
	+ RAN4 to study the RRM impact of satellite beams activation/deactivation scheme after RAN1/2 reaching more concrete conclusions.

### Sub-topic 2-4 Other RRM impacts

#### Issue 2-4-1: Beam switching related issues

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (Ericsson): RAN4 to check if beam steering latency other than 0 may impact RRM requirements.
* Proposal 2 (Ericsson): RAN4 to check if timing offset/error (between beam switching timing and DL/UL framework) may impact RRM requirements.
* Proposal 3 (Ericsson): If applicable, the requirements for quasi-earth\_fixed cell and earth\_ moving cell both shall be studied with respect to the beam hopping scheme.

# Topic #3: Uplink Capacity/Cell Throughput Enhancement

### Sub-topic 3-1 RRM impact for objective#2

#### Issue 3-1-1: RRM impact for uplink Capacity/Cell Throughput Enhancement

**<** **Way Forward >**

* No need for RAN4 to discuss RRM requirement for uplink Capacity/Cell Throughput Enhancement.

# Topic #4: Signaling of the intended service area of a broadcast service (e.g. MBS broadcast) via NR NTN

### Sub-topic 4-1 RRM impact for objective#3

#### Issue 4-1-1: RRM impact for objective#3

**<Agreements>**

* For objective#3, there is no RRM impact.

# Topic #5: Support of regenerative payload

### Sub-topic 5-1 General requirements for regenerative payload

#### Issue 5-1-1: RRM requirements to be defined for regenerative payload

*Online agreement*

**<Agreement>**

       The existing requirements for NR NTN can be a baseline and it can be revisited based on agreements from other groups.

### Sub-topic 5-2 Timing requirements

#### Issue 5-2-1: Timing requirements for regenerative payload

**<Way Forward>**

* The common understanding is that $N\_{TA,adj}^{common}$ is configured by network.
* Further discuss the impact on timing requirements in TS 38.133 for regenerative mode of NTN.

### Sub-topic 5-3 Mobility requirements for regenerative payload

#### Issue 5-3-1: RRM requirements for RRC\_INACTIVE state mobility with regenerative payload

**<Way Forward>**

* Whether to update the specific RRM requirements for inactive state with regenerative payload should wait for RAN2/RAN3 progress.

#### Issue 5-3-2: RRM requirements for RRC Connection Mobility Control with regenerative payload

**<Way Forward> : Further discuss the following proposal**

* Whether to update the specific RRM requirements for RRC re-establishment with regenerative payload should wait for RAN2/RAN3 progress.
* Whether to update the specific RRM requirements for satellite switch and RACH-less handover with regenerative payload should wait for RAN2 progress.
* FFS: RAN4 to clarify requirement of satellite switching without PCI change is not applied for regenerative mode of NTN.

### Sub-topic 5-4 Other requirements for regenerative payload

#### Issue 5-4-1: RRM requirements for network verified UE positioning

**<Way Forward>**

* Proposal 1 (CATT):
	+ RAN4 should define the RRM requirements for network verified UE positioning for regenerative architecture.

#### Issue 5-4-2: Multiple SMTCs mechanism

**<Way Forward>**

* Proposal 1 (ZTE):
	+ RAN4 shall clarify whether the legacy multiple SMTCs mechanism can be used for regenerative payload or not.

# Topic #6: Support of (e)RedCap UEs with NR FR1-NTN

### Sub-topic 6-1 Applicability clarification

#### Issue 6-1-1: The operating band of (e)Redcap UE with FR1-NTN

**<Agreements>**

* For RRM requirements, the operating band of (e)Redcap UE with FR1-NTN bands include all of the following NR-NTN FR1-NTN bands:
	+ n256, n255 and n254 defined in Table 5.2-1 in TS 38.108.
* For RRM requirements, RAN4 shall only study the FDD operation and no TDD discussion in NR NTN scenario.

#### Issue 6-1-2: The bandwidth of (e)Redcap UE with FR1-NTN

**<Way Forward>**

* Both bandwidth with and without reduction of R18 eRedCap UE should be supported for (e)RedCap UE with FR1-NTN bands.
* Note: There is no RRM impact on the two different types of eRedCap UEs (bandwidth with and without reduction).

#### Issue 6-1-3: The satellite types considered for (e)Redcap UE with FR1-NTN

**<Agreements>**

* For RRM requirements, the satellite types considered for (e)Redcap UE with FR1-NTN bands include both GSO and Non-GSO.

#### Issue 6-1-4: The capability considered for (e)Redcap UE with FR1-NTN

**<Agreements>**

* GNSS capabilities and simultaneous GNSS and NR-NTN operation is supported for (e)Redcap UE with FR1-NTN.

#### Issue 6-1-5: The network scenario considered for (e)Redcap UE with FR1-NTN

**<Way Forward>**

* For scenario considered for (e)Redcap UE with FR1-NTN bands, RAN4 only supports NR SA operation mode with single carrier.

