3GPP TSG-RAN WG4 Meeting #111 R4-2408948

Fukuoka, Japan, May 20th – 24th, 2024

**Agenda item:** 10.15.4

**Source:** Moderator (Qualcomm)

**Title:** Topic summary for [111][137] NR\_NTN\_Ph3\_UERF

**Document for:** Information

# Introduction

This summary is split into two main topics:

* RedCap UE RF requirements
* other requirements

# Topic #1: RedCap UE RF requirements

*Topic description:* RedCap UE RF requirements

Previous agreements can be found in approved WF R4-2406610

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2407413** | **Sony** | **Observation 1: For the NTN Redcap and eRedcap, the general transmission requirements might be reusable, but further check on the regulatory requirements maybe needed.** **Proposal 1: Further check if any update is needed for NTN Redcap and eRedcap with respect to regulatory requirements with considering the feasibility of Redcap and eRedcap implementations.** **Proposal 2: It is proposed to adopt the same tightening rule as in Rel-17 Redcap to derive the REFSENS for NTN Redcap HD-FDD, which results in 0 dB tightening for n255, and 0.5 dB tightening for n254 and n256 for 5MHz, e.g., REFNSEN = -100 dBm for all three NR bands in NTN with 5MHz BW for 2Rx.****Proposal 3: NTN Redcap HD-FDD REFSENS for channel BW wider than 5 MHz can be calculated by REFSENS(5MHz) + 10log10(n x NRB/25), where NRB is the maximum transmission bandwidth configuration with n=1 for 15kHz SCS, n=2 for 30kHz SCS, and n=4 for 60kHz SCS.****Proposal 4: Reuse the same way as in Rel-18 eRedcap REFSENS (as in 7.3I.3 of 38.101-1) to define the NTN eRedcap REFSENS.** **Proposal 5: RAN4 further checks if other reception requirements from NR NTN can be reused for NTN Redcap and eRedcap.** |
| **R4-2407513** | **CATT** | **Proposal 1: RAN4 may consider the definition of suffixes for NTN RedCap / eRedCap UE shown in Table 4.3-1 as starting point.**Table 4.3-1: Definition of suffixes

|  |  |
| --- | --- |
| Clause suffix | Variant |
| None | Single Carrier |
| A | RedCap |

**Proposal 2: RAN4 may consider supplementing the RedCap requirements for NTN RedCap / eRedCap UE under the Clause 5.3 (Channel bandwidth), Clause 6.2 (Tx power) and Clause 7.3 (REFSENSE) as starting point.** |
| **R4-2407558** | **Apple** | *Moderator: please see R4-2407558 for the various tables referred in proposals***Proposal 1: NR NTN RedCap UE 2Rx FD-FDD REFSENS requirements and UL configuration are specified as in Table 2.1-1 and Table 2.1-2 respectively.****Proposal 2: NR NTN RedCap UE 2Rx HD-FDD REFSENS requirements and UL configuration are specified as in Table 2.1-4 and Table 2.1-5 respectively.****Proposal 3: NR NTN RedCap UE 1Rx FD-FDD and 1Rx HD-FDD REFSENS requirements are specified in Table 2.1-7 and Table 2.1-8 respectively.****Proposal 4: The UL configurations for NR NTN RedCap UE 1Rx FD-FDD and 1Rx HD-FDD REFSENS requirements are specified in Table 2.1-2 and Table 2.1-5 respectively.****Proposal 5: For NR NTN eRedCap UE supporting IE supportOfERedCap-r18 but not supporting IE eRedCapNotReducedBB-BW-r18, the 2Rx FD-FDD REFSENS requirements and UL configuration are specified as in Table 2.2-1 and Table 2.2-2 respectively.****Proposal 6: For NR NTN eRedCap UE supporting IE supportOfERedCap-r18 but not supporting IE eRedCapNotReducedBB-BW-r18, the 2Rx HD-FDD REFSENS requirements and UL configuration are specified as in Table 2.2-3 and Table 2.2-4 respectively.****Proposal 7: For NR NTN eRedCap UE supporting IE supportOfERedCap-r18 but not supporting IE eRedCapNotReducedBB-BW-r18, the 1Rx FD-FDD and 1Rx HD-FDD REFSENS requirements are specified as in Table 2.2-5 and Table 2.2-6 respectively.****Proposal 8: For NR NTN eRedCap UE supporting IE supportOfERedCap-r18 but not supporting IE eRedCapNotReducedBB-BW-r18, the UL configuration for 1Rx FD-FDD and 1Rx HD-FDD REFSENS requirements are the same as specified in Table 2.2-2 and Table 2.2-4 respectively.** |
| **R4-2407757** | **Mediatek India Technology Pvt.** | ***Observation 1: In 38.101-1, two antenna-port reference sensitivity allowance ΔRHD-FDD for HD-FDD RedCap UE can be obtained based on Tables 7.3.2-1a and 7.3I.2-2.******Proposal 1: Regarding 2Rx HD-FDD Refsens for NTN RedCap UE, reuse the two-antenna port reference sensitivity allowance ΔRHD-FDD extracted from TS 38.101-1 as listed in Table 1 below.*** Table 1: 2Rx HD-FDD reference sensitivity allowance ΔRHD-FDD for RedCap UE