#### Issue 6-1-6: The SCS considered for (e)Redcap UE with FR1-NTN

**<Way Forward>**

* For RRM requirements, the SCS considered for (e)Redcap UE with FR1-NTN support 15kHz, 30kHz and 60kHz.

### Sub-topic 6-2 General consideration on RRM requirements

#### Issue 6-2-1: The general principle for defining the RRM requirements for (e)RedCap UE with FR1-NTN

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (CATT, MTK, Xiaomi, Samsung, HW, vivo, ZTE):
	+ A general principle is that to define the RRM requirements for (e)RedCap UE with FR1-NTN bands based on the existing requirements for FR1-NTN.
* Proposal 2 (Ericsson):
	+ RRM requirements for RedCap UE in NTN can be started by taking RedCap UE in TN as baseline.
	+ The requirements and enhancements for NR NTN in Rel-17 and Rel-18 shall be introduced for RedCap UE in NTN.

#### Issue 6-2-2: What RRM requirements are defined for (e)RedCap UE with FR1-NTN

*Online agreement*

**<Agreement>**

* FR2 related requirements shall not be defined for (e)RedCap UE with FR1-NTN bands.
* The requirements defined for both NTN and (e)RedCap UE requirements should be defined for (e)RedCap UE with FR1-NTN bands, including the following:
	+ Cell Re-selection for RRC\_IDLE state mobility
	+ Cell Re-selection for RRC\_INACTIVE state mobility
	+ NR Handover
		- NR FR1 - NR FR1 RACH-based Handover
	+ RRC Connection Mobility Control
		- SA: RRC Re-establishment
		- Random access
		- SA: RRC Connection Release with Redirection
	+ Timing
		- UE transmit timing
		- UE timer accuracy
		- Timing advance
	+ Signalling characteristics
		- Radio Link Monitoring
		- Link Recovery Procedures
		- Active BWP switch delay
		- Active TCI state switching delay
		- UE-specific CBW change
	+ Measurement Procedure
		- General measurement requirement
		- NR intra-frequency measurements
		- NR inter-frequency measurements
		- L1-RSRP measurements for Reporting
* For the requirements that have only been defined for NTN, RAN4 to define the following FR1-NTN requirements for (e)Redcap:
	+ NR SAN Satellite switching with re-synchronization
	+ Pathloss reference signal switching delay
	+ Network verified UE location
* For the requirements that have only been defined for (e)Redcap and not been defined for FR1-NTN, RAN4 NOT to define the following requirements for NTN (e)RedCap in Rel-19:
	+ NR measurements for positioning in RRC\_INACTIVE state
	+ NR Handover to other RATs
		- Note: For NTN (e)RedCap, it refers to, for example, NTN to E-UTRA handover
	+ RRC connection release with redirection to E-UTRAN
	+ deriveSSB-IndexFromCell tolerance
	+ Uplink spatial relation switch delay
	+ Inter-RAT measurements in idle/inactive/connected mode
	+ PRS-RSRPP measurements
	+ NR measurements with autonomous gaps

**<Way Forward>**

* FFS for the following requirements:
	+ Minimization of Drive Tests (MDT) in RRC\_IDLE state and RRC\_INACTIVE state
	+ NR Rel-17/18 Conditional Handover, and RACH-less Handover
		- Note: further check whether they are supported for RedCap NTN in RAN1/2 spec.
		- FFS: Send LS to RAN1/2 to ask the status. RAN4 does not trigger the RAN1/2 discussion to support these features.
	+ Configured Grant based Small Data Transmissions (CG-SDT)
	+ Random access based Small Data Transmissions (RA-SDT)

#### Issue 6-2-3: Features to be considered for (e)RedCap UE with FR1-NTN

**<Way Forward>**

* RAN4 to analyze the RRM requirement impacts from following features for (e)RedCap UE with FR1-NTN case by case:
	+ 1Rx
	+ FFS: NCD-SSB
	+ HD-FDD
	+ FFS: R17 relaxed measurement
	+ FFS: RRC\_IDLE/RRC\_INACTIVE mode eDRX enhancement
	+ FFS: Determine if CSSF and concurrent gap is supported in Redcap NTN
	+ FFS: FH in PRS measurement
	+ Single cell search and measurement engine

### Sub-topic 6-3 Reduction in the number of UE Rx branches

#### Issue 6-3-1: The principle for defining the requirements for 2Rx/1Rx (e)Redcap UE with FR1-NTN

*Online agreement*

**<Agreement>**

* For RRM requirements, the number of Rx considered for (e)Redcap UE with FR1-NTN bands support include both 1Rx and 2Rx.
* RAN4 should define separate sets of RRM requirements for 1Rx and 2 Rx (e)Redcap UE, if needed.
	+ As baseline, follow the same principle for (e)RedCap UE in TN network.
* For 2Rx (e)RedCap UEs with FR1-NTN: Reuse the existing requirements for NTN as a baseline.
* Meanwhile, consider the following difference between 2Rx (e)RedCap and non-RedCap UE:
	+ The number of searchers
	+ Others if any