|  |
| --- |
| **TN 2Rx HD-FDD reference sensitivity allowance ΔRHD-FDD** |
| **Operating band / SCS / Channel bandwidth** |
| **Operating Band** | **SCS kHz** | **5 MHz** | **10 MHz** | **15 MHz** | **20 MHz** |
| **(dB)** | **(dB)** | **(dB)** | **(dB)** |
| nXX | 15 | -0.8 | -0.8 | -0.8 | -0.7 |
| 30 | 　 | -0.9 | -0.9 | -0.7 |
| 60 | 　 | -0.8 | -0.8 | -0.8 |

***Observation 2: Regarding 1Rx FD-FDD refsens for NTN RedCap UE, the agreement in RAN4#110-bis meeting was to reuse TN (e)RedCap UE 1Rx refsens allowance for NTN (e)RedCap UE as indicated in TS 38.101-1 Table 7.3I.2-1.******Observation 3: In 38.101-1, single antenna port reference sensitivity allowance ΔR1R for HD-FDD is 2.5dB for all RedCap CBW.******Proposal 2: Regarding 1Rx HD-FDD Refsens for NTN RedCap UE,*** ***Option 1: Reuse the single antenna port reference sensitivity allowance ΔR1R in TS 38.101-1 Table 7.3I.2-1 for each FDD band.******Option 2: Reuse the single antenna port reference sensitivity allowance ΔR1R of 2.5dB for all NTN RedCap CBW for each FDD band.******Observation 4: In 38.101-1, two antenna-port reference sensitivity allowance ΔRHD-FDD for HD-FDD RedCap UE obtained according to Tables 7.3.2-1a and 7.3I.2-2 ranges from -0.7dB to -0.9dB. The adoption of HD-FDD shows an improvement in the reference sensitivity compared to full-duplex FDD operation.******Observation 5: By comparing the one antenna-port RF FD-FDD architecture with one antenna-port RF HD-FDD architecture, it seems that the IL improvement occurs in both one antenna-port Rx Refsens and Tx output power.******Proposal 3: As only for 1Tx HD-FDD PC3 of NTN RedCap UE, because of the single-band 1Rx Refsens difference caused by using FD-FDD and HD-FDD, clarify whether it is reasonable to think about the HD-FDD higher Tx output power value than FD-FDD Tx output power value (i.e., 23dBm).*** |
| **R4-2407995** | **China Telecomunication Corp.** | **Proposal 1**: the frequency error of (e)Redcap UE should defined based on capable of frequency pre-compensation with requirement in 6.4.1 of TS38.101-5 as starting point. **Observation 1**: higher power class is desired to improve the link budget in practical.**Observation 2**: higher latency will be beard in case of HD-FDD compared with FD-FDD.  |
| **R4-2408067** | **Nokia Poland** | **Proposal 1: Rel17 TN RedCap REFSENS tightening rules apply for NTN RedCap. This results in 0.5 dB of REFSENS tightening for bands n254, and n256. For band n255, the framework yields 0dB tightening. These tightening values are for 5 MHz channel bandwidth with 2RX.****Proposal 2: For channel bandwidth larger than 5 MHz, 5MHz REFSENS value will be scaled based on the number of PRBs.** |
| **R4-2408128** | **vivo** | **Proposal 1:** The 2Rx REFSENS for FR1-NTN HD-FDD bands are proposed:

| Operating Band | SCS kHz | 5MHz(dBm) | 10MHz(dBm) | 15MHz(dBm) | 20MHz(dBm) |
| --- | --- | --- | --- | --- | --- |
|  | 15 | -100.0 | -96.8 | -95.0 | -94.3 |
| n256 | 30 |  | -97.1 | -95.1 | -94.5 |
|  | 60 |  | -97.5 | -95.4 | -94.7 |
|  | 15 | -100.0 | -96.8 | -95.0 | -93.8 |
| n255 | 30 |  | -97.1 | -95.1 | -94.0 |
|  | 60 |  | -97.5 | -95.4 | -94.2 |
|  | 15 | -100.0 | -96.8 | -95.0 |  |
| n254 | 30 |  | -97.1 | -95.1 |  |
|  | 60 |  | -97.5 | -95.4 |  |

**Proposal 2:** The 1Rx REFSENS for FR1-NTN HD-FDD bands are proposed:

| Operating Band | SCS kHz | 5MHz(dBm) | 10MHz(dBm) | 15MHz(dBm) | 20MHz(dBm) |
| --- | --- | --- | --- | --- | --- |
|  | 15 | -97.5 | -94.3 | -92.5 | -91.8 |
| n256 | 30 |  | -94.6 | -92.6 | -92.0 |
|  | 60 |  | -95.0 | -92.9 | -92.2 |
|  | 15 | --97.5 | -94.3 | -92.5 | -91.3 |
| n255 | 30 |  | -94.6 | -92.6 | -91.5 |
|  | 60 |  | -95.0 | -92.9 | -91.7 |
|  | 15 | -97.5 | -94.3 | -92.5 |  |
| n254 | 30 |  | -94.6 | -92.6 |  |
|  | 60 |  | -95.0 | -92.9 |  |

**Proposal 3:** For the Uplink configuration for reference sensitivity for HD-FDD, it is suggested reuse the configuration for FD-FDD. |
| **R4-2408617** | **Spreadtrum Communications** | **Proposal 1: For NTN HD-FDD Redcap UE:*** **For 2RX HD-FDD REFSENS:**
* **n256: Existing n256 2RX RESENS+0.5 dB**
* **n255: Existing n255 2RX RESENS+0 dB**
* **n254: Existing n254 2RX RESENS+0 dB**

**Proposal 2: For NTN eRedcap UE, we can wait until NTN Redcap’s conclusion about requirements.** |
| **R4-2408799** | **ZTE Corporation, Sanechips** | ***Proposal 1: It is better to wait for RAN1 outcome before defining RF requirements for NTN RedCap with HD-FDD.******Proposal 2: After feasibility assessment from RAN1, if there is no RAN4 impact, we can use the tightening value in Table 2.2 as starting point.******Proposal 3: It is necessary to define frequency error requirement for (e)RedCap UEs with NR NTN operating in FR1-NTN bands.*** |
| **R4-2408816** | **Qualcomm Inc.** | **draftCR to introduce RedCap and eRedCap into 38.101-1** |
| **R4-2409046** | **Samsung** | **Proposal 1: Proposed to reuse the tightening rule which is 0dB for n255, 0.5 dBfor n254 and n256 for 5MHz, for 2Rx HD-FDD NTN (e)RedCap UE.** **(New) Table 7.3I.x-y: HD-FDD RedCap UE with 2 Rx antenna port reference sensitivity**