#### Issue 6-3-2: How to relax the requirements for 1Rx (e)RedCap UEs with FR1-NTN ?

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (vivo, ZTE):
	+ Introduce corresponding RRM requirements for 1 Rx and current requirements for Redcap UE with 1Rx can be the reference.
* Proposal 2 (Xiaomi):
	+ For 1RX RedCap: Relax measurement requirements from the aspects of extending the number of measurement samples or relaxing the measurement accuracy.
* Proposal 3 (ZTE):
	+ RAN4 shall define the Qout requirements for RedCap UEs in FR1-NTN bands. The evaluation period for 2Rx shall be reused and the evaluation period shall be extended for 1Rx by factor 2. Qin shall be reused.
	+ RAN4 shall reuse the 1dB offset as legacy for 1Rx RedCap UE in NR NTN.
* Proposal 4 (QC):
	+ For 1Rx RedCap NTN UE, RAN4 to adopt the same requirement relaxations and modifications as follows:
		- Extended delays for PSS/SSS detection and SSB index identification (PBCH decoding)
		- Handover delay Extension
		- Extended RLM OOS and BFD evaluation periods
		- Aggregation level of 16 for RLM/BFD hypothetical PDCCH parameters
		- Measurement accuracy relaxation for SS-RSRP, SS-RSRQ, SS-SINR, L1-RSRP

### Sub-topic 6-4 HD-FDD

#### Issue 6-4-1: The specific impact of HD-FDD for (e)Redcap UE with FR1-NTN

*Online agreement*

**<Agreement>**

* RAN4 to consider the impact of HD-FDD for (e)Redcap UE with FR1-NTN.
	+ The TN HD-FDD related requirements and applicable conditions defined for (e)RedCap UE can be used as a starting point, and RAN4 take into account NTN specific aspects if any.

### Sub-topic 6-5 eDRX enhancement

#### Issue 6-5-1: How to consider the impact of eDRX enhancement for (e)Redcap UE with FR1-NTN?

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (CATT, CMCC, Samsung):
	+ The eDRX enhancement introduced for (e)RedCap UEs should be considered when defining RRC\_IDLE or/and RRC\_INACTIVE state mobility requirements for (e)RedCap UEs with FR1-NTN bands.
	+ Proposal 1a (CATT): RAN4 need to discuss whether the eDRX enhancement for both Rel-17 RedCap and Rel-18 eRedCap UEs should be introduced for (e)RedCap UEs with FR1-NTN bands.
		- Option 1: Only introduce the eDRX enhancement for Rel-17 RedCap UEs.
		- Option 2: Introduce the eDRX enhancement for both Rel-17 RedCap and Rel-18 eRedCap UEs.
	+ Proposal 1b (CMCC): Support eDRX configuration for Redcap over NTN, and define following applicability rule for each deployment scenario:
		- For GEO deployment, all DRX and eDRX cycle can be supported.
		- For earth-fixed LEO deployment, requirements are applicable for up to 10.24s eDRX cycle
		- For earth-moving LEO deployment, requirements are not applicable for eDRX cycle
	+ Proposal 1c (Samsung):
		- RAN4 to discuss and specify the requirements related to eDRX for GSO and NGSO (LEO) separately. Not all eDRX cycle can be applicable for NGSO (LEO) scenario.
	+ Proposal 1d (QC): For eRedCap UE, RAN4 can consider the following aspect for RRM requirement definition if necessary and applicable for NR NTN support.
		- Enhanced eDRX in RRC INACTIVE
* Proposal 2 (LG):
	+ For NTN RRM requirements for RedCap UE,
		- For IDLE/INACTIVE mode: Preclude eDRX\_IDLE cycle configuration for RedCap NTN

### Sub-topic 6-6 NCD-SSB

#### Issue 6-6-1: The impact of NCD-SSB for (e)RedCap UEs with FR1-NTN

*Online agreement*

**<Agreement>**

* For (e)RedCap UEs with FR1-NTN, there is no need to define NCD-SSB specific measurement requirements.

### Sub-topic 6-7 Bandwidth reduction

#### Issue 6-7-1: The impact of bandwidth reduction for (e)Redcap UE with FR1-NTN

*Online agreement*

**<Agreement>**

* RAN4 will NOT define the following requirements for (e)RedCap UE with FR1-NTN:
	+ BWP specific serving cell MO
	+ RedCap specific initial UL/DL BWP

### Sub-topic 6-8 Specification structure

#### Issue 6-8-1: Specification structure for (e)Redcap UE with FR1-NTN

**<Way Forward> : Further discuss the following proposal**

* Proposal 1 (CATT, CMCC):
	+ Use the following principles to define the RRM requirements for (e)RedCap UEs with FR1-NTN bands:
		- Define them in the new sections of section number with new suffix X in the specification.
		- Utilize the reference method for the requirements that can be reused.
* Proposal 2 (CMCC):
	+ Slightly prefer to introduce the Redcap over NTN requirements in new subsections in TS 38.133 or new subclauses in current NTN section.