| Operating band / SCS / Channel bandwidth |
| --- |
| Operating Band | SCS kHz | 5MHz(dBm) | 10MHz(dBm) | 15MHz(dBm) | 20MHz(dBm) |  |  |  |  |  |  |
|  | 15 | -100 | -96.8 | -95 | -94.3 |  |  |  |  |  |  |
| n256 | 30 |  | -97.1 | -95.1 | -94.5 |  |  |  |  |  |  |
|  | 60 |  | -97.5 | -95.4 | -94.7 |  |  |  |  |  |  |
|  | 15 | -100.0 | -96.8 | -95.0 | -93.8 |  |  |  |  |  |  |
| n255 | 30 |  | -97.1 | -95.1 | -94.0 |  |  |  |  |  |  |
|  | 60 |  | -97.5 | -95.4 | -94.2 |  |  |  |  |  |  |
|  | 15 | -100 | -96.8 | -95 |  |  |  |  |  |  |  |
| n254 | 30 |  | -97.1 | -95.1 |  |  |  |  |  |  |  |
|  | 60 |  | -97.5 | -95.4 |  |  |  |  |  |  |  |
| NOTE：The transmitter shall be set to PUMAX as defined in clause 6.2.4 of 3GPP TS 38.101-1 [5]. |

**Observation 1**: By applying the agreed refsens allowance ΔR1R to the 2Rx refsens table above, the 1Rx HD-FDD REFSENS can be calculated in the table below.**(New) Table 7.3I.x-z: HD-FDD RedCap UE with 1 Rx antenna port reference sensitivity**

| Operating band / SCS / Channel bandwidth |
| --- |
| Operating Band | SCS kHz | 5MHz(dBm) | 10MHz(dBm) | 15MHz(dBm) | 20MHz(dBm) |  |  |  |  |  |  |
|  | 15 | -97.5 | -94.3 | -92.5 | -91.8 |  |  |  |  |  |  |
| n256 | 30 |  | -94.6 | -92.6 | -92 |  |  |  |  |  |  |
|  | 60 |  | -95 | -92.9 | -92.2 |  |  |  |  |  |  |
|  | 15 | -97.5 | -94.3 | -92.5 | -91.3 |  |  |  |  |  |  |
| n255 | 30 |  | -94.6 | -92.6 | -91.5 |  |  |  |  |  |  |
|  | 60 |  | -95 | -92.9 | -91.7 |  |  |  |  |  |  |
|  | 15 | -97.5 | -94.3 | -92.5 |  |  |  |  |  |  |  |
| n254 | 30 |  | -94.6 | -92.6 |  |  |  |  |  |  |  |
|  | 60 |  | -95 | -92.9 |  |  |  |  |  |  |  |
| NOTE：The transmitter shall be set to PUMAX as defined in clause 6.2.4 of 3GPP TS 38.101-1 [5]. |

**Observation 2:** The (e)RedCap UEs can fit into the existing regulatory framework/survey that had been done for FR1-NTN normal UEs as summarized in TR 38.863 or Rel-17. There should be no additional burden to simply adopt (e)RedCap UEs into FR1-NTN. We can continue check this and see if there’s any other inputs. |
| **R4-2409108** | **Ericsson** | Proposal-1: Consider the at least 0.5 dB tightening for the HD-FDD NTN band in general. |
| **R4-2409336** | **Huawei, HiSilicon** | **Observation 1: GNSS capabilities are assumed for NTN RedCap UE, which TN RedCap UE don’t have.****Observation 2: some of GNSS services operating in the frequency range 1559~1610MHz can’t be simultaneously supported together with NR NTN operation in band n254 and n255.****Observation 3: Based on the current NTN system design, NTN UE not only pre-compensate the doppler frequency shift generated by SAN (due to SAN relative motion), but also pre-compensate the doppler frequency shift generated by NTN UE (due to NTN UE relative motion). However, in current terrestrial network system, the doppler shift generated by UE will not be pre-compensated.****Proposal 1: RAN4 can further discuss the relaxation of frequency error requirements for both NTN RedCap/eRedCap UE and normal NTN UE.****Observation 4: As there is no discussion on NTN UE (including NTN RedCap/eRedCap UE) RF requirements under the non-zero doppler shift condition, there is a risk for NTN UE to declare the supports of LEO scenario due to the Edge RB falling into Guard band.** |

## Open issues summary

*Open issues and candidate options before meeting:*

There are multiple proposals for refsens so the background on refsens is summarized here.

Note that there is a also a TEI proposal for flexible Tx-Rx spacing for NR NTN in R4-2409572, which may have impact to RedCap.

Previous agreements from R4-2406610:

**Agreement**: Re-use non-RedCap NTN UE refsens for 2Rx FD-FDD NTN (e)RedCap UE

**Agreement**: Re-use TN (e)RedCap UE 1 Rx refsens allowance for NTN (e)RedCap UE as follows

|  |  |  |
| --- | --- | --- |
| Operating band | Channel bandwidth (MHz) | ΔR1R (dB) |
| FDD band  | 5  | 2.5 |
| FDD band  | 10, 15, 20 | 3.0 |

### Given that 2Rx FD-FDD refsens and 1Rx FD-FDD Refsens is already agreed, the discussion is focused on HD-FDD and eRedCap.

### Issue 1-1: UL RB allocation for HD-FDD Refsens, both for 1Rx and 2Rx

In principle UL RB allocation size does not matter for HD-FDD as the UL transmission is not taking during reception. In 38.101-1 full allocation is used

* Proposals
	+ Option 1: Full allocation
	+ Option 2: Same as FD-FDD allocation
* Recommended WF
	+ Full allocation

### Issue 1-2: HD-FDD refsens for 2 Rx

* Proposals
	+ Option 1: 0.5 dB relaxation for n256 (Spreadtrum)
	+ Option 2: 0.5 dB tightening for n254 and n256 (Qualcomm, Samsung, Apple, Sony, Vivo, Nokia. ZTE)
	+ Option 3: At least 0.5 dB tightening in general (Ericsson)
	+ Option 4: Tightening as in table below: (Mediatek)

|  |
| --- |
| **TN 2Rx HD-FDD reference sensitivity allowance ΔRHD-FDD** |
| **Operating band / SCS / Channel bandwidth** |
| **Operating Band** | **SCS kHz** | **5 MHz** | **10 MHz** | **15 MHz** | **20 MHz** |
| **(dB)** | **(dB)** | **(dB)** | **(dB)** |
| nXX | 15 | -0.8 | -0.8 | -0.8 | -0.7 |
| 30 | 　 | -0.9 | -0.9 | -0.7 |
| 60 | 　 | -0.8 | -0.8 | -0.8 |

* Recommended WF
	+ Option 2

### Issue 1-3: HD-FDD refsens for 1 Rx

* Proposals
	+ Option 1: 2.5 dB relaxation compared to 2Rx HD-FDD (Samsung, Qualcomm, Apple, Mediatek)
	+ Option 2: 3 dB relaxation for 5 MHz CBW, 2.5 dB relaxation for 10 to 20 MHz CBW, compared to 2Rx HD-FDD refsens (Mediatek)
* Recommended WF
	+ Option 1

### Issue 1-4: Frequency error

* Proposals
	+ Option 1: RAN4 can further discuss the relaxation of frequency error requirements for both NTN RedCap/eRedCap UE and normal NTN UE (Huawei)
		- Observation 1: GNSS capabilities are assumed for NTN RedCap UE, which TN RedCap UE don’t have.
		- Observation 2: some of GNSS services operating in the frequency range 1559~1610MHz can’t be simultaneously supported together with NR NTN operation in band n254 and n255.
		- Observation 3: Based on the current NTN system design, NTN UE not only pre-compensate the doppler frequency shift generated by SAN (due to SAN relative motion), but also pre-compensate the doppler frequency shift generated by NTN UE (due to NTN UE relative motion). However, in current terrestrial network system, the doppler shift generated by UE will not be pre-compensated.
	+ Option 2: The frequency error of (e)Redcap UE should defined based on capable of frequency pre-compensation with requirement in 6.4.1 of TS38.101-5 as starting point. (China telecommunication corp., ZTE)
* Recommended WF
	+ Option 1

### Issue 1-5: Output power

Moderator suggests proponent can elaborate on this proposal during online discussion considering that PC3 was agreed as target in previous meeting, TN RedCap only supports PC3 and new baskets are being discussed in June plenary where RedCap PC2 is one possible area.

* Proposals
	+ Option 1: As only for 1Tx HD-FDD PC3 of NTN RedCap UE, because of the single-band 1Rx Refsens difference caused by using FD-FDD and HD-FDD, clarify whether it is reasonable to think about the HD-FDD higher Tx output power value than FD-FDD Tx output power value (i.e., 23dBm). (Mediatek)
	+ Option 2:
* Recommended WF
	+ TBD

### Issue 1-6: Specification structure, baseline changes and timeline for specification updates

There were number of proposals in this area, at least

Sony: Reuse the same way as in Rel-18 eRedcap REFSENS (as in 7.3I.3 of 38.101-1) to define the NTN eRedcap REFSENS.

CATT: RAN4 may consider the definition of suffixes for NTN RedCap / eRedCap UE shown in Table 4.3-1 as starting point.

Table 4.3-1: Definition of suffixes

|  |  |
| --- | --- |
| Clause suffix | Variant |
| None | Single Carrier |
| A | RedCap |

CATT:RAN4 may consider supplementing the RedCap requirements for NTN RedCap / eRedCap UE under the Clause 5.3 (Channel bandwidth), Clause 6.2 (Tx power) and Clause 7.3 (REFSENSE) as starting point.

Samsung: The (e)RedCap UEs can fit into the existing regulatory framework/survey that had been done for FR1-NTN normal UEs as summarized in TR 38.863 or Rel-17. There should be no additional burden to simply adopt (e)RedCap UEs into FR1-NTN. We can continue check this and see if there’s any other inputs.

Spreadtrum: For NTN eRedcap UE, we can wait until NTN Redcap’s conclusion about requirements.

ZTE: It is better to wait for RAN1 outcome before defining RF requirements for NTN RedCap with HD-FDD.

**Instead of discussing each of the proposals individually, moderator suggest to directly discuss draftCR in R4-2408816,** as it seems this draft CR has already implemented most of the proposals. At the same time, it needs to be recognized that Rel-19 spec is only expected at December 2024, and some feasibility assessment is still on-going in RAN1.

* Proposals
	+ Option 1: R4-2408816 needs further revision, (note: also depends on earlier issues)
	+ Option 2: R4-2408816 is considered as baseline for specification structure, recognizing that further changes may be needed pending e.g. on the outcome of HD-FDD feasibility study and TEI discussion on flexible Tx-Rx spacing
* Recommended WF
	+ TBD

# Topic #2: Other requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2409105 | Ericsson | Proposal-1: RAN4 discuss if the 38.307 should be updated for RedCap NTN as release independent feature (operating band). |
| R4-2409106 | Ericsson | Observation 1 UE RF may be impacted due to the beam switching time uncertainty and switching delay.Proposal-1: Wait RAN1 reach conclusions on OCC feature before RAN4 start to evaluate the RF impact |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Issue 2-1: Release independence for NTN RedCap

* Proposals
	+ Option 1: RAN4 discuss if the 38.307 should be updated for RedCap NTN as release independent feature (operating band).
* Recommended WF
	+ TBD

### Issue 2-2: UL enhancements

* Proposals
	+ Option 1: Wait RAN1 reach conclusions on OCC feature before RAN4 start to evaluate the RF impact
* Recommended WF
	+ TBD